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Editorial: e-KJER December 2024 Issue

Ali İbrahim Can GÖZÜM[1]

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Dear readers and researchers,

We are proud and honored to present to you the fourth issue of the eleventh volume of the e-Kafkas Journal of Educational Research (e-KJER), the result of the devoted and disciplined work of the new editorial board with international and national participation, field editors, reviewers, and the journal team in December 2024. e-KJER is proud to share that it has been accepted by new indexes such as EBSCO and H.W. Wilson Databases, indicating that the journal is on its way to becoming one of the significant journals in Educational Sciences. The journal is also under scrutiny of other important indexes such as Scopus. This issue contains 17 articles, each offering a unique perspective on current educational research topics. Our contributors have explored the complexities of education and presented innovative ideas and research findings that are sure to provoke discussion and debate.

Table 1.
Research topic and key findings

Authors (Year)	Research Topic (Article Title)	Key Findings
Kavak & Deretarla Gül (2024)	Impact of STEM Education on Preschool Children's Scientific Process Skills	The experimental group was significantly more successful in scientific process skills compared to the control group.
Bezen (2024)	Comparative Evaluation of Socioscientific Issues in Secondary Physics Curriculum and Textbooks	Socio-scientific topics are included to a limited extent, and it is recommended that the curriculum be enriched with SSI goals in 2024.
Kadirhan, Şat & Alkış (2024)	Exploring Faculty Members' Experiences with Virtual Classroom Platforms and Their Perceived Usability during the COVID-19	Zoom was the most preferred platform; factors such as experience, gender, and age affected platform preferences.
Topal (2024)	A Critical Evaluation of CALL and MALL Products for Learning and Teaching American English	Students showed improvement in grammar, pronunciation, and listening skills, but there were issues with assessment and feedback.
Girit Yıldız & Acat (2024)	The Effect of Quantum Learning Model on Attitude, Anxiety, and Achievement of Middle School Students Towards Mathematics	QLM increased students' academic success and reduced anxiety; their attitudes towards mathematics also changed positively.

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Table 1. continuing

Ocak, Kuzu & Karakuyu (2024)	Developing High School Prep Class Students' Verbal Skills by Using Web 2.0 Application	Web 2.0 applications and interactive activities increased speaking motivation.
Irmak & Yılmaz Ergül (2024)	Analyzing Instructional Strategies in Science Education: A Dual Approach Combining Systematic Review and Secondary Qualitative Data Analysis	Teachers were cautious about methods like STEM and project-based learning, showing difficulty in adopting these strategies.
Şen & Gümüş (2024)	Observing Primary School Pre-service Teachers' Oral Argumentation in Science Writing Heuristic Implementation	Use of the scientific writing strategy (SWH) improved argumentation skills.
Güner Demir, Taşkın, Mızıkacı & Ergüven (2024)	Public Opinion about European Researchers' Night on Climate Change and Polar Science in Türkiye	The events increased public interest in scientific research and encouraged young people to pursue scientific careers.
Bastaban & Kurnaz (2024)	Art Education Experiences in Unified Classrooms: A Phenomenological Study	Positive effects of arts education were observed in multi-grade classrooms, encouraging collaboration and social development.
Uslu Gülşen (2024)	The Effect of Sense of School Belonging on Academic Achievement: A Meta-Analytic Review	School belonging had a small but significant effect on academic success.
Uğraş, Doğan & Uğraş (2024)	Adaptation of Artificial Intelligence Literacy Scale into Turkish: A Sample of Pre-Service Teachers	The adapted scale was found to be valid and reliable, and it is an effective tool for evaluating pre-service teachers' AI literacy.
Akbabaoğlu & Uyanık Aktulun (2024)	The Effect of A Number Sense Education Program Supported By Web 2.0 Tools on The Number Sense Development of First Grade Elementary School Students	The experimental group made significant progress in numerical emotion development.
Pedük, Dağ & Akşin Yavuz (2024)	Teachers' Views On Preschool Guidance Services	Teachers evaluated guidance activities through informal observations and emphasized the importance of family involvement.
Akyıl & İme (2024)	The Mediating Role of Mental Well-Being Between Psychological Resilience, Life Satisfaction and Emotional Intelligence	Mental well-being mediated the relationship between emotional intelligence and life satisfaction.
Vural & Önel (2024)	The Effect of Intelligence Games on 6th and 7th Grade Students' Critical Thinking Skills, and Student Opinions on Their Science Course Achievement	Puzzle games enhanced students' cognitive abilities and contributed to their science performance.
Oğur & Olçay (2024)	The Awareness of Special Education Teachers about Comprehensive Sex Education	Teachers only presented sex education from a biological perspective and emphasized the need for more comprehensive training.

The articles presented in this issue cover a variety of critical topics. These are:

- Kavak & Deretarla Gül (2024): This study explored the effect of STEM activities on the scientific process skills of children aged 60-72 months. The findings revealed that children in the experimental group significantly outperformed those in the control groups in developing these skills. This suggests that STEM activities are effective in enhancing basic scientific process skills in early childhood.

- Bezen (2024): This study evaluated the integration of socioscientific issues (SSI) in Turkey's 2018 secondary physics curriculum and corresponding textbooks for grades 9-12. The findings revealed that only 14 of the 213 curriculum objectives included SSI content, with the most content found in grades 9 and 12, and discrepancies in SSI representation between the curriculum and textbooks were identified. The study suggests enhancing the 2024 updated curriculum with more SSI-focused objectives and enriching physics textbooks with relevant examples and activities to better address the social, environmental, and ethical dimensions of scientific knowledge.
- Kadirhan, Şat & Alkış (2024): This study explored faculty experiences with Virtual Communication Platforms (VCPs) during the COVID-19 epidemic, focusing on usability and preferences. Quantitative findings highlighted Zoom as the most favored platform, alongside Google Meet and Adobe Connect, while Perculus and Microsoft Teams scored poorly, with perceptions influenced by factors such as gender, age, and experience. Qualitative findings revealed usability challenges, positive aspects, and improvement suggestions, providing actionable insights for institutions to enhance VCP adoption, training, and distance education effectiveness.
- Topal (2024): This study examined the impact of CALL and MALL tools (three websites, one mobile app, and one corpus) on teaching and learning American English, focusing on their technical and pedagogical features. The analysis highlighted benefits for learners and teachers in areas like grammar, pronunciation, vocabulary, listening, and cultural and pragmatic awareness, while noting shortcomings such as limited assessment and feedback features. The study contributes to the literature by addressing gaps and offering recommendations for future research and development of language learning technologies.
- Yıldız & Acat (2024): This study examined the Quantum Learning Model (QLM) and its effects on academic achievement, attitudes toward mathematics, and anxiety levels in seventh-grade students. The results showed that QLM significantly improved students' academic performance, stabilized their anxiety levels, and maintained positive attitudes toward mathematics, contrasting with the control group, which experienced a decline in attitudes and a significant increase in anxiety. Students and teachers highlighted the benefits of QLM strategies like note-taking, mind maps, and celebration activities, emphasizing their role in fostering a supportive and effective learning environment.
- Ocak, Kuzu & Karakuyu (2024): This study explored the reasons behind high school students' reluctance to speak English during distance education and sought solutions to address these challenges. Findings revealed that students experienced embarrassment and speaking anxiety, leading to reduced participation in class activities. Incorporating Web 2.0 applications, dialogues, reading-listening exercises, games, and movies into lessons was found to increase students' willingness to speak and improve their motivation.
- Irmak & Yılmaz Ergül (2024): This study combined a systematic review and secondary qualitative data analysis to examine the instructional strategies and rationales used by pre-service and in-service science teachers (PaIST) in teaching physics. The findings revealed a variety of strategies, including direct instruction, hands-on activities, and real-life narratives, with rationales focused on enhancing motivation, cognitive development, collaboration, and meaningful learning. Despite the proven effectiveness of methods like STEM education and project-based learning, PaIST showed hesitancy in adopting these approaches, indicating a need for further research on the barriers affecting their instructional choices.
- Şen & Gümüş (2024): This study explored primary school pre-service teachers' (PST) oral argumentation during the implementation of a science writing heuristic (SWH) over six weeks. Observations using the Assessment of Scientific Argumentation in Class (ASAC) protocol revealed that PSTs' oral argumentation skills improved over time, with higher scores in cognitive and epistemic aspects compared to social aspects. The findings suggest that the use of SWH and ASAC can enhance PSTs' argumentation skills, with implications for teaching and learning in science education.
- Güner Demir, Taşkın, Mızıkacı, Ergüven (2024): This study examined participant feedback from the European Researchers' Night events in Istanbul and Gaziantep in 2022, which focused on

climate change and polar science. The findings highlight the success of these events in promoting public awareness of scientific research, encouraging youth interest in science careers, and demonstrating the value of public outreach in research.

- Bastaban & Kurnaz (2024): This study explored the experiences of unified classroom teachers in teaching the Visual Arts course and examined the impact of unified classrooms on art education. Using a phenomenological design, the research revealed that, contrary to prior literature which often highlights the challenges of unified classrooms, art education in these settings had positive effects. Teachers observed that the process fostered collaboration, social development, and cognitive growth, showing that art can play a significant role in building individual and life skills for students in unified classrooms.
- Uslu Gülşen (2024): This meta-analysis aimed to clarify the concept of "a sense of school belonging" and examine its impact on academic achievement. The analysis of 22 studies revealed a small but statistically significant effect of a sense of school belonging on academic achievement, with the effect diminishing over time as publication years increased. Additionally, the study found no significant differences between measurement tools, suggesting that researchers can use various tools to measure this relationship without concerns about bias or reliability.
- Uğraş, Doğan & Uğraş (2024): This study adapted the Al-LS scale, originally translated by Wang et al. (2022), into Turkish to assess the AI-L of pre-service teachers. Using a sample of 440 pre-service teachers, the adaptation process included translation studies, Exploratory Factor Analysis (EFA), and Confirmatory Factor Analysis (CFA), confirming that the Turkish version maintains the original scale's structure and fits well. The scale demonstrated both validity and reliability, with Cronbach's Alpha coefficients indicating a strong and dependable measure for evaluating AI-L in pre-service teachers.
- Akbabaoğlu & Uyanık Aktulun (2024): This study evaluated the effectiveness of a Number Sense Education Program, enhanced by Web 2.0 Tools, on first-grade students' number sense development. The experimental group showed significant improvements in various NSS subdimensions, including Number Recognition, Number Comparisons, and Nonverbal Calculation, with no significant change in Counting Skills. The findings highlight the positive impact of Web 2.0 Tools on number sense development, as the experimental group outperformed the control group in post-test scores across all measured areas.
- Pedük, Dağ & Akşin Yavuz (2024): This study investigated preschool teachers' perspectives on guidance and counseling activities within the classroom, focusing on their interactions with parents, the challenges they face, and their coping strategies. The findings revealed that teachers primarily used informal observation to assess guidance practices and mostly focused on activities aimed at self-acceptance and interpersonal relationships, while family and society-related competencies were not addressed. Additionally, teachers incorporated play and language activities, with family involvement being a key aspect in their work with parents.
- Akyıl & İme (2024): This study explored the mediating role of mental well-being in the relationship between emotional intelligence, life satisfaction, and psychological resilience among university students. The findings showed that mental well-being fully mediated the link between emotional intelligence and life satisfaction, and partially mediated the relationship between emotional intelligence and psychological resilience. The results suggest that higher mental well-being leads to greater life satisfaction and resilience, regardless of emotional intelligence, highlighting the importance of supporting mental health for improving these outcomes.
- Vural & Önel (2024): This study assessed the critical thinking abilities of sixth and seventh grade students who participated in an intelligence games course and their perceptions of its impact on their science performance. The findings indicated a slight improvement in critical thinking skills from pre-test to post-test, although no significant correlation was found between students' critical thinking abilities and their parents' education levels. Students reported that intelligence games were beneficial for their science courses and helped enhance their cognitive abilities, such as attention and memory.
- Oğur & Olçay (2024): This study examined the knowledge and professional development needs of teachers providing sex education to individuals with autism spectrum disorder (ASD).

Conducted with 200 teachers, it found that only 10% taught sex education to students with ASD, focusing mainly on biological aspects while neglecting topics like relationships, rights, and well-being. The study highlights the need for better teacher training in comprehensive sex education for individuals with ASD.

References

Akbabaoğlu, Z. & Uyanık Aktulun, Ö. (2024). The effect of a number sense education program supported by web 2.0 tools on the number sense development of first grade elementary school students. *e-Kafkas Journal of Educational Research, 11,* 702-722. doi:10.30900/kafkasegt. 1443274

Akyıl, Y., & İme, Y. (2024). The Mediating Role of Mental Well-Being Between Psychological Resilience, Life Satisfaction and Emotional Intelligence. *e-Kafkas Journal of Educational Research, 11,* 742-752. doi:10.30900/kafkasegt. 1433531

Bastaban, Ü. & Kurnaz, E. (2024). Art education experiences in unified classrooms: A phenomenological study. *e-Kafkas Journal of Educational Research, 11,* 655-672. doi:10.30900/kafkasegt. 1443274

Bezen, S. (2024). Comparative evaluation of socioscientific issues in secondary physics curriculum and textbooks. *e-Kafkas Journal of Educational Research, 11,* 510-523. doi:10.30900/kafkasegt.1469478

Bulut Peduk S., Dag, B. & Aksin Yavuz, E. (2024). Preschool teachers' opinions on guidance services. *e-Kafkas Journal of Educational Research, 11,* 723-741. doi:10.30900/kafkasegt. 1447457

Girit-Yildiz, D. & Acat, M. B. (2024). The effect of quantum learning model on attitude, anxiety, and achievement of middle school students towards mathematics. *e-Kafkas Journal of Educational Research, 11,* 561-581. doi:10.30900/kafkasegt.1523483

Güner Demir, T., Taşkın, P., Mızıkacı, F. & Ergüven, N. S. (2024). Public opinion about european researchers' night on climate change and polar science in Türkiye. *e-Kafkas Journal of Educational Research, 11,* 635-654. doi:10.30900/kafkasegt.1470131

Irmak, Ş., & Yılmaz Ergül, D. (2024). Instructional strategies in science education: A dual approach combining systematic review and secondary qualitative data analysis. *e-Kafkas Journal of Educational Research, 11,* 597-616. doi:10.30900/kafkasegt.1503657

Kadirhan, Z., Sat, M., & Alkis., Y (2024). Exploring Faculty Members' Experiences with Virtual Classroom Platforms and Their Perceived Usability during the COVID-19. *e-Kafkas Journal of Educational Research, 11,* 524-542. doi:10.30900/kafkasegt.1483268

Kavak, Ş., & Deretarla Gül, E., (2024). Impact of STEM education on preschool children's scientific process skills. e-*Kafkas Journal of Educational Research, 11,* 491-509. doi:10.30900/kafkasegt.1489648

Ocak, G., Kuzu, H. A. & Karakuyu, A. (2024). Developing High School Prep Class Students' Verbal Skils by Using Web 2.0 Application. *e-Kafkas Journal of Educational Research, 11,* 582-596. doi: 10.30900/kafkasegt.1389295

Oğur, Ç. & Olçay, S. (2024). The awareness of special education teachers about comprehensive sex education. *e-Kafkas Journal of Educational Research, 11,* 767-788. doi: 10.30900/kafkasegt.1543452

Şen, M. & Gümüş, B. (2024). Observing primary school pre-service teachers' oral argumentation in science writing heuristic implementation. *e-Kafkas Journal of Educational Research, 11,* 617-634. doi:10.30900/kafkasegt.1536299

Topal, İ. H.. (2024). A critical evaluation of CALL and MALL products for learning and teaching American English. *e-Kafkas Journal of Educational Research, 11,* 543-560. doi: 10.30900/kafkasegt.1400193

Uğraş, H., Doğan, M., & Uğraş, M. (2024). Adaptation of artificial intelligence literacy scale into turkish: A sample of pre-service teachers. *e-Kafkas Journal of Educational Research,* 11, 688-701. doi:10.30900/kafkasegt. 1429630

Uslu Gülşen, F. (2024). The effect of a sense of school belonging on academic achievement: A metaanalytical review. *e-Kafkas Journal of Educational Research, 11,* 673-687. doi:10.30900/kafkasegt. 1359812

Vural, A. & Önel, A. (2024). The effect of intelligence games on 6th and 7th grade students' critical thinking skills, and student opinions on their science course achievement. *e-Kafkas Journal of Educational Research, 11,* 753-766. doi:10.30900/kafkasegt. 1328591

e-Kafkas Journal of Educational Research e-KJER Research Article

Impact of STEM Education on Preschool Children's Scientific Process Skills[1]

Şule Kavak[2] Ebru Deretarla Gül[3]

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Abstract

This study was conducted to reveal the effect on scientific process skills of STEM activities. The study group consisted of 57 children, one experimental group, and two control groups. In this study, a semi-experimental research method was used. In the data collection process, three data tools were used to collect data. One of these is the "Demographic Information Form" containing personal information of the children and their parents. The other is the "Scientific Process Skills Test" developed by the researcher to evaluate the basic scientific process skills of children aged 60-72 months. The "Goodenough Harris" test developed by Florence Goodenough was used to ensure developmental equality among the children participating in the study. In the analysis of the experimental process of this study, a 3x3 mixed design ANOVA method was used. To show the significant difference between the groups, parametric and nonparametric tests were used depending on whether they showed normal distribution or not. The study findings showed that the scientific process skills of the children who participated in the experimental group differed significantly from those of the children in the control groups. The findings obtained in this study suggest that STEM activities improve the basic scientific process skills of 60-72-month-old children.

Keywords: Early STEM, children, 21st century, thinking skills, science.

[1] This study was produced from the doctoral thesis of Dr. Şule Kavak, under the supervision of Prof. Dr. Ebru Deretarla Gül, in the Department of Pre-School Education at Çukurova University, Institute of Educational Sciences and it was also supported by Çukurova University the Scientific Research Project Unit, with the scientific research project number SDK-2018-10900.

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Introduction

Preschool education is the foundational step in a child's academic journey, where they begin to develop essential skills for future learning (Duncane & Murnane, 2016). During this stage, children are naturally curious and eager to explore the world around them, making it an ideal time to introduce scientific concepts (Heckman, 2011; Eshach & Fried, 2005). Neurological development and curiosity peak during these years, presenting a prime opportunity to engage children in scientific exploration (Shonkoff & Marshall, 2000). Early exposure to science, technology, engineering, and mathematics plays a crucial role in nurturing this curiosity (Tippett & Milford, 2017). STEM education is an interdisciplinary approach that integrates science, technology, engineering, and mathematics teaching. STEM education aims to develop children's critical thinking, creativity, and collaboration skills by providing them with real-life problem-solving opportunities. STEM education also supports children's scientific process skills and design-oriented thinking by developing engineering skills (Bybee, 2010). A holistic view of these disciplines not only improves academic skills, but also prepares individuals for the challenges of the 21st century and supports their innovation and adaptability (Tippett & Milford, 2017; Kanematsu & Barry, 2016). These core competencies support children's ability to adapt to the changing world and enable them to be successful.

STEM education provides children with opportunities to learn through experience, while developing scientific process skills, which include basic skills such as observation, communication, prediction, and measurement (Duran & Ünal, 2016; French, 2004). These skills form the basis of scientific thinking and contribute to the development of metacognitive tasks. Scientific process skills encourage children to produce systematic solutions to problems and their academic development. Recent research emphasizes that more emphasis should be placed on the development of scientific process skills in the early years (Moomaw & Davis, 2010; Morgan, Farkas, Hillemeier, Maczuga, 2016). This shows that there is a need for activities that can develop such skills from an early age and that STEM education is an approach to developing skills in this regard.

This study aims to develop three of the most basic skills of scientific process skills: "scientific communication, estimation, and measurement." Communication skills help children express their observations and findings, which are important in collaborative learning environments (Jones, Lake, & Lin, 2008). Estimation skills allow children to predict outcomes, so they engage in the basic elements of scientific inquiry, such as forward-thinking and hypothesis testing (Jones et al., 2008). Measurement introduces children to quantitative reasoning, teaching them how to evaluate and compare data. measurement is a fundamental skill in both mathematics and science (Bybee & Fuchs, 2006). These fundamental skills were selected because they are compatible with the cognitive development stages of early childhood and are closely related to STEM principles.

The theoretical structure of this study is based on constructivist learning theories that argue that children construct knowledge through experience (Piasta & Wagner, 2010). Piaget and Vygotsky's theories play an important role in understanding the applications of STEM education in early childhood. According to Piaget's theory of cognitive development, children are individuals who actively construct knowledge and learn through experiences (Piaget, 1964). From Piaget's perspective, children expand their cognitive schemas by observing, trying, and discovering. Hands-on experiences and problem-solving tasks in STEM education are compatible with the importance Piaget places on active learning and support children's learning processes. On the other hand, Vygotsky's sociocultural theory emphasizes the importance of social interaction and cooperation in children's learning (Vygotsky, 1978). Collaborative tasks and group work in STEM activities encourage social learning by allowing children to learn from each other, as Vygotsky suggested. STEM activities based on this theory are designed to encourage preschool children to be active participants in their learning, interact with their environment, and explore, experiment, and build (Bybee & Fuchs, 2006).

The main purpose of this study is to develop preschool children's scientific process skills and to present how STEM education should be planned to increase the contribution of these skills to their development. There is a relationship between STEM education and scientific process skills (SPS) in the literature. STEM activities provide children with opportunities to acquire and develop scientific process skills (French, 2004). STEM education enables children to be active in the learning process and develops their thinking skills (Gelman & Brenneman, 2004). These activities also support the development of scientific

process skills such as observation, prediction, measurement and communication (Jones, Lake & Lin, 2008).

Various main themes regarding early STEM education stand out in the literature. Gelman and Brenneman (2004) developed the "Preschool Pathways to Science (PrePS)" curriculum and demonstrated that early STEM interaction improves scientific skills and supports the cognitive development of preschool children. Bybee and Fuchs (2006) emphasized the importance of early STEM education in shaping students' long-term attitudes toward science and mathematics, drawing attention to its role in preparing students for future academic and professional success. Similarly, Maltese and Tai (2010) investigated the origins of early science interest and found that early exposure to science-related activities was strongly associated with the development of curiosity and inquiry skills. Clements (2013) emphasized that STEM education should be adapted to diverse cultural and socioeconomic contexts, suggesting that culturally responsive STEM programs can help reduce achievement gaps. In a study on curriculum differentiation, Kershaw et al. (2009) found that parental involvement in early STEM activities had a positive effect on children's knowledge acquisition and contributed to their future success in science and mathematics. The National Research Council (NRC, 2012) provides a framework for effective pedagogical approaches in early STEM education, recommending a focus on hands-on activities that encourage scientific inquiry and problem-solving skills. Darling-Hammond et al. (2020) emphasize the importance of professional development of teachers to assist in the effective integration of STEM education into early childhood programs. Finally, Piasta and Wagner (2010) evaluate the difficulties in assessing scientific process skills in young children and suggest methods for measuring critical skills such as questioning, critical thinking, and communication. Kale and Yoldaş (2021) drew attention to the development of scientific skills in STEM subjects in their study examining the effects of skills related to STEM practices on the scientific processes of preschool teachers. In addition, with the spread of STEM education in preschool education in recent years, the increase in the number of theses and researches on STEM in Turkey also shows the importance of early STEM (Çavaş, Ayar, Turuplu, Gürcan, 2020; Ormancı & Çepni, 2019; Şamlı & Kurtulmuş, 2023).

In conclusion, there is a strong relationship between STEM education and the development of scientific process skills, and this type of education improves children's scientific thinking abilities. The aim of this study is to experimentally examine the effects of STEM education on preschool children's scientific process skills. The following research questions were investigated:

- Is there a statistically significant difference between the scientific communication skills pretest, posttest, and follow-up scores of the experimental and control group children?
- Is there a statistically significant difference between the prediction skills pretest, posttest, and follow-up scores of the experimental and control group children?
- Is there a statistically significant difference between the measurement skills pretest, posttest, and follow-up scores of the experimental and control group children?
- Is there a statistically significant difference between the total scientific process skills pretest, posttest, and follow-up scores of the experimental and control group children?

Design methods

In this study, to determine the effect on children's scientific process skills, one of the quasi-experimental models, the "control group pretest-posttest paired group design" experimental model, was used. ANOVA was used to compare scores between groups and assess the impact of STEM activities on children's scientific process skills (Karasar, 2007).

Table 1.
Design Method

Group	Pre-Test	Intervention	Post-Test	Follow-Up Test
EG	O1	STEM Activities	O4	O7
CG1	O2	National Education Program + Researcher	O5	O8
CG2	O3	National Education Program + Teacher	O6	O9

EG (Experimental Group): The group that takes the STEM-based activities (Science, Technology, Engineering, and Mathematics).
CG1 (Control Group 1): The group where the National Education Program content is implemented by the researcher.
CG2 (Control Group 2): The group where the National Education Program content is implemented by the teacher.

Explanation of Symbols:

O1 – O4 – O7: Pre-test, post-test, and follow-up test measurements for the Experimental Group.
O2 – O5 – O8: Pre-test, post-test, and follow-up test measurements for Control Group 1.
O3 – O6 – O9: Pre-test, post-test, and follow-up test measurements for Control Group 2.

STEM Activities: Activities with a focus on science, technology, engineering, and mathematics, applied to the experimental group.

National Education Program + Researcher: The National Education Program content applied by the researcher in Control Group 1.

National Education Program + Teacher: The National Education Program content applied by the teacher in Control Group 2.

Variables:

Independent Variable: The STEM-based educational activities whose effects are being studied.
Dependent Variable: The scores of 60-72 month-old children on the Scientific Process Skills Scale.

Development of STEM Education Activities

This study was prepared based on STEM research conducted in the world and Turkey. STEM activities implemented especially in early childhood and national and international studies conducted in this field were examined, and activities were planned within the framework of 21st century skills (Fulton et al., 2011). Design-oriented thinking and engineering, science, and mathematics disciplines are at the core of the activities, and it is aimed at children to use their scientific process skills and produce creative solutions throughout the process.

The main theme of the activities is a character named “Kerem” and the STEM adventures of this character are told through a total of 16 stories. Each story directs children to seek solutions by confronting them with different STEM-based challenges and problems. Children follow the “Ask, Plan, Build, Test, Evaluate and Improve” steps to solve each problem situation. During these processes, materials that will help search for solutions are found in Kerem’s backpack, and children are allowed to choose two additional materials, thus encouraging to creative and original solutions.

Each activity lasts approximately two hours and was implemented two days a week for 8 weeks. The activities were prepared with the cognitive and language outcomes of the 2013 Preschool National Education Program and implemented with a preschool group of 20 people as a pilot study. As a result of the pilot study, the duration of the activities, the stages, the materials used, and their suitability for the outcomes were updated. In addition, corrections were made regarding the suitability of the words in the story for children and the originality of the material used in line with the feedback received from three experts.

STEM Building Cycle

Defining the Problem (Asking) Stage: In this stage, a problem situation is presented to the children, and questions are asked to initiate their search for a solution. Children's sense of curiosity is aroused and the conditions necessary for them to find more suitable solutions are clearly explained.

Planning Stage: The solution process is planned based on the questions regarding the solution of the problem. The materials to be used in the solution are determined and their properties are discussed.

Building Stage: In this stage, children build their solution designs with the determined materials. In this process, brainstorming is done, solutions are discussed and the construction process is planned.

Testing Phase: The designs that the children built are tested and if their solutions succeed are observed.

Evaluation Phase: Children discuss how successful the designs they planned and built were and evaluate the results.

Development Phase: Deficiencies that emerged during the evaluation phase are identified and brainstorming is done on how the designs can be improved.

Participants

The study focused on children between the ages of 60-72 months. Developmental differences of children in this age range progress rapidly. Therefore, children with similar characteristics and cognitive levels were selected with the Good Enough Harris test. Using the demographic information form, it was matched in terms of similar characteristics so that the socioeconomic levels and ages of the children in the experimental and control groups were the same. In this way, the groups were matched as homogeneity. In order to reduce the interaction of the students in the experimental group with the control group and thus to control external variables, the morning and afternoon groups were determined so that they could not meet each other.

These children were divided into three groups: the experimental group (n=19), the control group 1 (n=19), and the control group 2 (n=19). The control groups took the Turkey 2013 preschool education program, while the experimental group participated in an eight-week STEM activities program prepared by the researcher in this study. After the intervention, posttests and follow-up tests were performed to compare the scientific process skills of each group.

Data Collection Tools

This study used three data collection tools: “A demographic information form” to collect general characteristics of the children, 'The Good Enough Harris drawing test (GH)' to assess cognitive development and ensure the homogeneity of the groups, 'The Scientific Process Skills Test', consisting of 26 items, divided into three subdimensions, to measure basic skills of the scientific process of the children.

Good Enough Harris Drawing Test (GH): The GH test was developed by Florence Goodenough in 1926 and into its modern form by psychologist Dale B. Harris in 1963. The test provides insight into the cognitive development of children between 5 and 12 years of age. In this respect it is considered reliable for this age range (Scott, 1981). The Good Enough Harris (GH) drawing test was administered to children, instructing them to produce the most detailed human figure possible using conventional drawing materials (Table 2). The purpose of using the GH test in this study was to determine the equality of children's development levels and to include children with similar developmental stages in the experimental groups. This test also served as a measure to control external variables and establish group homogeneity. The results of the GH test analysis have affirmed that all participants in the group were statistically comparable. Ezell (1975) and Loxton, Mostert and Moffatt’s (2006) research show that the GH test is effective in measuring children's development scores and socioeconomic status. As noted by Kağıtcıbaşı and Biricik (2011), the GH test offers multiple benefits, such as its straightforward applicability, absence of cultural and gender biases, and its general acceptance among child participants. This claim was included in the work of Thomas and Silk (1990) and supports the conclusion. Furthermore, the results of the GH test showed that neither gender nor socioeconomic status significantly influenced the performance results.

Scientific Process Skills Test: The Scientific Process Skills Test, developed by Kavak (2021), assessed three subdimensions of scientific process skills through 26 items. The scale consists of scientific communication, prediction, and measurement subdimensions. Scientific communication also includes questions of classification and observation. While developing the scale, each subdimension was defined according to the literature and the items were written according to the expected gains in the appropriate age range. When determining these gains, cognitive acquisitions and language acquisitions were taken into account in the preschool National Education programme. After taking expert opinions, a pilot application was made for a group of 20 children. The content validity ratio (KMO) was determined with the Lawshe test. EFA was carried out based on data collected from 371 children with the items determined. The validity of the construct was demonstrated through tetrachoric analysis, and the main

form of the scale, consisting of 26 items and three subdimensions, was obtained. The subdimensions include the establishment of relationships, prediction, and measurement skills. The test answers are scored as "no" (0) or "yes" (1), and the total score ranges from 0 to 26. In the correlation analysis between the factors of the scale, it was found that all three factors were significantly and positively correlated with each other at a moderate level. Accordingly, a total scientific process skills score can be obtained from the overall scale. The lowest score that can be obtained from the scale is 0, and the highest score is 26.

Data Analysis

It is seen that the ratio of standard errors of the skewness and kurtosis values is between -1.96 and +1.96. In this case, it can be said that the scores obtained from these scales from each group are normally distributed (Field, 2009).To determine whether there was a significant difference in the average scores of children's scientific process skills in relation to STEM-based educational activities, a 3X3 mixed-design ANOVA test was employed. To determine whether there was a significant difference between the children's pre-experimental and post-experimental scientific process skills average scores, the ANOVA test was used for groups showing normal distribution, and the Friedman and Kruskal-Wallis tests were utilized for groups not showing. Furthermore, a comparison of the average scores of the groups was performed using the effect size calculations using the eta-squared correlation coefficient method. According to this, regardless of positive or negative values, effect sizes lower than .30 were interpreted to have a small effect, those between .30 and .50 as having a medium effect, and those greater than .50 as having a large effect (Field, 2011).

Findings

Table 2 shows the descriptive statistics for the Good Enough Harris (GH) test scores in each group. The scores in the experimental group ranged from 5 to 15, with a mean of 9.53 and a standard deviation of 3.27. In control group 1, the scores ranged from 4 to 14, with a mean of 8.47 and a standard deviation of 2.74. In control group 2, the scores ranged from 5 to 17, with a mean of 9.74 and a standard deviation of 3.21.

Table 2.
Descriptive Statistics on GH

Group		Min.	Max.	Mean	S	Skewness (SHç: 0,52)	Kurtosis (SHb:1,014)	Skewness/ Error	Kurtosis/ Error
EG	GH total score	5	15	9.53	3.27	.41	-1.09	0.78	-1.08
CG1	GH total score	4	14	8.47	2.74	.41	-.64	0.77	-.63
CG2	GH total score	5	17	9.74	3.21	.69	-.23	1.32	-.23

The skewness and kurtosis values in each group fall within the range of -1.96 to +1.96, indicating that the scores are normally distributed (Field, 2009). Based on the GH test results, which were used to ensure group homogeneity, it could be concluded that all groups were equal and homogeneous.

Table 3.
Results of the One-Way ANOVA Test of GH Scores according to Experimental, Control 1 and Control 2 Groups

Source of Variance		Sum of Square	sd	Mean Square	F	p
GH Total Scores	Between-groups	17.404	2	8.702	.916	.406
	In-group	513.158	54	9.503		
	Total	530.561	56			

Table 3 presents the results of the one-way ANOVA test for the GH scores among the experimental, control 1, and Control 2 groups. The test did not reveal significant differentiation between groups ($F(2, 54) = .916$; $p > .05$). Therefore, it can be concluded that the groups were considered equal in terms of their GH scores. The findings indicated that the GH test scores were normally distributed in all groups and that there were no significant differences between the groups, confirming their homogeneity.

Table 4.
Descriptive Statistics on the Scientific Process Skills Test (SPST)

Group		Min.	Max.	Mean	S	Skewness (SHç:0.52)	Kurtosis (SHb:1.014)	Skewnes s/Error	Kurtosi s/Error
EG	Total pretest	5	24	13.32	4.98	.37	-.07	.71	-.07
	Posttest total	17	26	22.42	2.55	-.69	-.37	-1.31	-.37
	Total followup	19	26	23.68	2.00	-.86	.37	-1.64	.36
CG 1	Total pretest	5	22	14.05	4.87	.03	-.67	.05	-.66
	Total posttest	12	24	16.95	3.69	.14	-1.08	.26	-1.06
	Total followup	9	24	17.89	4.19	-.40	-.30	-.76	-.30
CG 2	Total pretest	4	22	14.16	5.53	-.51	-.62	-.97	-.61
	Total posttest	6	24	16.95	6.18	-.49	-1.22	-.94	-1.20
	Total followup	7	24	17.37	5.51	-.56	-.93	-1.07	-.91

Control group 2 also showed an ascending trend in mean scores from the pretest to followup, with standard deviation patterns consistent with the previous groups.

Skewness and kurtosis values in all groups and tests were restricted between -1.96 and +1.96, suggesting a normal distribution of SPST scores in all measurements. In summary, descriptive analyses intimate that all cohorts demonstrated growth in scientific process skills from the initial measurement to the subsequent tests. The trend in standard deviations implies increased consistency of the score in followup assessments, underscoring the efficacy of applied interventions in improving the abilities of scientific process of children.

Table 5 includes the skill scores for the scientific process of the children who participated in two different training. Consequently, it was found that the joint effects of being in different process groups and repeated measures factors on scientific process skills were significant ($F(4, 108)=17.00$; $p < .05$, partial $\eta 2=0.39$). This finding showed that different practices in the groups had different effects on the increase in the scientific process skills score. It was understood that the scientific process skill scores of the children in the experimental group in which STEM activities were applied were higher. As a result of the Bonferroni comparison test, it was seen that the mean of the experimental group differed significantly from the control 1 and 2 groups.

Table 5.
Pretest-Posttest-Follow-up Test ANOVA Results of SPST Scores

Source of Variance	KT	sd	KO	F	p	Effect Size	Sig. Diffr.
Between Groups	3311.02	56					1-2
Group	487.30	2	243.65	4.66	.01	.15	1-3
Error	2823.72	54	52.29				2-3
Within Groups	2066.667	114					
Measure	1117.088	2	558.54	103.52	.00	.66	E-C1
Group*Measure	366.877	4	91.72	17.00	.00	.39	E-C2
Error	582.702	108	5.40				
Sum	7444.351	170					

When Table 6 is examined, in the experimental group, the scientific process skills scientific communication subdimension scores ranged from 1 to 13 in the pretest, ranged from 6 to14 in the posttest, and ranged from 8 to 14 in the follow-up test; their averages increased progressively from the pretest to the follow-up test. It was seen that the standard deviations decreased.

Table 6.
Descriptive Statistics on the SPST Scientific Communication Subtest

Group		Min.	Max.	Mean	SS	Skewness (SHç:0.52)	Kurtosis (SHb:1.014)	Skewness/Error	Kurtosis/ Error
EG	pretest	1	13	7.37	3.00	-.36	.28	-.68	.28
	posttest	6	14	11.37	2.27	-.87	.05	-1.65	.05
	followup	8	14	12.26	1.79	-1.03	.44	-1.96	.43
CG1	pretest	2	12	7.47	3.04	-.40	-.79	-.77	-.78
	posttest	3	12	8.26	2.42	-.40	-.19	-.76	-.19
	followup	3	13	9.11	2.90	-.60	-.38	-1.15	-.37
CG2	pretest	1	12	7.37	3.55	-.63	-.76	-1.21	-.75
	posttest	1	14	8.42	4.03	-.59	-.82	-1.13	-.80
	followup	1	14	8.68	3.97	-.60	-.80	-1.15	-.79

The scientific communication subdimension scores in the control 1 group were found to vary from 2 to 12 in the pretest, from 3 to 12 in the posttest and from 3 to13 in the follow-uptest; their averages increased from the pretest to the follow-up test. On the other hand, it was seen that the standard deviations increased in the posttest compared to the pretest, and decreased in the follow-uptest compared to the posttest, but nevertheless increased compared to the pretest.

Scientific communication subdimension scores in the control 2 group ranged from 1 to 12 in the pretest, from 1 to 14 in the posttest, and from 1 to 14 in the follow-up test; their averages increased progressively from the pretest to the follow-up test; on the other hand, it was seen that standard deviations decreased in the posttest compared to the pretest, and increased in the follow-up test compared to the posttest, but nevertheless decreased compared to the pretest.

When the ratio of the skewness and kurtosis values to standard errors was examined, it was seen that all values fell between -1.96 and + 1.96. In this case, it can be said that the scores obtained from these tests in each group were normally distributed (Field, 2009). The results of the 3X3 ANOVA test conducted to determine whether the scores obtained from the tests differed according to the pretest, posttest and follow-uptests are given below.

When Table 7 is examined, it was found that there was a significant difference in the scientific communication subdimension of the children participating in different education programs from before to after the experiment. In other words, the common effects of being in different process groups and repeated measurement factors on scientific process skills were significant ($F(4, 108)=10, 04$; $p < .05$, partial $\eta 2=0.27$). This finding showed that the program applied in each group had different effects on increasing the scientific communication subdimension of scientific process skills. As a result of the Bonferroni comparison test, it was seen that the mean of the experimental group differed significantly from the Control 1 and 2 groups.

Table 7.
Scientific communication Subtest of SPST Pretest-Posttest-Follow-up Scores ANOVA Results

Source of Variance	KT	sd	KO	F	p	Effect Size	Sig.Diffr.
Between Groups	1464.01	56					1-2
Group	170.26	2	85.13	3.55	.04	.12	1-3
Error	1293.75	54	23.96				2-3
Within Groups	548.0	114					
Measure	210.33	2	105.16	46.14	.00	.46	EG-CG1
Group*Measure	91.53	4	22.88	10.04	.00	.27	EG-CG2
Error	246.14	108	2.28				
Sum	2560.01	170					

As shown in Table 8, the prediction subdimension scores in the experimental group ranged from 1 to 6 in the pretest, 4 to 7 in the posttest, and from 5 to 7 in the follow-up test; their averages increased progressively from the pretest to the follow-uptest; it was seen that the standard deviations decreased.

Table 8.
Descriptive Statistics on the SPST Prediction Subtest

Group		Min.	Max.	Mean	SS	Skewness (SHç:0.52)	Kurtosis (SHb:1.014)	Skewness /Error	Kurtosis/ Error
EG	pretest	1	6	3.74	1.59	-.07	-.69	-.13	-.68
	posttest	4	7	6.37	.83	-1.48	2.41	-2.83	2.37
	followup	5	7	6.58	.69	-1.44	.91	-2.74	.90
CG1	pretest	2	6	3.79	1.32	.27	-.57	.51	-.56
	posttest	2	7	4.79	1.32	-.39	-.47	-.74	-.46
	followup	2	7	5.00	1.25	-.19	.79	-.37	.78
CG2	pretest	1	6	4.16	1.54	-.40	-.69	-.76	-.68
	posttest	1	7	4.68	1.80	-.43	-.46	-.82	-.45
	followup	2	7	4.95	1.27	-.44	.43	-.84	.43

The prediction subdimension scores in the control 1 group varied from 2 to 6 in the pretest, from 2 to 7 in the posttest, and from 2 to 7 in the follow-up test; their averages increased progressively from the pretest to the follow-up test; it was seen that the standard deviations remained at the same values in the pretest and posttest, and decreased in the follow-up test compared to the pretest and posttest.

The prediction subscale scores in the control 2 group ranged from 1 to 6 in the pretest, 1 to 7 in the posttest, and between 2 and 7 in the follow-up test; their averages increased progressively from the pretest to the follow-up test; on the other hand, it was seen that the standard deviations increased in the posttest compared to the pretest, and decreased in the follow-up test compared to the pretest and posttest.

When the ratio of the skewness and kurtosis values to standard errors was examined, it was seen that some of the values were not between -1.96 and + 1.96 in the experimental group. In this case, it can be said that the scores obtained from these tests were normally distributed in the control 1 and control 2 groups, but not normally in the experimental group (Field, 2009). Thus, ANOVA was used in the control groups and the Friedman test in the experimental group for measurements related to whether the pretest, posttest, follow-up tests differed. The Kruskal-Wallis test was used to determine whether the measurements differed in the groups. The results of the Friedman test conducted to determine whether the scores obtained from these tests differ in the experimental group according to the pretest, posttest and follow-uptests are given below.

As shown in Table 9, there was a statistically significant difference between repeated measures of the prediction subtest $\chi 2$ (sd=2, n=19) = 34.06, $p < .05$. The increase seen from the pretest to the posttest and from the pretest to the follow-up test was statistically significant.

Table 9.
Friedman Test Result of Pretest, Posttest and Follow-up Tests in the Experiment Group

Measures	Mean rank	sd	χ^2	p	Sig.diff.	η^2
Pretest	1.03	2	34.06	.00*	1-2	.61
Posttest	2.39				1-3	.62
Follow up	2.58					
*p<.05						

There was a statistically significant difference between repeated measurements of the prediction scores of the students in the control 1 group ($F(2, 36) = 8.56$, $p < .05$, partial $\eta 2 = .32$). As a result of the Bonferroni comparison test performed to determine between which measurements these differences were, a significant difference was observed between the mean scores of the pretest and posttest, pretest, and follow-up test (Table 10).

Table 10.
Result of the ANOVA Test of the Pretest, Posttest, and Follow-up Tests in the Control 1 Group

Source of Variance	KT	sd	KO	F	p	Effect Size	Sig. diff.
Between Groups	56.877	18	3.160				1-2
Measure	15.895	2	7.947	8.556	.00*	.322	1-3
Error	33.439	36	.929				
Sum	106.21	56.00					

According to Table 11, there were no statistically significant differences between repeated measurements of the prediction scores of the students in the control 2 group ($F(2, 36) = 3.08$, $p > .05$). In addition to these, the results of the Kruskal-Wallis test to determine whether the repeated measurements differed between the groups are given below.

Table 11.
ANOVA Test Result of Pretest, Posttest and Follow-up Tests in Control 2 Group

Source of Variance	KT	sd	KO	F	p
Between Groups	93.719	18	5.207		
Measure	6.140	2	3.070	3.082	.06
Error	35.860	36	.996		
Sum	135.72	56.00			

As shown in Table 12, the pretest scores of the groups did not differ ($\chi2$ =.99; sd =2; p>.05), and the posttest and follow-up tests were not different between the experimental group and the control 1 ($\chi2$ =15.81; sd =2; p<.05) and 2 ($\chi2$ =20.69;sd =2; p<.05).

Table 12.
Kruskal-Wallis Test Results whether Repeated Measurements Differentiated between Groups

Measures	Groups	Mean rank	sd	χ^2	p	Sig. Diffr.	η^2
Pretest	EG	27.37	2	.99	.61		
	CG 1	27.63					
	CG 2	32.00					
Posttest	EG	41.05	2	15.81	.00*	EG-CG1	.61
	CG 1	22.50				EG-CG2	.51
	CG 2	23.45					
Follow up	EG	42.66	2	20.69	.00*	EG-CG1	.63
	CG 1	22.32				EG-CG2	.66
	CG 2	22.03					

*p<.05

When Table 13 is examined, in the experimental group, the measurement sub-dimension scores ranged from 0 to 5 in the pretest, 4 to 5 in the posttest, and from 4 to 5 in the follow-up test; their averages increased progressively from the pretest to the follow-up test. It was seen that the standard deviations decreased.

Table 13.
Descriptive Statistics on the Measurement Subtest

Group		Min.	Max.	Mean	SS	Skewness (SHç:0.52)	Kurtosis (SHb:1.04)	Skewness/ Error	Kurtosi /Error
EG	pretest	0	5	2.21	1.65	.29	-1.12	.55	-1.11
	posttest	4	5	4.68	.48	-.86	-1.42	-1.65	-1.40
	followup	4	5	4.84	.37	-2.04	2.41	-3.90	2.38
CG1	pretest	1	5	2.79	1.44	.16	-1.20	.31	-1.18
	posttest	2	5	3.89	.99	-.15	-1.36	-.28	-1.34
	followup	2	5	3.79	.98	-.33	-.74	-.64	-.73
CG2	pretest	0	5	2.63	1.21	-.24	.21	-.46	.21
	posttest	1	5	3.84	1.12	-.99	.86	-1.88	.85
	followup	1	5	3.74	.99	-.94	1.90	-1.79	1.88

The measurement sub-dimension scores in the control 1 group varied from 1 to 5 in the pretest, from 2 to 5 in the posttest, and from 2 to 5 in the follow-up test; means increased from the pretest to the posttest and decreased in the follow-up test compared to the posttest; it was seen that the standard deviations decrease from the pretest to the follow-up test. The measurement sub-dimension scores in the control 2 group ranged from 0 to 5 in the pretest, 1 to 5 in the posttest, and from1 to 5 in the follow-up test; means increased from the pretest to the posttest and decreased in the follow-up test compared to the posttest; it

was seen that the standard deviations decreased from the pretest to the follow-up test. When the ratio of the skewness and kurtosis values to standard errors was examined, it was seen that some of the values were not between -1.96 and + 1.96 in the experimental group. In this case, it can be said that the scores obtained from these tests in the control 1 and control 2 groups were normally distributed but not in the experimental group (Field, 2009). Hence, ANOVA was used in the control groups and the Friedman test in the experimental group for the measurements related to whether the pretest, posttest, follow-up tests differed. The Kruskal-Wallis test was used to determine whether the measurements differed in the groups.

According to Table 14, there was a statistically significant difference between repeated measurements of children's measurement subtest. $\chi 2$ (sd=2, n=19) = 30.47, $p < .05$. The increase seen from the pretest to the posttest and from the pretest to the follow-up test was statistically significant.

Table 14.
Friedman Test Result of Pretest, Posttest and Follow-up Tests in the Expreriment Group

Measures	Mean rank	sd	χ^2	p	Sig.diffr.	η^2
pretest	1.16	2	30.47	.00*	1-2	.57
posttest	2.34				1-3	.58
followup	2.50					
*p<.05						

According to Table 15, there was a statistically significant difference between repeated measurements regarding the measurement scores of the students in the control 1 group ($F(2, 36) = 9.136$, $p < .05$, partial η^2= .34). As a result of the Bonferroni comparison test performed to determine between which measurements these differences were, a significant difference was observed between the mean scores of the pretest and posttest, pretest, and follow-up test.

Table 15.
ANOVA Test Result for Pretest, Posttest and Follow-up Tests in Control 1 Group

Source of Variance	KT	sd	KO	F	p	Effect Size	Sig.Diffr.
Between Groups	44.246	18	2.458				1-2
Measure	14.140	2	7.070	9.136	.001	.337	1-3
Error	27.860	36	.774				
Sum	86.25	56.00					
*p<.05							

As shown in Table 16, there was a statistically significant difference between repeated measurements for the measurement scores of the students in the control 2 group ($F(2, 36) = 19.743$, $p < .05$, partial η^2= .52). As a result of the Bonferroni comparison test performed to determine between which measurements these differences were, a significant difference was observed between the mean scores of the pretest and posttest, pretest, and follow-up test. In addition to these, the results of the Kruskal-Wallis test performed to determine whether repeated measurements differed between groups are given below.

Table 16.
ANOVA Test Result for Pretest, Posttest and Follow-up Tests in Control 2 Group

Source of Variance	KT	sd	KO	F	p	Effect Size	Sig. Diffr.
Between Groups	51.053	18	2.836				1-2
Measure	17.088	2	8.544	19.743	.000	.523	1-3
Error	15.579	36	.433				
Sum	83.72	56.00					

As shown in Table 17the groups did not differ in their pretest scores ($\chi 2$ =1.52; sd =2; p>.05) and that the posttest and follow-up tests were 1 ($\chi 2$ =9.00; sd =2; p<.05) between the experimental group and the control group 2 ($\chi 2$ =18.77; sd =2; p<.05) differed in groups.

Table 17.
Kruskal-Wallis Test Results whether Repeated Measurements Differentiated between Groups

Measures	Groups	Mean rank	sd	χ^2	p	Sig.diffr.	η^2
pretest	EG	25.32	2	1.52	.47		
	CG 1	31.47					
	CG 2	30.21					
posttest	EG	37.71	2	9.00	.01*	EG-CG1	.42
	CG 1	24.68				EG-CG2	.44
	CG 2	24.61					
followup	EG	41.61	2	18.77	.00*	EG-CG1	.60
	CG 1	23.13				EG-CG2	.65
	CG 2	22.26					

*p<.05

Discussion

The impact of STEM education activities on preschool children's scientific process skills has been an area of interest for researchers and educators. Introducing STEM concepts at a young age can not only foster early academic skills, but also lay the foundation for lifelong scientific curiosity and learning (Bybee, 2013; Çiftçi, 2018).

The descriptive statistics of the Scientific Process Skills Test (SPST) indicate that the initial data were uniform across all groups, providing a consistent baseline for the study (Table 3-4). This uniformity ensures that any changes observed can be attributed to the interventions applied during the experimental process. The ANOVA results, which compare the pretest, posttest, and follow-up scores, reveal moderate efficacy of the experimental protocol (Table 5). This suggests that the STEM-centered activities had a positive effect on children's scientific process knowledge, regardless of their group assignment. These findings align with existing literature, which emphasizes the importance of STEM education in enhancing children's understanding of scientific concepts. Studies have shown that early exposure to STEM activities fosters the development of critical scientific skills, including observation, hypothesis generation, and experimentation (Honey, Pearson, & Schweingruber, 2014). By engaging in hands-on, inquiry-based learning, children can better grasp abstract scientific ideas and apply them in real-world contexts (Bybee, 2013). Moreover, the moderate efficacy observed in this study is consistent with previous research suggesting that while STEM interventions can have a positive impact on scientific literacy, the extent of this impact may vary depending on factors such as the duration and intensity of the intervention (Trundle, Atwood, & Christopher, 2002). This highlights the need for continuous and sustained engagement in STEM activities to maximize their effectiveness in fostering scientific process skills.

In addition, the affirmative influence of STEM activities, regardless of group designation, supports the notion that STEM education can be universally beneficial. Research has shown that STEM-based curricula are particularly effective in promoting equitable learning outcomes, as they provide opportunities for all children, irrespective of background or ability level, to engage in meaningful scientific exploration (Clements & Sarama, 2020). Research by Zorlu & Zorlu (2017) reveals a moderate and positive association between scientific process skills and the inclination towards STEM professions. Echoing this sentiment, the current study substantiates that STEM pedagogies bolster children's scientific process proficiencies, potentially augmenting their future affinity for STEM-orientated career paths. In conclusion, the results of this study contribute to the growing body of evidence supporting the integration of STEM activities in early childhood education. The moderate efficacy observed indicates that while STEM interventions are beneficial, further research is needed to optimize their implementation and assess their long-term impact on children's scientific process skills.

Among the characteristics measured under the scientific communication skill, children's observation, classification, and grouping which are at the base of the scientific processes, are also included. The scientific communication scores of all children participating in STEM activities, which were the same in the pretest, showed an increase of four points in the experimental group compared to the other groups

in the posttest. The children in the experimental group were observed to reach the maximum score (Table 6). When the SPST communication subtest was analyzed and the results of the Friedman and Kruskal-Wallis test were interpreted, significant score enhancements were discerned in the experimental group after the intervention (Table 7). This finding revealed the tangible impact of STEM activities on the refinement of scientific skills, such as observation and classification. Preschool children are naturally curious and have an innate ability to engage in scientific enquiry. The findings of the study, such as improving children's thinking skills, align with the results found in the literature (DeJarnette, 2018; Kavak & Gül, 2021; Mercan & Kandır, 2019). Children can learn by taking care of their pets in their classrooms, observing daily weather conditions, experimenting with water and mud, etc. basics of life and earth sciences; they learn engineering skills by playing with structures and blocks (Aldemir & Kermani, 2017). When doing these, they actually realize many of their scientific process skills by themselves. In fact, children are already gaining some STEM experience in their daily lives. The quality of observations they make in these processes, how they relate to situations, and how they can develop these processes depend on the extent to which they are supported by the adults around them. In their studies, Dejonckheere et al. (2016) clearly demonstrated that children's exploration and scientific reasoning skills are further developed as a result of their studies involving STEM activities at the level of scientific reasoning in preschool.

Indeed, there is a connection between preschool and STEM education. Especially from a young age, instead of memorizing information, it is necessary to engage in activities that support children's relationships with what they have learned, their experience, and reasoning. Thus, children will be able to use their tendency to understand the relationships in the scientific process steps and to use all of their processes in both their social and professional life experiences. Millar (1994) argues that observation is not a process specific to the method of science but is just one of the approaches that people always use to understand the world, whether they act scientifically or not. Thus, he argues that observation is a content-independent process. Therefore, when viewed separately from the cognitive processes that come with skills, such as observation, classification, and scientific communication, it will cease to be a skill that can be gained through any practice or teaching approach.

In fact, scientific processes do not only give children a scientific perspective and expe-rience. At the same time, it brings in contact with scientific environments rich in language. Providing a language-rich environment supports children's language acquisition and pragmatic functions of language, enabling them to communicate with adults (French, 2004). A scientific lesson plan and its outcomes provide significant benefits for the development of scientific communication skills. The foundation of scientific communication is based on observation, as data gathered through observation plays a critical role in sharing and understanding scientific information. While teachers may view observation as a time-consuming skill, it is actually the most fundamental and essential component of scientific processes. The results of this study also support this perspective. Therefore, to enhance observation skills and strengthen scientific communication, the use of STEM activities from an early age should be encouraged more effectively.According to descriptive statistics, there was a significant increase in the prediction skills of the children in the experimental group than the children in the control groups (Table 8). In this study, STEM activities increased children's prediction skills. When the prediction scores of the groups were examined, it was observed that there was no significant increase in the control 1 and 2 groups (Tables 9-10-11), while the average scores of the children in the experimental group increased from 3.74 to 6.58.

To use their prediction skills, children are expected to have previously acquired knowledge (Turan, 2012) and be able to establish a cause-effect relationship between this information. STEM education provides structured opportunities for children to hone these skills. For example, Gelman and Brenneman (2004) observed that children as young as three can engage in hypothesis testing, prediction, and experimentation, all of which are core components of the scientific process. STEM activities include processes that will support children's understanding of cause-and-effect relationships. Hanauer (2018) states that skills, such as drawing and crea-ting graphics, will strengthen students' prediction skills and they will be able to establish cause-effect relationships more easily. In the environment where research and inquiry-based STEM activities are performed, individuals' skills are supported to use scientific processes, such as observation, measurement, classification, use of numbers, data collection, data

analysis, hypothesis formulation, prediction, and experimentation, are supported (Gökbayrak & Karişan, 2017). Preschool prediction skills are generally associated with science activities and almost most of the studies (Aydoğdu & Ergin, 2008; Gökbayrak & Karişan, 2017; Kavak, 2019; Kefi, 2013; Kunt, Özel, Kunt, 2015; Özdemir, 2004; Strong, 2013; Tan & Temiz, 2003; Tatar, 2006) tried to gain prediction processes with these activities. The results of the studies of Kunt et al. (2015) show that while 60-72-month-old children's observation, classification and space-spatial skills develop better, although measurement, inference and prediction skills increased, observation showed that they lagged behind their classification skills. According to this result, it can be said that children's prediction and measurement skills also develop, but they are less supported in activities compared to other skills. Thus, it can be said that activities that improve the prediction and measurement skills of these children should be included more frequently.

According to the findings of the comparison tests, there is no significant difference between the experimental group and the two control groups (Control 1 and Control 2), and there is also no statistically significant difference between the Control 1 and Control 2 groups (Tables 12, 13, 14). In early childhood, measurement skills are often limited to mathematics and, occasionally, science activities. These activities are typically grounded in Piaget's conservation principle (Piaget, 1970). Since preschool children may not fully grasp standard units of measurement, they are encouraged to use non-standard tools based on familiar objects. STEM activities enhance the understanding and practical use of measurement, making it a more concrete and accessible process for young children.

Due to their developmental stage, children naturally become aware of changes in their height and weight and often express a desire to measure these. It is important to provide them with measurement results in a way that helps them understand comparisons and outcomes, even during their free play and routine activities. In this case, it is crucial to support children to be aware of their measurement skills and to use them in a conscious and concrete way. This skill should be also supported in a way that parallels children's intellectual and scientific skills. Ostlund (1992) defines measurement as the results obtained using standard or non-standard measurement tools. To comprehend the nature of measurement and gain measurement skills, an individual must be able to recognize measurement tools and have the ability to use them practically. However, the development of measurement skills depends on the development of both cognitive, affective and psychomotor skills (Maral, Oğuz Ünver, Yürümezoğlu, 2012).

Measurement skills form the foundation of all sciences (Maral et al., 2012). The ability to measure is essential for developing skills such as questioning, reasoning, and drawing conclusions by comparing events, which are especially emphasized among 21st-century skills (National Research Council, 2012). It is evident that measurement activities conducted in preschool are usually integrated with mathematics and science, while separate studies focusing specifically on this skill are scarce. However, measurement is a critical skill that we frequently need and use in our daily lives, and awareness of this skill should be cultivated from an early age (Clements & Sarama, 2020; Baroody, Lai, & Mix, 2014). In STEM education, measurement forms the foundation for processes such as sharing information, collaborating, and presenting findings (Bumbacher, Salehi, Wieman, & Blikstein, 2018; Honey, Pearson, & Schweingruber, 2014). Thus, STEM activities provide a valuable approach for developing and applying measurement skills (Bybee, 2013).

The role of STEM activities in the development of scientific process skills is inevitable, and its effect has been proven by many studies (Strong, 2013; Kavak, 2019; Çiftçi, 2018). However, most of the studies conducted cover children at the primary and secondary school levels. Exposure to STEM activities in preschool can instil a positive attitude towards science, making children more likely to pursue STEM fields later in life. A report from the National Research Council (2012) indicated that early STEM education has a strong potential to foster positive attitudes toward science and mathematics, reducing anxiety around these subjects in the later academic years. Gonzalez and Freyer's (2014) results also relate STEM education from the preschool period to support children in developing a positive attitude toward STEM fields. However, there are challenges associated with implementing STEM activities in preschool settings. Teachers need appropriate training to effectively integrate these concepts into the classroom (McClure et al., 2017). Additionally, it is crucial to strike a balance between structured learning and play, ensuring that STEM activities are age-appropriate and engaging.

Conclusion and Suggestions

To show that the groups are on an equal level, the Good Enough Harris (draw a human) test was applied in psychometric dimension and the children and homogeneous groups were determined according to their scores. This test showed that the children participating in the present study were of the same developmental age and level. A statistically significant difference was found when the scores obtained before the application of preschool children participating in STEM activities were compared with the overall scores of the scientific process skills test obtained after the application. When the scientific communication sub-dimension of the test was examined, the scores of the children in the experimental group differed statistically significantly than the scores of the children in the control groups. This finding shows that STEM activities applied in the experimental group are effective in the communication sub-dimension. Scientific communication sub-dimension includes questions about classification, grouping and communication skills, which are among the basic skills and develop depending on the observation skills. Therefore, the acquisition of this skill after the experiment process of the children also shows an increase in their ability to communicate scientifically and their ability to classify and observe. In the prediction sub-dimension, it was concluded that the scores of the children in the experimental group and control 1 group differed statistically significantly in the posttests. No statistically significant differences were found in the control 1 and 2 groups. The effect of the applications in the experimental group on the prediction skills was calculated by removing the researcher effect. When the measurement sub-dimension was examined, it was concluded that the posttest scores of the children in the experimental group and control 1 group differed statistically significantly, while there was no statistical difference in the control 2 group. This finding shows that the experimental process is also effective in the measurement sub-dimension. The significant difference seen in the control 1 group is seen as the researcher effect, as in the prediction sub-dimension. It is thought that this effect may have arisen due to the Hawthorne effect. According to the findings of the general scores of scientific process skills and sub-dimensions of STEM activities, it is concluded that there is a significant relationship between STEM and scientific process skills in general.

In addition to the results, off-the-record interviews with parents during the experimentation period accrued that children's STEM activities also showed progress in 21st-century skills, such as cooperation, communication, questioning, flexible and creative thinking, and sharing skills in other areas of children, during the experimental study. This result corroborated by parental feedback shows our exploration of broader underscores the holistic developmental attributes of STEM activities, such as 21st-century skills. The relationship between our findings and existing literature reinforces the validity and significance of the results.

In conclusion, this study contributes to the growing body of knowledge on the multifaceted benefits of integrating STEM activities into early childhood education. The insights obtained here have implications for pedagogical practices and policy considerations aimed to improve the holistic development of children.

Limitations

This experimental study period covers a period of one semester. Some of the participants could not attend all of the sessions due to their health problems; therefore, their results were not included in the final tests. Children whose cognitive levels differ according to the homogeneity distribution test. Thus, they were not included in this study were not kept out of the classroom during the activities. The differences of the practising physicians in the control groups were not evaluated by a second researcher.

It is essential to acknowledge the limitations of our study, which include potential confounders and the relatively short-term nature of the investigations. Hence, we recommend that further research encompasses more comprehensive and longitudinally orientated approaches to provide a more nuanced understanding of the enduring impact of early exposure to STEM on a broader range of cognitive and practical skills.

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Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

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References

Aldemir, J., & Kermani, H. (2017). Integrated STEM curriculum: improving educational outcomes for head start children. *Early Child Development and Care,* 187(11), 1694–1706. doi:10.1080/03004430.2016.1185102

Aydoğdu, B., & Ergin, Ö. (2008). The effects of open-ended and inquiry-based laboratory techniques on students' science process skills. *Ege Eğitim Dergisi,* 9(2), 15–36.

Baroody, A. J., Lai, M. L., & Mix, K. S. (2014). The development of young children's early number and operation sense and its implications for early childhood education. *In Handbook of research on the education of young children* (pp. 205-240). Routledge.

Bybee, R. W., & Fuchs, B. (2006). Preparing the 21st century workforce: a new reform in science and technology education. *Journal Of Research in Science Teaching,* 43(4), 349-352. doi:10.1002/tea.20147

Bybee, R. W. (2013). The case for STEM education: Challenges and opportunities. NSTA press.

Bumbacher, E., Salehi, S., Wieman, C., & Blikstein, P. (2018). Tools for science inquiry learning: Tool affordances, experimentation strategies, and conceptual understanding. *Journal of Science Education and Technology*, 27, 215-235. doi:10.1007/s10956-017-9719-8

Clements, D. H. (2013). *Math in the early years 2013.* The Progress of Education Reform, 14(5).

Clements, D. H., & Sarama, J. (2020). *Learning and teaching early math: The learning trajectories approach*. Routledge.

Çavaş, P., Ayar, A., Bula Turuplu, S. & Gürcan, G. (2020). A study on the status of STEM education research in Turkey. *YYU Journal of Education Faculty,* 17(1), 823-854. doi:10.33711/yyuefd.751853

Çiftçi, M. (2018). *The effect of developed STEM activities on secondary school students' scientific creativity levels, their understanding of STEM disciplines, and their awareness of stem professions.* [Unpublished master's thesis]. Recep Tayyip Erdoğan University, Institute of Science and Technology.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science,* 24(2), 97-140. doi:10.1080/10888691.2018.1537791

Dejonckheere, P. J. N., De Wit, N., Van De Keere, K., & Vervaet, S. (2016). Exploring the classroom: Teaching science in early childhood. *International Electronic Journal Of Elementary Education*, 8(4), 537–558. doi:10.12973/eu-jer.5.3.149

DeJarnette, N. K. (2018). Early childhood STEAM: Reflections from a year of STEAM initiatives implemented in a high-needs primary school. *Education,* 139(2), 96-112.

Duncan, G. J., & Murnane, R. J. (2016). Rising Inequality in Family Incomes and Children's Educational Outcomes. *The Russell Sage Foundation Journal of the Social Sciences,* 2, 142-158. doi:10.7758/RSF.2016.2.2.06

Duran, M., & Ünal, E. (2016). Effects of hands-on/minds-on activities on students' attitudes toward science and conceptual learning about gases. *Journal of Science Education and Technology,* 25(3), 456-471.

Eshach, H., & Fried, M. N. (2005). "Should Science be Taught in Early Childhood?" *Journal of Science Education and Technology,* 14(3), 315-336. doi:10.1007/s10956-005-7198-9

Ezell, M. P. (1975). *Comparisons of Draw-A-Child Test Among Preschool Children*. [Unpublished doctoral dissertation]. University of Utah State. doi:10.26076/47d0-df46

French, L. (2004). Science as the center of a coherent, integrated early childhood curriculum. *Early Childhood Research Quarterly,* 19(1), 138-149. doi:10.1016/j.ecresq.2004.01.004

Field, A. (2009). *Discover Statistics Using Spss-Third Edition.* Revista Mexicana De Biodiversidad (Vol. 82). doi:10.1234/12345678

Heckman, J. J. (2011). "The Economics of Inequality: The Value of Early Childhood Education." *American Educator*, 35(1), 31-35.

Gelman, R., & Brenneman, K. (2004). Science learning pathways for young children. *Early Childhood Research Quarterly*, 19(1), 150–158. doi:10.1016/j.ecresq.2004.01.009

Gonzalez, M., & Freyer, C. (2014). A Collaborative Initiative: STEM and universally designed curriculum for at-risk preschoolers. *National Teacher Education Journal,* 7(3), 21–29.

Gökbayrak, S., & Karişan, D. (2017). An investigation of the effects of STEM based activities on preservice science teacher's science process skills. *Western Anatolia Journal Of Educational Sciences,* 8(2), 63–84.

Guide, P. (2013). Boston Children's Museum. Ανάκτηση.

Hanauer, D. I. (2018). A Genre Analysis Of Student Microbiology Laboratory Notebooks. In M. J. Curry & D. I. Hanuer (Eds.), *Language, Literacy, and Learning in STEM Education (David Ian ,* Vol. 53, Pp. 1689–1699).

Honey, M., Pearson, G., & Schweingruber, H. A. (Eds.). (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research* (Vol. 500). Washington, DC: National Academies Press.

Jones, I., Lake, V. E., & Lin, M. (2008). *Early childhood science process skills.* In B. Spodek & O. Saracho (Eds.), Contemporary perspectives on science and technology in early childhood education (Pp. 17–40).

Kağıtcıbaşı, C., & Biricik, D. (2011). Generational gains on the draw-a-person IQ scores: a three-decade comparison from Turkey. *Intelligence,* 39(5), 351–356. doi:10.1016/j.intell.2011.06.001

Kale, S., & Yoldaş, C. (2021). Investigation of the effect of STEM applications on the acientific process skills of pre-school. *Turkish Studies-Educational Sciences,* 16(1). doi:10.47423/TurkishStudies.44882

Kanematsu, H., & Barry, D. M. (2016). *STEM and ıct education in intelligent environments*. Springer.

Karasar, N. (2007). *Scientific research method: concepts, principles, techniques*. Nobel.

Kavak, T. (2019). *The effect of STEM applications on 4th grade students' attitudes towards science and technology, scientific process and problem solving skills.* [Unpublished master's thesis]. Fırat University.

Kavak, Ş., & Gül, E. D. (2021). Scientific Process Skills Scale Development For Preschool Children. *Journal of Ahi Evran University Kırşehir Education Faculty,* 22(2), 1071-1099. doi:10.29299/kefad.807517

Kefi, S. (2013). Preschool Teachers ' Levels Of Using The Basıc Science process Skills. *Journal of Education and Training Research,* (34), 300–319.

Kershaw, P., Anderson, L., Warburton, W., & Hertzman, C. (2009). *15 by 15: A comprehensive policy framework for early human capital investment in BC.* Early Learning and Child Care: Building a Comprehensive Policy Framework for Canada, 17-43.

Kunt, B., Özel, E., & Kunt, H. (2015). Determination of science process skills of 60-72 months old preschool students. *Eurasian Academy of Sciences Eurasian Education & Literature Journal,* 3(3), 41-55.

Loxton, H., Mostert, J., & Moffatt, D. (2006). Screening of intellectual maturity: Exploring South African preschoolers' scores on the Goodenough-Harris Drawing Test and teachers' assessment. *Perceptual and motor skills,* 103(2), 515-525. doi:10.2466/pms.103.2.515-525

Maltese, A. V., & Tai, R. H. (2010). Eyeballs in the fridge: Sources of early interest in science. *International Journal of Science Education,* 32(5), 669-685. doi:10.1080/09500690902792385

Maral, Ş., Oğuz-Ünver, A., & Yürümezoğlu, K. (2012). An activity-based study on providing basic knowledge and skills of measurement in teaching. Educational Sciences: *Theory & Practice,* 12(1), 541-563.

McClure, E. R., Guernsey, L., Clements, D. H., Bales, S. N., Nichols, J., Kendall-Taylor, N., & Levine, M. H. (2017). *STEM starts early: Grounding science, technology, engineering, and math education in early childhood.* Joan Ganz Cooney center at sesame workshop.

Mercan, Z. & Kandır, A. (2019). *The effect of the early STEAM future preparation program on children's visual spatial reasoning skills.* [Doctoral dissertation], Gazi University Institute of Education Sciences.

Milford, T., & Tippett, C. (2015). The design and validation of an early childhood STEM classroom observational protocol. *International Research in Early Childhood Education,* 6(1), 24.

Millar, R. (1994). What is "scientific method"and can it be taught. *Teaching Science,* 164–177.

Moomaw, S., & Davis, J. L. (2010). STEM comes to preschool. *Young Children,* 65(4), 12-17.

Morgan, P. L., Farkas, G., Hillemeier, M. M., & Maczuga, S. (2016). Science achievement gaps begin very early, persist, and are largely explained by modifiable factors. *Educational Researcher,* 45(1), 18-35. doi:10.3102/0013189X16633182

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* National Academies Press.

Ormanci, Ü., & Çepni, S. (2019). Thematic analysis of conducted studies regarding preschool science education in Turkey. *Journal of Turkish Science Education*, 16(3), 415-439. doi:10.36681/

Ostlund, K. L. (1992). *Scientific process Skills: Assessing Hands-On Student Performance.* ISBN-201-29092-8.

Özdemir, M. (2004). *The effect of laboratory method based on scientific process skills in science education on academic achievement, attitude and permanence*. [Unpublished Master's Thesis]. Zonguldak Karaelmas University.

Piaget, J. (1964). *Part I: Cognitive development in children: Piaget development and learning.* J. Res. Sci. Teach., 2: 176-186.

Piasta, S. B., & Wagner, R. K. (2010). Developing early literacy skills: A meta-analysis of alphabet learning and instruction. *Reading Research Quarterly*, 45(1), 8-38. doi:10.1598/RRQ.45.1.2

Scott, L. H. (1981). Measuring intelligence with the Goodenough-Harris Drawing Test. *Psychological Bulletin*, 89(3), 483. doi:10.1037/0033-2909.89.3.483

Shonkoff, J. P., & Marshall, P. C. (2000). *From neurons to neighborhoods: The science of early childhood development.* National Academies Press.

Strong, M. G. (2013). *Developing elementary math and science process skills through engineering design ınstruction.* Hofstra University.

Şamlı, H. Ö., & Kurtulmuş, Z. (2023). Examination of postgraduate theses on STEM education in preschool education in Turkey. *Journal of STEM Teacher Institutes*, 3(1), 40-55.

Tan, M., & Temiz, B. K. (2003). The importance and role of the science process skills in science teaching. *Pamukkale University Journal of Education*, 13(1), 89–101.

Tatar, N. (2006). *The effect of research-based learning approach in primary science education on science process skills, academic achievement and attitude.* [Doctoral dissertation]. Gazi University Institute of Educational Sciences, Ankara.

Thomas, G. V., & Silk, A. M. (1990). *An introduction to the psychology of children's drawings.* New York University Press.

Tippett, C. D., & Milford, T. M. (2017). Findings from a pre-kindergarten classroom: Making the case for STEM in early childhood education. *International Journal of Science and Mathematics Education*, 15, 67-86. doi:10.1007/s10763-017-9812-8

Turan, S. G. (2012). *Development of a Science process Skills Assessment Tool for Preschool Children.* [Unpublished master's dissertation]. Gazi University Institute of Educational Sciences.

Trundle, K. C., Atwood, R. K., & Christopher, J. E. (2002). Preservice elementary teachers' conceptions of moon phases before and after instruction. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 39(7), 633-658. doi:10.1002/tea.10039

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (Vol. 86). Harvard University Press.

Zorlu, F., & Zorlu, Y. (2017). Comparison of science process skills with STEM career interests of middle school students. *Universal Journal of Educational Research*, 5(12), 2117–2124.

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Comparative Evaluation of Socioscientific Issues in Secondary Physics Curriculum and Textbooks

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Abstract

Socioscientific issues (SSI) provide an essential framework for understanding and managing the effects of scientific research and technological developments in physics on society. In this study, it was aimed to comparatively evaluate the secondary physics curriculum (9th, 10th, 11th and 12th grades) published in 2018 in Turkey and the 9th, 10th, 11th and 12th-grade physics textbooks approved by the Ministry of National Education within the framework of this curriculum in terms of SSI. A qualitative research method was utilised in the study. The study's data source comprised a secondary physics curriculum and textbooks. The research data were analysed using document analysis. As a result of the study, it was determined that only 14 out of 213 objectives in the secondary physics curriculum contained SSI content. It was determined that the grade level with the most socioscientific content was nine and then 12. In the study, as a result of the comparative analysis of the secondary physics curriculum and physics textbooks, it was determined that there was no equivalent for an outcome in the 9th-grade physics textbook that included SSI content in the curriculum. In this context, this study determined that the current education reform is incompletely reflected in the textbooks. Based on this, it can be suggested that the secondary physics course curriculum updated in 2024 is aimed to present a curriculum that includes objectives that will support students to understand the social, environmental and ethical dimensions of scientific knowledge, to increase the SSI content in the curriculum and to enrich physics textbooks with examples and activities with SSI content in line with the curriculum.

Keywords: Socioscientific issues, physics textbooks, physics curriculum, activities.

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Introduction

Today, changes in science and technology cause dilemmas in the social sphere. This situation reveals various discussion topics within society. These discussions and dilemmas are called socioscientific issues (SSI) in the literature (Akbaş & Çetin, 2018). SSI affects many aspects of our daily lives and is encountered in many fields, especially education. These areas include, for example, health and medicine. Here, discussions on the ethical dimensions of genetic research, human health and medical practices occur as part of SSI (Badeo & Duque, 2022). In the environmental context, environmental issues such as climate change, depletion of natural resources, and waste management are addressed within the framework of SSI. These issues play an essential role in the environmental impacts of our personal and social behaviours, sustainability and environmental protection policies (Kumar, Choudhary, & Singh, 2024). With a focus on technology, SSI determines how we use technology and its impact on society. For example, issues such as the effects of artificial intelligence and automation on the workforce, digital privacy and security, and so on provoke socioscientific debates (Johnson, Macalalag, & Dunphy, 2020). In terms of the education system, SSI plays a role in reducing social inequalities and promoting social mobility. Issues such as educational policies, student achievement, teacher quality and educational opportunities can be examined from a socioscientific perspective in the literature (Yun, Shi, & Jun, 2020). All these examples show that SSI is encountered in many different areas of our daily lives. Here, SSI enables individuals and societies to act in an informed and responsible manner while shaping their decisions (Novak & Treagust, 2022).

Controversial SSI requires students' evidence-based reasoning. SSI has personal significance for students and provides them with a contextual framework for developing understanding. SSI requires moral judgment and ethical evaluation in the decision-making process regarding potential solutions (Zeidler, 2003). While it is seen that SSI has a role in many fields, its relationship with the field of science is also observed quite clearly in daily life. While science deals with scientific research and discoveries to understand natural phenomena and the physical world, SSI examines the effects of science on society and how people perceive and use scientific knowledge. Therefore, SSI provides an essential framework for understanding and managing the impacts of scientific research and technological developments in science on society. In this context, it can be stated that including SSI in science education enables students to associate scientific knowledge with daily life and approach social problems sensitively (Johnson, Macalalag, & Dunphy, 2020; Karisan & Zeidler, 2017). It is also stated that the integration of SSI into science education supports students' critical thinking and problem-solving skills (Gutierez, 2015), interdisciplinary learning (Johnson et al., 2020), ethical and moral development (Zeidler, Sadler, Simmons, & Howes, 2005), effective citizenship education (Chowdhury, Holbrook, & Rannikmäe, 2020), cultural and social awareness (Hwang, Ko, Shim, Ok, & Lee, 2023) and scientific literacy (Zeidler & Kahn, 2014). At this point, it comes to mind that socioscientific topics mainly increase students' scientific literacy levels (Zeidler & Sadler, 2023). Because SSI teaches students how to use scientific knowledge in their daily lives, evaluate scientific evidence, and participate in scientific processes (Hwang et al., 2023). SSI constitute a context for scientific literacy. SSI support scientific literacy more in the context of reasoning and associating issues with daily life. In other words, individuals can develop their scientifically literate skills while researching or thinking about SSI. Accordingly, people with scientific literacy can examine critically, decide on social matters, and provide reasoned answers to whatever situation they encounter (Zeidler et al., 2005). According to Dawson and Venville (2010), scientific literacy in this context helps students participate more effectively in scientific discussions. Furthermore, socioscientific concerns help scientifically literate people strengthen their critical thinking, problem-solving, communication, and reasoning abilities and their comprehension of the nature of science (Leung, 2022; Tunç Şahin, 2022). As a result, students can assess how scientific and technical advancements have affected society and learn how to tackle complex issues from several angles. The benefits of scientific literacy for science courses have also been studied in the literature (Urhan, 2016; Yapıcıoğlu & Kaptan, 2017). Urhan (2016) discovered that students can achieve different argument levels in other situations in SSI with high scientific literacy levels. Yapıcıoğlu and Kaptan (2017) found that the socioscientific case-based teaching technique enhances scientific literacy.

In addition, SSI allows students to apply scientific and technological knowledge to real-world problems and enables students to think creatively and critically while finding solutions to problems. In

the meantime, it allows students to express their ideas clearly and effectively, as well as to understand the perspectives of others and to collaborate (Dawson & Carson, 2020). SSI increases students' ability to understand, analyse, and critically evaluate scientific and technological texts. Here, students are expected to make rational decisions on complex problems based on scientific evidence and apply these decisions effectively (Leung, 2022). In this context, SSI also increases students' sensitivity to social issues. Finally, SSI develops the ability to make connections between different disciplines (e.g., providing the opportunity to integrate knowledge from various fields, such as technology, into physics). Here, enabling students to participate in scientific and technological developments allows them to shape a better future through social change (Ram, 2020). In addition, SSI creates a context for science literacy. SSI supports science literacy more in the context of reasoning and associating topics with daily life. In other words, individuals can develop their science literacy skills while researching or thinking about SSI (Newton & Zeidler, 2020). In short, when SSI is presented to students in a scientifically correct context, it provides effective teaching. Therefore, it is seen that SSI has become one of the essential components of science and physics education, and it has made positive contributions to the learning environment because SSI contributes to the progress of society along with the personal development of individuals (Yavuz Topaloğlu & Balkan Kıyıcı, 2018).

Physics Phenomena

One of the main goals of physics education is to help students understand and be taught socioscientific themes since these subjects get their content from real-world events (Albe, 2008; Walker & Zeidler, 2007). Therefore, the importance of SSI in physics education is relatively high. This is because physics provides an understanding of natural phenomena and forms the basis for scientific and technological progress in our society. Including SSI in physics education encourages students to understand the impact of scientific developments on society. For example, students can address topics such as energy production and consumption, environmental impacts, nuclear technology, etc., and their social and ecological consequences. At this point, physics education provides the basic knowledge necessary to adapt to technological innovations. This is because including SSI in physics learning allows students to understand the social impacts of new technologies and how to manage these technologies. In addition, teaching physics with SSI content helps students evaluate scientific evidence and understand complex issues (e.g., energy crisis, global problems such as climate change, requiring solutions based on scientific and technological knowledge) (Jumadi & Dwandaru, 2023). As a result, these subjects are included in the physics curricula of many nations to increase students' comprehension of these subjects. As a result, SSIs are essential in physics education, as they improve students' ability to apply scientific knowledge to their daily lives. It enables them to find solutions to the complex problems faced by society with scientific approaches. For this reason, there is a place for SSI in physics education. By teaching SSI, students can deepen their scientific understanding and make more informed decisions for their societies (Aldahmash, Mansour, Alshamrani, & Almohi, 2016). From this point of view, the teaching of SSI can be based on this; it can be stated that SSI has an essential position in physics education as it contributes to the holistic development of students (Novak & Treagust, 2022). However, studies reveal that students lack the necessary skills to decide about socioscientific problems. Educators must discuss or at least sufficiently handle these topics in their lessons. Considering that teachers educate individuals who will shape society, are knowledgeable about SSI, and are aware of risk factors, teachers themselves should be mindful of SSI and be conscious of these issues (Sadler, 2009). Proper direction from teachers through instructional programs can help with this.

SSI in Curriculum and Textbooks

Curricula and textbooks reveal how and in what form SSI takes place in the education and training environment. The education and training environment is created based on the curriculum, and the achievements in the curriculum are transferred to the classroom environment through textbooks. At this point, textbooks are defined as an essential part of the curriculum (Arık Güngör & Saraçoğlu, 2023). Teachers follow the curriculum and use textbooks to create teaching approaches (McDonald, 2016; Yapıcıoğlu & Kaptan, 2017). Curricula and textbooks are among the effective materials for students and teachers. Because students' learning can be realized through a well-designed curriculum and textbook (Arık Güngör & Saraçoğlu, 2023). In recent years, SSI has gained importance with its

support for many skills and has taken its place in curricula and textbooks (Leung, 2022). With the inclusion of SSI in curricula, teachers have started to be asked to design learning environments that will develop students' higher-order thinking skills, student-centred, based on research and inquiry, and include reasoning in a discussion environment, and to use them in teaching activities (Badeo & Duque, 2022). At this point, the content of curricula and textbooks teachers use has started to play an even more critical role. Because it is known that the SSIs in the curriculum and textbooks constitute the reference point of teachers during teaching (Chou, 2021), it was thought that it was necessary to address how and to what extent the SSIs in the secondary physics course curriculum and textbooks, which are effective in students' learning and are expected to be compatible with each other, were addressed in the research. When the literature was examined, studies were found in which the secondary physics curriculum was reviewed in the context of SSI and other science curricula (Aydın & Silik, 2020; Et & Gömleksiz, 2021). Therefore, studies on how SSI is addressed in science curricula have also been found. For example, it has been stated that SSIs are included in science curricula to encourage students to make solutions and decisions supported by evidence-based arguments (Owen, Zeidler, & Sadler, 2017). Lee and Witz (2009) stated that SSIs are included in the science curriculum by highlighting the science-technology-society relationship that encourages students to participate in decision-making. In addition, Tsai (2018) stated that SSI is included in the curriculum by aiming for scientific competence in science and Thurrodliyah, Prihatin and Novenda (2020) focused on developing reasoning skills. In addition, in the literature, while there was a study in which science textbooks were examined in the context of SSI (Et, 2023), there was no study in which physics textbooks were reviewed in the context of SSI. Although studies investigating the impact of the science-technology-society relationship on society have been found in the literature (Lumpe & Beck, 1996), it is known that these studies do not address content as comprehensively as SSI. Because SSI addresses a more comprehensive content by requiring ethical and moral evaluations (Fang, Hsu, & Lin, 2019), for this purpose, considering the need for a detailed analysis in terms of physics course, it was requested to examine the secondary physics curriculum and textbooks together in terms of SSI. Considering that the content of the textbooks is prepared in line with the curriculum, to conduct a qualified physics education study, curriculum materials such as the curriculum and textbooks were considered as a whole in the survey and handled comparatively together. In other words, the study sought to answer how SSI is reflected in the secondary physics curriculum and textbooks. With the examination, it was among the expectations that the textbook should be consistent with the content of the curriculum. Because it is known that textbooks should be prepared to reflect the curriculum (Doğan, 2021).

Purpose of the Study

It is stated that with the inclusion of SSI in the secondary physics course curriculum and textbooks, attention is drawn to the elements that concern society, students are allowed to express their opinions and experiences, and meaningful learning can occur. At this point, it is essential to determine how SSI, which is also a factor in achieving the goal of science literacy, is handled in the secondary physics curriculum and textbooks (Yenilmez Türkoğlu & Öztürk, 2019). The 2018 curriculum published by the Ministry of National Education (MoNE) includes 'Objectives', one of the curriculum elements, in detail. However, the content element is only included in the secondary physics curriculum as subject headings. Therefore, there is a need to examine the centrally used textbooks to make sense of the content pointed out by the objectives because the textbook's content is binding for all schools in Turkey.

SSI was included in the secondary physics curriculum in Turkey for the first time in 2013 under basic skills with the statement "Perceives the relationship between Science-Technology-Society-Environment and perceives the relationship between Science-Technology-Society-Environment, reasoning about SSI, discusses, poses problems and produces solutions." The 2018 curriculum's importance continued to be emphasized among its basic philosophy and general objectives: "It is aimed to make inferences about socioscientific events related to the use of different energy sources" (MoNE, 2013; MoNE, 2018). In this context, as in the literature (Mohamad & Shaaban 2021), SSI is considered an essential context in the secondary physics curriculum in Turkey.

In line with all these statements, this study aims to comparatively evaluate the secondary physics curriculum (9th, 10th, 11th, and 12th grades) published in 2018 and the 9th, 10th, 11th, and 12th-grade physics textbooks approved by MoNE within the framework of this curriculum in terms of SSI. The sub-problems of the research are given below:

1. What outcomes are related to SSI in the secondary physics (9th, 10th, 11th and 12th grades) curriculum published in 2018?

2. What are the SSI activities in the 9th, 10th, 11th and 12th grade physics textbooks approved by MoNE?

Method

This study aimed to comparatively evaluate the secondary physics curriculum (9th, 10th, 11th and 12th grades) published in 2018 and the 9th, 10th, 11th and 12th-grade physics textbooks approved by the MoNE within the framework of this curriculum in terms of SSI. For this purpose, the qualitative research method was utilized. With qualitative research method, it is desired to reveal the process, situation or understanding of the phenomena (Yıldırım & Şimşek, 2016).

Data Source

The data source of the study consists of the secondary physics curriculum published in 2018 and the MoNE secondary physics 9th, 10th, 11th and 12th-grade textbooks. The curriculum and textbook are provided to teachers and students by MoNE for use in the teaching process.

The data source of the study, the Secondary Education Physics (9th, 10th, 11th and 12th grades) Curriculum published in 2018, was accessed through the MoNE Curriculum Monitoring and Evaluation System (https://mufredat.meb.gov.tr/ProgramDetay.aspx?PID=351) (MoNE, 2018). The MoNE secondary physics 9th, 10th, 11th and 12th-grade textbooks to be included in the study were accessed from https://ogmmateryal.eba.gov.tr/etkilesimli-kitaplar/fizik. The Education Information Network (EBA) is a social electronic content network established by the MoNE of the Republic of Turkey. At this point, four physics textbooks were included in the study, one textbook for each grade level on EBA. These textbooks: Secondary Physics 9 Textbook (Sever, Türeci, Atar, & Dağ, 2019), Secondary Physics 10 Textbook (Kaderoğlu, Kaya, Karaaslan, & Koç, 2021), Secondary Physics 11 Textbook (Döyen et al., 2021) and Secondary Physics 12 Textbook (Çifci, Bozkurt, & Nalbant, 2022). The authenticity and originality of the data sources were confirmed by accessing them from their official websites. Primary sources related to the research topic were accessed (Sak, Şahin Sak, Şendil, & Nas, 2021).

Data Analysis

The study data sources were analysed through document analysis. Document analysis provides a systematic analysis of the content of written documents. The document analysis process in the research is detailed in Figure 1 (Yıldırım & Şimşek, 2016).

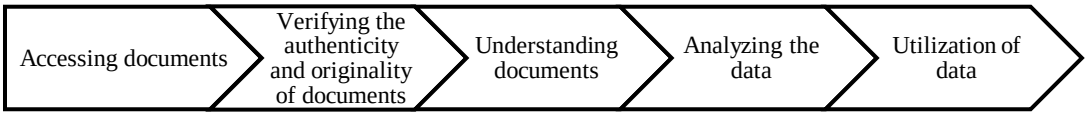

Figure 1. Document Analysis Process in the Research

A detailed explanation of the document analysis process is given below in Figure 1.

1. The authenticity and originality of the sources were confirmed by accessing the data sources from their official websites.

2. The obtained sources were analysed in detail and comparatively within the scope of descriptive analysis.

3. The curriculum outcomes to be included in the analysis regarding SSI and the activities in the textbooks prepared in line with these outcomes were determined. While deciding on these learning outcomes and activities, SSI content expressions for discussion, generating ideas, inferring, interpreting, questioning and proposing solutions were considered. Because SSI inherently involves

the skills expressed, the objectives and activities involving these skills were reviewed and included in the analysis after deciding whether they included SSI (Zeidler & Nichols, 2009).

For example, “9.4.5.1. Evaluate renewable and non-renewable energy sources regarding advantages and disadvantages.” has an SSI in its content and is oriented towards interpretation and questioning, as stated by Zeidler and Nichols (2009), which was included in the analysis. This outcome statement corresponds to the activity in the textbook. Sample activity visual in the textbook (Sever et al., 2019, p. 203):

> Your Turn 23
>
> If you were the manager of your city, which source would you use to generate electricity for the town? Explain the reasons for your choice regarding cost, accessibility, ease of production, community, technology and environmental impacts.

4. Tables were created to present the analysis in detail to the readers.

5. The tables included the grade level, unit name, subject name, and outcome statements evaluated regarding SSI in the curriculum.

6. Then, the relevant outcome statement and the SSI activity in the textbook were indicated in the tables.

7. While sharing research results/data, research results were included in a way that would not harm or benefit the institutions, organisations or individuals in the documents.

Validity and Reliability

After the data collection and analysis process, two experts with doctoral degrees in physics education examined the written and visualized documents for the validity and reliability of the research. The data are observable, testable, and based on digital and printed sources. The experts examined the objectives and activities presented for evaluation in terms of the SSI, taking into consideration the characteristics of the SSI (having a scientific basis, requiring making choices or generating ideas at a personal/social level, involving value and ethical reasoning, being a current social issue from life, etc.) and the statements that are intended for discussion, generating ideas, making inferences, interpreting, questioning, and proposing solutions as stated by Zeidler and Nichols (2009) (Ratcliffe & Grace, 2003). The experts first analysed each other independently. After the first analysis, the number of “agreements” and “disagreements” among the experts was calculated for the reliability of the research (Miles & Huberman, 1994). The percentage of agreement calculated due to the first coding was 96%. Then, the experts came together to compare the data obtained. The experts discussed the differences between their coding, and this process continued until 100% agreement was achieved (Yıldırım & Şimşek, 2016). The research data were finalized and presented to the readers in the findings section.

Findings

This study aimed to comparatively evaluate the secondary physics curriculum (9th, 10th, 11th and 12th grades) published in 2018 in Turkey and the 9th, 10th, 11th and 12th-grade physics textbooks approved by the MoNE within the framework of this curriculum regarding SSI. In line with this purpose, two sub-problems were identified in the study, and the findings obtained for these problem statements are presented in detail below.

Outcomes Related to SSI in the Secondary Physics Curriculum

In the secondary physics curriculum (9th, 10th, 11th and 12th grades), 72 lesson hours were allocated for 44 objectives in six units in 9th grade, 72 lesson hours for 39 objectives in four units in 10th grade, 144 lesson hours for 62 objectives in two units in 11th grade, and 144 lesson hours for 68 objectives in six units in 12th grade. The objectives in the secondary physics curriculum were examined in terms of SSI. The objectives include "discussing, generating ideas, making inferences, interpreting, questioning, offering solutions", among the skills expected by SSI (Zeidler & Nichols, 2009). The findings obtained in this context are explained in detail in Table 1.

Table 1.
Outcomes Related to SSI In The Secondary Physics Curriculum

Grade	Unit Name	Topic Name	Outcome
9	9.1.Introduction to Physical Science	9.1.4. Science research centres	9.1.4.1. Explains the importance of science research centres for physics.
	9.2.Matter and its Properties	9.2.2. Resilience	9.2.2.1. Explains the concept of durability.
	9.4. Energy	9.4.4. Yield	9.4.4.2. Develop recommendations to increase the efficiency of a sample system or design.
	9.4. Energy	9.4.5. Energy Resources	9.4.5.1. Evaluate renewable and non-renewable energy sources regarding advantages and disadvantages.
	9.5.Heat and Temperature	9.5.4. Energy Resources	9.5.4.1. Explains energy transmission pathways with examples.
	9.5. Heat and Temperature	9.5.4. Energy transmission pathways and energy transmission rate	9.5.4.3. Designs for the insulation of living spaces for energy conservation.
	9.5. Heat and Temperature	9.5.4. Energy transmission pathways and energy transmission rate	9.5.4.5. Develop projects for measures against global warming.
10	10.3. Waves	10.3.5. Earthquake Waves	10.3.5.2. Develop solutions to prevent loss of life and property damage caused by earthquake waves.
11	11.2. Electricity and Magnetism	11.2.5. Alternating Current	11.2.5.2. Compares alternating current and direct current.
12	12.1.Circular Motion	12.1.2. Rotational Translation Motion	12.1.2.3. Explains the variables on which the kinetic energy of an object undergoing rotational and translational motion depends.
	12.2.Simple Harmonic Motion	12.2.1. Simple Harmonic Motion	12.2.1.4. Determines the variables on which the period depends in a spring and simple pendulum.
	12.4. Introduction to Atomic Physics and Radioactivity	12.4.3. Radioactivity	12.4.3.3. Explains nuclear fission and fusion events.
	12.4. Introduction to Atomic Physics and Radioactivity	12.4.3. Radioactivity	12.4.3.4. Explains the effects of radiation on living organisms.
	12.6. Applications of Modern Physics in Technology	12.6.2. Semiconductor Technology	12.6.2.4. Explains the operation of solar cells.

Table 1 shows seven objectives at the 9th-grade level, one at the 10th-grade level, one at the 11th-grade level and five at the 12th-grade level in the secondary physics curriculum were determined to be related to SSI by considering the objective descriptions. In total, 14 of the 213 objectives in the curriculum were found to be associated with SSI. Considering these learning outcome statements, the findings related to the second sub-problem of the study are presented in detail below.

SSI Activities in Physics Textbooks

In the study, 9th, 10th, 11th and 12th-grade physics textbooks approved by the MoNE were analysed regarding SSI, and the results obtained are given in Table 2. In Table 2, the type of activity and the SSI activity in the physics textbooks are provided in return for the outcome number of the outcome statement in the curriculum. The ones that were not named in the SSI activities were called by the researcher, considering the content of the activity.

Table 2.
Findings Related to SSI Activities In Physics Textbooks

Outcome No	Activity Type In Physics Textbooks	SSI Activity
9.1.4.1.	Your Turn (p. 46)	Scientific Discovery
9.4.4.2.	Your Turn (p. 196)	Sustainable Living
9.4.5.1.	Your Turn (p. 203)	Energy Sources

Table 2 continuing

Outcome No	Activity Type In Physics Textbooks	SSI Activity
9.5.4.1.	Your Turn (p. 241)	Energy Sources
9.5.4.3.	Your Turn (p. 245)	Energy Sources
9.5.4.3.	Your Turn (p. 246)	Environmentally Friendly
9.5.4.5.	Project (p. 250)	Climate Change
10.3.5.2.	Project (p. 173)	Natural Disasters
11.2.5.2.	Activities (p. 356)	Scientists
12.1.2.3.	Research (p. 41)	Electric Transportation Vehicles
12.2.1.4.	Research (p. 92)	Energy Sources
12.4.3.3.	Research (p. 177)	Nuclear Armament
12.4.3.4.	Research (p. 178)	Radiation Effect
12.6.2.4.	Research (p. 239)	Energy Sources

As seen in Table 2, 14 activities with SSI content were identified in physics textbooks. It is seen that there is no activity in the textbook for each outcome statement in Table 1. In the secondary physics textbook, no SSI activity proposal was found for the outcome statement "9.2.2.1. Explains the concept of durability." under the subject title "9.2.2. Resilience". In addition, as stated in Table 1, it was determined that SSI activities were primarily included in the 9th-grade level. It was determined that SSI activities were primarily included in the textbooks under the 'it's your turn' title.

Discussion and Conclusion

In this study, the secondary physics curriculum and textbooks were comparatively evaluated regarding SSI. In line with the aim of the research, information about the current situation of the curriculum and textbooks in terms of SSI was obtained. As a result of the study, 14 acquisitions with SSI content were found. It was determined that the grade level with the most intense SSI content was 9th and then 12th. One acquisition and activity with SSI content was identified at the 10th and 11th grade levels. When the secondary physics curriculum and physics textbooks were examined comparatively by the researchers, it was observed that the 9th-grade physics textbook did not include any SSI activity in the 9th-grade physics textbook in response to the socioscientific outcome statement "9.2.2.1. Explains the concept of durability." under the subject heading "9.2.2. Resilience " in the curriculum. Therefore, this study also revealed to what extent the textbooks were prepared according to the curriculum guidelines regarding SSI matter. In other words, this study demonstrated how the current educational reform is reflected in the textbooks. It is stated in the literature that this incompatibility between the textbook and the curriculum will negatively affect student achievement (Anderson & Krathwohl, 2001). It is argued that students' cognitive process skills develop directly to the curriculum and textbooks' objectives, teaching-learning processes, and assessment-evaluation steps. Therefore, it is emphasized that the harmony between the curriculum and textbooks is crucial for effectively realising the teaching process. In other words, it is stated that the higher this harmony is, the more achievements can be reached at the desired level (Kalender & Baysal, 2021). In addition, it can be stated that this kind of deficiency is mainly mentioned in the research because there is a centralized teaching system in Turkey (Koyunlu Ünlü & Şen, 2018). To put it more clearly, the 2018 curriculum published by MoNE includes 'objectives' among the curriculum elements in detail, and textbooks are developed and used to make sense of the content element these objectives point to. The content of the curriculum and textbooks is determined by MoNE, and these books are printed and distributed free of charge to school students. All students studying physics throughout the country complete their education through almost the same curriculum and textbooks. Therefore, teachers use the curriculum and textbooks as their primary sources. From this point of view, in Turkey's education and training environment, the content of textbooks has a significant role in achieving the goals of education and training, especially the curriculum (Yapıcıoğlu & Atabey, 2020). Therefore, as a result of this research, it was aimed to draw attention to the need to increase SSI activities in line with the aim of the physics curriculum by determining the deficiency in the textbook and revealing that there is limited space for acquisitions and activities with SSI content in teaching tools. This result expressed in the study is also supported by Mohamad and Shaaban (2021). In the literature, it is known that students' skills in explaining natural phenomena, problem-solving, critical thinking and scientific understanding will improve with SSI activities that are increased as a result of such studies or included in teaching (Doğan, 2021; Novak & Treagust, 2022). In addition, it is also stated in the literature that classroom environments dominated

by superficial science understanding should enable teachers to include comprehensive inquiry activities with the main teaching tools (Khine & Liu, 2017). In short, it is thought that education and training environments should be supported with powerful teaching tools and SSI content, with the findings of the literature supporting the research result. Therefore, it is believed that efforts should be made to place SSI context in most physics subjects. Jumadi and Dwandaru (2023) also support the research result and argue that teaching in an SSI context should be supported to understand physics topics that encourage understanding the effects of scientific developments on society. In this way, it is argued that the social and environmental consequences of issues such as energy production and consumption, energy crisis, climate change and nuclear technology, which have been on the agenda in recent years, can be addressed by students. In another respect, it is also emphasized that physics education provides the basic knowledge necessary to adapt to technological innovations.

In addition, when the outcomes with SSI content stated in the research were analysed, it was seen that these outcomes were completed with the predicate expressions "explains the importance, develops suggestions, evaluates, designs, compares". By the nature of the SSI, it can be stated that this is an expected result. SSI requires students to acquire different skills with the developments and changes in science, technology, and society. Therefore, it comes to mind that curricula are being developed and updated by considering the need for individuals who question and produce in society with the outcomes of SSI content. For this reason, it is observed that individuals who explain, offer suggestions and evaluate are desired in the outcome statements (Et, 2023). In addition, with these updates in the curriculum, it is thought that the expectations from individuals are increasing daily by putting the existence and interaction of society and science in the foreground. This relationship concerns all subjects that have social importance in physics. Therefore, it comes to mind that the importance of the link established between physics subjects within the scope of knowledge and societal interaction is increasing daily (Chen & Xiao, 2021).

In addition, it is thought that the recent addition of technology to the interaction of science and society and the realization of this questioning within the framework of science-society-technology has led to increased dilemmas and discussions on these issues (Yun et al., 2020). All the factors in this spiral affect the emergence of SSI and their frequent agenda in the education system. SSI is considered in the literature as an issue that concerns society, is scientific, can be discussed, and has an ethical context (Leung & Cheng, 2023). In line with all these statements, considering that SSI with multiple dimensions involves individuals in a scientific research process and that individuals make scientific decisions and find themselves in scientific discussions (Melton, Saiful, & Shein, 2022), it is thought that the use of SSI in curricula and textbooks will enable students to approach social problems sensitively and consciously while strengthening their scientific thinking skills. Therefore, it is believed that the integration of SSI into teaching tools will make science education more comprehensive and meaningful, and thus, students will be able to use scientific knowledge more effectively in their daily lives (Jumadi & Dwandaru, 2023; Salloum, 2021).

Suggestions

The inclusion of SSI in curricula and textbooks enables students to use scientific knowledge effectively in their daily lives, develop many skills, be sensitive to social problems and act as active citizens. Therefore, SSI has an essential place in education. It is known that the use of SSI in curricula and textbooks is becoming increasingly important to help students connect scientific knowledge to their daily lives and understand social contexts. Recent studies support this importance by revealing that renewed or updated curricula focus on scientific research and innovative skills (Atakan & Akçay, 2022; Bayır & Kahveci, 2022). It is believed that this study will provide a perspective to the expert field educators who create the content of the physics curricula and textbooks to be updated.

In this context, it was determined that there was a discrepancy between the secondary physics curriculum published in 2018 and the textbooks examined comparatively in terms of SSI at the 9th-grade level. At this point, the researcher developed an SSI activity proposal to overcome the deficiency since there is no SSI activity in the textbook for the unit name '9.2. Matter and its Properties', the subject name '9.2.2. Resilience' and outcome '9.2.2.1. Explains the concept of durability.' it was paid attention that the SSI activity suggestion developed by the researcher (see Table

3) was related to the outcome, related to daily life, necessary for humanity and society, and offered students the opportunity to discuss (Atabey, Topçu, & Çiftçi, 2018).

Table 3.
SSI Activity Suggestion

Outcome No	Activity Type	SSI Activity
9.2.2.1.	Your Turn	Urban Transformation
With zoning permission, a new settlement centre will be created in a large area. Considering the growing population, state authorities prefer to build high-rise buildings in this area. However, scientists state that as the size of the buildings increases, unsolvable durability problems arise—the engineers who will work in this region state that durability is a prerequisite for building structures. If a house were to be built for you in this region, how would you react to the situation, considering durability? Explain.		

The suggestion in Table 3 was prepared as a discussion question. This SSI activity suggestion presented by the researcher can be considered a step towards eliminating the deficiency in the 9th-grade physics textbook.

In addition to this, some suggestions are given below by mentioning some critical issues in terms of SSI in a general framework and considering the secondary physics curriculum updated in 2024:

1. Presenting a curriculum that includes objectives to support students' understanding of the social, environmental and ethical dimensions of scientific knowledge,

2. Enriching physics textbooks with examples and activities involving SSI,

3. Supporting meaningful learning by showing students how science can be related to daily life through textbooks enriched with SSI,

4. The physics curriculum and textbooks should address issues such as social responsibility, environmental protection, and technology ethics, allowing students to apply their scientific thinking to social problems,

5. The methods used in teaching SSI in the physics textbook include discussion, project-based learning, field studies and interactive simulations,

6. Through these methods used in physics teaching, students are allowed to explore the social contexts of scientific knowledge and develop critical thinking skills,

7. Provide support to teachers by including the integration of SSI into teaching and helpful teaching strategies in teacher handbooks,

8. Linking SSI related to physics subjects with disciplines such as social sciences, mathematics, and technology can help students gain the ability to address and solve complex social problems.

Finally, in future studies, it can be suggested to comparatively evaluate the secondary physics curriculum (9th, 10th, 11th and 12th grades) published in 2024 and the 9th, 10th, 11th and 12th-grade physics textbooks approved by MoNE within the framework of this curriculum in terms of SSI and to discuss the current situation with the results of this research.

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References

Akbaş, M., & Çetin, P. S. (2018). The investigation of gifted students' argumentation level and informal reasoning related to socioscientific issues. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 12*(1), 339-360. doi:10.17522/balikesirnef.437794

Albe, V. (2008). When scientific knowledge, daily life experience, epistemological and social considerations intersect: Students' argumentation in group discussions on a socio-scientific issue. *Research in Science Education, 38*(1), 67-90. doi:10.1007/s11165-007-9040-2

Aldahmash, A. H., Mansour, N. S., Alshamrani, S. M., & Almohi, S. (2016). An analysis of activities in Saudi Arabian middle school science textbooks and workbooks for the inclusion of essential features of inquiry. *Research in Science Education, 46*, 879-900. doi:10.1007/s11165-015-9485-7

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives: Complete edition*. Addison Wesley Longman, Inc.

Arık Güngör, B., & Saraçoğlu, S. (2023). Evaluation of high school transition system (LGS) science question in terms of context-based learning approach. *SDU International Journal of Educational Studies, 10*(2), 22-46. doi:10.33710/sduijes.1318492

Atabey, N., Topçu, M. S., & Çiftçi, A. (2018). The investigation of socioscientific issues scenarios: A content analysis research. *OPUS International Journal of Society Researches, 9*(16), 1968-1991. doi:10.26466/opus.474224

Atakan, M., & Akçay, B. (2022). Representation of changes about nature of science in Turkish middle school science textbooks. *Science & Education*, 1-30. doi:10.1007/s11191-022-00403-6

Aydın, F., & Silik, Y. (2020). An investigation of how pre-service elementary school teachers relate socio-scientific issues in the scope of learning outcomes of 2017 science education curriculum (Grade 3 and 4). *Inonu University Journal of the Faculty of Education*, *21*(2), 740-756. doi:10.17679/inuefd.648944

Badeo, J. M., & Duque, D. A. (2022). The effect of socio-scientific issues (SSI) in teaching science: A meta-analysis study. *JOTSE: Journal of Technology and Science Education*, *12*(2), 291-302. doi:10.3926/jotse.1340

Bayır, E., & Kahveci, S. (2022). Examination of secondary school science textbooks in terms of scientific process skills. *Cumhuriyet International Journal of Education*, *11*(1), 253-262. doi:10.30703/cije.1026825

Chen, L., & Xiao, S. (2021). Perceptions, challenges and coping strategies of science teachers in teaching socioscientific issues: A systematic review. *Educational Research Review*, *32*, 100377. doi:10.1016/j.edurev.2020.100377

Chou, P. I. (2021). The representation of global issues in Taiwanese elementary school science textbooks. *International Journal of Science and Mathematics Education*, *19*, 727-745. doi:10.1007/s10763- 020-10083-9

Chowdhury, T. B. M., Holbrook, J., & Rannikmäe, M. (2020). Socioscientific issues within science education and their role in promoting the desired citizenry. *Science Education International, 31*(2), 203-208. doi:10.33828/sei.v31.i2.10

Çifci, A., Bozkurt, H., & Nalbant, M. (2022). *Ortaöğretim Fizik 12 Ders Kitabı* [Secondary Physics 12 Textbook]. Ankara: Ministry of National Education.

Dawson, V. M., & Venville, G. (2010). Teaching strategies for developing students' argumentation skills about socioscientific issues in high school genetics. *Research Science Education, 40*(2), 133–148. doi:10.1007/s11165-008-9104-y

Dawson, V., & Carson, K. (2020). Introducing argumentation about climate change socioscientific issues in a disadvantaged school. *Research in Science Education*, *50*, 863-883. doi:10.1007/s11165-018-9715-x

Doğan, O. K. (2021). Methodological? or dialectical? Reflections of scientific inquiry in biology textbooks. *International Journal of Science and Mathematics Education, 19*(8), 1563-1585. doi:10.1007/s10763-020-10120-7

Döyen, A. G., Çetinol, A., Erbek, E., Turan, M., Alagöz, N. E., & Özübek, U. (2021). *Ortaöğretim Fizik 11 Ders Kitabı* [Secondary Physics 11 Textbook]. Ankara: Ministry of National Education.

Et, S. Z., & Gömleksiz, M. (2021). Evaluation of science, biology and physics curriculum in terms of socioscientific issues. *Fırat University Journal of Social Sciences, 31*(2), 745-756. doi:10.18069/firatsbed.872628

Et, S. Z. (2023). Analysis of secondary school science textbook activities in terms of socioscientific issues: A document analysis. *Journal of Curriculum and Educational Studies, 1*(1), 53-80. doi:10.5281/zenodo.8101729

Fang, S. C., Hsu, Y. S., & Lin, S. S. (2019). Conceptualizing socioscientific decision making from a review of research in science education. *International Journal of Science and Mathematics Education, 17*, 427– 448. doi:10.1007/s10763-018-9890-2

Gutierez, S. B. (2015). Integrating socio-scientific issues to enhance the bioethical decision-making skills of high school students. *International Education Studies, 8*(1), 142-151. doi:10.5539/ies.v8n1p142

Hwang, Y., Ko, Y., Shim, S. S., Ok, S. Y., & Lee, H. (2023). Promoting engineering students' social responsibility and willingness to act on socioscientific issues. *International Journal of STEM Education, 10*(11), 1-16. doi:10.1186/s40594-023- 00402-1

Johnson, J., Macalalag, A. Z., & Dunphy, J. (2020). Incorporating socioscientific issues into a STEM education course: Exploring teacher use of argumentation in SSI and plans for classroom implementation. *Disciplinary and Interdisciplinary Science Education Research, 2*(9), 1-12. doi:10.1186/s43031-020-00026-3

Jumadi, J., & Dwandaru, W. S. B. (2023). Socio-scientific issues in physics learning to improve students' critical thinking skills. *Revista Mexicana de Física E, 20*(1), 010202-1. doi:10.31349/RevMexFisE.20.010202

Kaderoğlu, A., Kaya, N., Karaaslan, V. E., & Koç, Y. S. (2021). *Ortaöğretim Fizik 10 Ders Kitabı* [Secondary Physics 10 Textbook]. Ankara: Ministry of National Education.

Kalender, B., & Baysal, Z. N. (2021). Öğretim programı ve ders kitaplarının program ögelerinin uyumu açısından incelenmesi: Hayat bilgisi örneği [Examining the curriculum and textbooks in terms of the compatibility of curriculum elements: Life science example]. *Bogazici University Journal of Education, 38*(2), 75-96. doi:10.52597/buje.990925

Karisan, D., & Zeidler, D. L. (2017). Contextualization of nature of science within the socioscientific issues framework: A review of research. *International Journal of Education in Mathematics, Science and Technology, 5*(2), 139-152. doi:10.18404/ijemst.270186

Khine, M. S., & Liu, Y. (2017). Descriptive analysis of the graphic representations of science textbooks. *European Journal of STEM Education, 2*(3), 06. doi:10.20897/ejsteme/81285

Koyunlu Ünlü, K., & Şen, Ö. (2018). The investigation of 5th grade science textbooks activities in terms of scientific inquiry and engineering design process. *Sakarya University Journal of Education, 8*(4), 185-197. doi:10.19126/suje.448331

Kumar, V., Choudhary, S. K., & Singh, R. (2024). Environmental socio-scientific issues as contexts in developing scientific literacy in science education: A systematic literature review. *Social Sciences & Humanities Open, 9*, 100765. doi:10.1016/j.ssaho.2023.100765

Lee, H., & Witz, K.G. (2009). Science teachers' inspiration for teaching socio-scientific issues: disconnection with reform efforts. *Internation Journal of Science Education, 31*(7), 931-960. doi:10.1080/09500690801898903

Leung, J. S. C. (2022). Shifting the teaching beliefs of preservice science teachers about socioscientific issues in a teacher education course. *International Journal of Science and Mathematics Education, 20(*4), 659–682. doi:10.1007/s10763-021-10177-y

Leung, J. S. C., & Cheng, M. M. W. (2023). Prioritizing emotion objects in making sense of student learning of socioscientific issues. *Journal of Research in Science Teaching, 60*(2), 357-389. doi:10.1002/tea.2180

Lumpe, A. T., & Beck, J. (1996). A profile of high school biology textbooks using scientific literacy recommendations. *The American Biology Teacher, 58*(3), 147-153.

McDonald, C. V. (2016). Evaluating junior secondary science textbook usage in Australian schools. *Research in Science Education, 46*(4), 481-509. doi:10.1007/s11165-015-9468-8

Melton, J. W., Saiful, A, J., & Shein, P, P. (2022). Interdisciplinary STEM program on authentic aerosol science research and students' systems thinking approach in problem-solving. *International Journal of Science Education*, *44*(9), 1419-1439. doi:10.1080/09500693.2022.2080886

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook (2nd edition).* California: Sage

Ministry of National Education. (2013). *Ortaöğretim fizik dersi (9, 10, 11 ve 12. Sınıflar) öğretim programı* [Secondary school physics course (Grades 9, 10, 11 and 12) curriculum]. Ankara: Talim ve Terbiye Kurulu Başkanlığı.

Ministry of National Education. (2018). *Ortaöğretim fizik dersi (9, 10, 11 ve 12. Sınıflar) öğretim programı* [Secondary school physics course (Grades 9, 10, 11 and 12) curriculum]. Ankara: Talim ve Terbiye Kurulu Başkanlığı.

Mohamad, A., & Shaaban, K. (2021). *Addressing the STSE issues in the Lebanese National Science curriculum and textbooks*. Lebanese American University: Department of Education.

Newton, M. H., & Zeidler, D. L. (2020). Developing socioscientific perspective taking. *International Journal of Science Education, 42*(8), 1302-1319. doi:10.1080/09500693.2020.1756515

Novak, A. M., & Treagust, D. F. (2022). Supporting the development of scientific understanding when constructing an evolving explanation. *Disciplinary and Interdisciplinary Science Education Research, 4*(1), 1-22. doi:10.1186/s43031-021-00043-w

Owen, D., Zeidler, D., & Sadler, T. (2017). Controversial issues in the science classroom. *Phi Delta Kappan, 99*(4), 45-49. doi:10.1177/0031721717745544

Ram, R. (2020). Engaging young people in science education through socioscientific issues of biosecurity. *Kōtuitui: New Zealand Journal of Social Sciences Online, 15*(1), 22-37. doi:10.1080/1177083X.2019.1637908

Ratcliffe, M., & Grace, M. (2003). *Science education for citizenship: Teaching socio-scientific issues*. UK: McGraw-Hill Education.

Sadler, T. D. (2009). Situated learning in science education: Socio-scientific issues as contexts for practice. *Studies in Science Education, 45(1),* 1-42. doi:10.1080/03057260802681839

Sak, R., Şahin Sak, T., Şendil, Ö., & Nas, E. (2021). Document analysis as a research method. *Kocaeli University Journal of Education, 4*(1), 227-250. doi:10.33400/kuje.843306

Salloum, S. (2021). Intertextuality in science textbooks: implications for diverse students' learning. *International Journal of Science Education, 43*(17), 2814-2842. doi:10.1080/09500693.2021.1992530

Sever, C., Türeci, D., Artar, N., & Dağ, O. (2019). *Ortaöğretim Fizik 9 Ders Kitabı* [Secondary Physics 9 Textbook]. Ankara: Ministry of National Education.

Thurrodliyah, N., Prihatin, J., & Novenda, I. (2020). The Development of Brain-Based Learning Model based on Socioscientific Issues (BBL-SSI) for Biology Learning in Senior High School. *Electronic Journal of Science Education, 3*(2), 31-42.

Tsai, C. Y. (2018). The effect of online argumentation of socio-scientific issues on students' scientific competencies and sustainability attitudes. *Computers & Education, 116*, 14-27. doi:10.1016/j.compedu.2017.08.009

Tunç Şahin, C. (2022). The argumentation levels of social studies undergraduate and graduate students regarding socio-scientific issues. *Milli Eğitim Dergisi, 51*(236), 3031-3060. doi:10.37669/milliegitim.953144

Urhan, G. (2016). *An Examination of students' quality of arguments and informal reasoning skills in argumentation based learning environments* (Unpublished doctoral dissertation). Gazi University, Ankara.

Yapıcıoğlu, A. E., & Kaptan, F. (2017). A mixed method research study on the effectiveness of socioscientific issue-based instruction. *Education and Science, 42*(192), 113-137. doi:10.15390/EB.2017.6600

Yapıcıoğlu, A. E., & Atabey, N. (2020). Evaluation of trends in theses on socio-scientific issues: The case of Turkey . *International Journal of Progressive Education, 16*(4), 115-134. doi:10.29329/ijpe.2020.268.8

Yavuz Topaloğlu, M., & Balkan Kıyıcı, F. (2018). The effect of the activities carried out in out-of-school learning environments based on socio-scientific issues on the decision-making of the students. *Kastamonu Education Journal*, *26*(5), 1667-1678. doi:10.24106/kefdergi.2200

Yenilmez, Türkoğlu, A., & Öztürk, N. (2019). Pre-service science teachers' mental models of socio-scientific issues. *Başkent University Journal of Education*, *6*(1), 127-137.

Yıldırım, A., & Şimşek, H. (2016*). Sosyal bilimlerde nitel araştırma yöntemleri [Qualitative research methods in the social sciences]*. Ankara: Seçkin.

Yun, A., Shi, C., & Jun, B. G. (2020). Dealing with socio-scientific issues in science exhibition: A literature review. *Research in Science Education*, *52*, 99–110. doi:10.1007/s11165-020-09930-0

Walker, A. K., & Zeidler, L. D. (2007). Promoting discourse about socioscientific issues through scaffolded inquiry. *International Journal of Science Education, 29*(11), 1387-1410. doi:10.1080/09500690601068095

Zeidler, D. L. (2003). *The role of moral reasoning on socioscientific issues and discourse in science education.* Kluwer Academic Press.

Zeidler, D. L., Sadler, T. D., Simmons, M. L., & Howes, E. V. (2005). Beyond STS: A research-based framework for socioscientific issues education. *Science Education, 89*(3), 357-377. doi:10.1002/sce.20048

Zeidler, D. L., & Nichols, B. H. (2009). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education*, *21*(2), 49-58. doi:10.1007/BF03173684

Zeidler, D. L., & Kahn, S. (2014). *It's debatable!: Using socioscientific issues to develop scientific literacy K-12*. NSTA Press.

Zeidler, D. L., & Sadler, T. D. (2023). Exploring and expanding the frontiers of socioscientific issues: Crossroads and future directions. In N. G. Lederman, D.L. Zeidler, & J.S. Lederman (Eds.), *Handbook of Research on Science Education, Volume III (pp. 899-929).* Routledge.

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Exploring Faculty Members' Experiences with Virtual Classroom Platforms and Their Perceived Usability during the COVID-19

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Abstract

This two-phase mixed-method study examined faculty experiences with Virtual Communication Platforms (VCPs) and their usability in distance education during the COVID-19 pandemic. A stratified random sample of 913 faculty members from 167 universities was selected to participate in an online questionnaire that included the System Usability Scale, demographic information, and open-ended questions. Twenty-five of the faculty members who had completed the online questionnaire were then interviewed using semi-structured interviews. The quantitative data were subjected to analysis using an independent sample t-test, one-way ANOVA, and descriptive statistics. In contrast, the qualitative data were examined through an inductive analysis technique. The quantitative analysis results indicate that Zoom was the most favored platform, obtaining a good usability score together with Google Meet and Adobe Connect. In contrast, Perculus and Microsoft Teams were evaluated as having poor usability. Results also revealed the significant effect of gender on Perculus, distance education experience on Zoom, and age and academic status on Zoom and Google Meet usability perceptions. Furthermore, the qualitative analysis results revealed usability challenges (e.g., technical challenges, functionality issues, usability concerns), positive aspects (e.g., usability and effectiveness, support and issue resolution, performance and accessibility), and suggestions for improvement (e.g., instruction and support, exploration and optimization, format and assessment enhancement) for VCPs. The study offers valuable insights for institutions to make informed decisions about adopting VCP, investing in targeted training programs, and ultimately fostering a more effective and inclusive distance learning environments.

Keywords: Virtual classroom platform, synchronous distance education, Covid-19, system usability, faculty members.

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Introduction

Distance education, a pedagogical approach characterized by the physical separation of students and teachers, has evolved significantly over time, primarily due to advancements in telecommunications technology. This approach harnesses technological means like the internet, video conferencing, and online learning platforms to connect learners and educators (Keegan, 1980). It frees students from the necessity of attending a fixed place at a fixed time for instruction (Markel, 1999). Despite being a relatively recent and trending phenomenon, it has a long and rich history dating back to the mid-19th century, when correspondence courses were offered through the mail (Schulte, 2011). The advent of radio and television in the 20th century further expanded the reach of distance education, making it more widely accepted (Moore & Kearsley, 2011). With the penetration of the internet into every part of our lives, the demand for distance education has increased rapidly. For instance, in China, the number of students enrolled in distance education programs rose from 1.1 million in 2000 to 10.03 million in 2015 (Li & Lalani, 2020).

The COVID-19 pandemic has significantly impacted the education sector worldwide, leading to the widespread adoption of compulsory distance education. The pandemic has underscored the significance of distance education in mitigating the adverse effects on higher education. It has also accelerated the adoption of distance education as it allows for continuous learning while maintaining social distancing protocols, making it an essential tool for educators and students during these challenging times (Grynyuk et al., 2022). According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), over 1.5 billion students have been affected by school closures due to the pandemic, leading to a surge in online learning (UNESCO, 2023).

Distance education has become increasingly important in today's fast-paced and rapidly changing society, providing students with access to education regardless of their location, time constraints, or physical disabilities. Working professionals can also benefit from distance education, improving their skills and knowledge without having to take time off work. Furthermore, distance education can be more cost-effective than traditional classroom-based education, as it eliminates the need for expensive facilities and reduces travel expenses (Mutea & Cullen, 2012). Consequently, the number of students enrolled in distance education programs has been increasing globally (Moore, 2000; Qayyum & Zawacki-Richter, 2018). Despite this increase, distance education has its own challenges, including the need for self-motivation, time management skills, and the potential for social isolation (Moore & Kearsley, 2011). Therefore, it is crucial to design and deliver distance education courses that are effective, engaging, and responsive to students' needs (Di Giacomo & Di Paolo, 2021).

There are mainly two types of distance education: synchronous and asynchronous distance education. Synchronous distance education is characterized by the participation of students and instructors in real time. Students and instructors interact simultaneously through virtual classrooms, video conferencing, or webinars (Bailey, 2022). In contrast, asynchronous distance education allows learners to access course materials, discussions, and assignments at their own pace and at any time they choose (Lytvyn et al., 2021).

Synchronous education is an essential component of distance education, as it fosters a sense of community among learners and instructors (McDaniels et al., 2016). This mode of education allows for real-time discussions and collaborations among learners by providing immediate feedback (Islam et al., 2022; Stewart et al., 2011). Furthermore, synchronous education has been shown to enhance student engagement, motivation, and retention (Khan et al., 2022; Nieuwoudt, 2020; Shoepe et al., 2020). However, synchronous distance education requires a stable internet connection, appropriate hardware, and a reliable virtual classroom platform (Karagöz & Ağadayı, 2020). Virtual classroom platforms (VCPs) such as Zoom and Google Meet have become indispensable tools for facilitating synchronous distance education. These platforms provide a range of features, such as video conferencing, chat rooms, and screen sharing, that enable instructors to deliver high-quality instruction to online learners (Correia et al., 2020; Mesran et al., 2021).

VCPs, in essence, refer to computer-based systems that allow learners and instructors to participate in synchronous, live audio and visual interaction with one another, regardless of their physical location (Chen et al., 2017; Oiwake et al., 2018; Rehman & Khan, 2016). They can be effectively employed for both individual and group instruction, as in traditional face-to-face classrooms. However, for VCPs to be successful in facilitating learning, system usability becomes a critical factor. As with all systems and technologies, the ease of use, learnability, and user satisfaction—components that Nielsen (1993) identifies as key to system usability—play an essential role in the effective implementation of VCPs.

In today's technology-driven world, learners expect high-quality user experiences from any digital platform they use. A user-friendly and easy-to-use VCP can significantly enhance the learning experience (Alhusban et al., 2024), while a poorly designed one can led to frustration and dissatisfaction among students and instructors and may hinder the achievement of educational goals (Alanazi et al., 2020; Van Nuland et al., 2017). The usability of VCPs is one of the most critical factors in predicting learners' satisfaction with distance education (Rizwan & Iftikhar, 2019). Learners' satisfaction is a crucial outcome of VCPs because it directly influences their engagement, motivation, and overall learning experience. Therefore, it is essential for educators to choose a VCP that is user-friendly for both instructors and learners with features such as clear navigation, a simple interface, and reliable connectivity. In summary, system usability is key to the success of VCPs, as it directly affects the quality and efficiency of synchronous distance learning.

Usability is a crucial factor that greatly influences faculty preferences when it comes to adopting and using Video Conferencing Platforms (VCPs) (Alajmi & Said Ali, 2022). Prior investigations in the context of COVID-19 have mainly focused on two areas: the preferences of users for specific virtual communication platforms like Google Meet, Zoom, and BigBlueButton (Mastrisiswadi et al., 2023), and the evaluation of the usability of Blackboard in relation to the demographic characteristics of faculty members (Alhadreti, 2021). Additionally, there have been individual assessments of the usability of Microsoft Teams for online teaching (Al-Qora'n et al., 2022). However, these studies have focused narrowly and have not thoroughly examined the usability features of many platforms, such as Google Meet, Zoom, Perculus, Microsoft Teams, and Adobe Connect. Furthermore, they have not adequately tackled the difficulties linked to their usage during the COVID-19 pandemic. The current study addressed the aforementioned gap by answering the following research questions.

- What is the usability level of VCPs from the perspective of faculty members, as measured by system usability scale (SUS)?
- Do the demographic characteristics of faculty members have any impact on the SUS scores?
- What are the challenges faculty members face when implementing VCPs in their classrooms?
- How do VCPs differ in terms of usage and preference among faculty members?

Method

A mixed-methods research with sequential explanatory design was employed, in which quantitative data were first collected and analyzed, followed by the collection and analysis of qualitative data (Creswell, 2012). The two phases of the research design are illustrated in Figure 1. Overall, the mixed-methods approach enabled a more comprehensive understanding of the research questions to be gained, beyond what could have been achieved with a single data source or method alone.

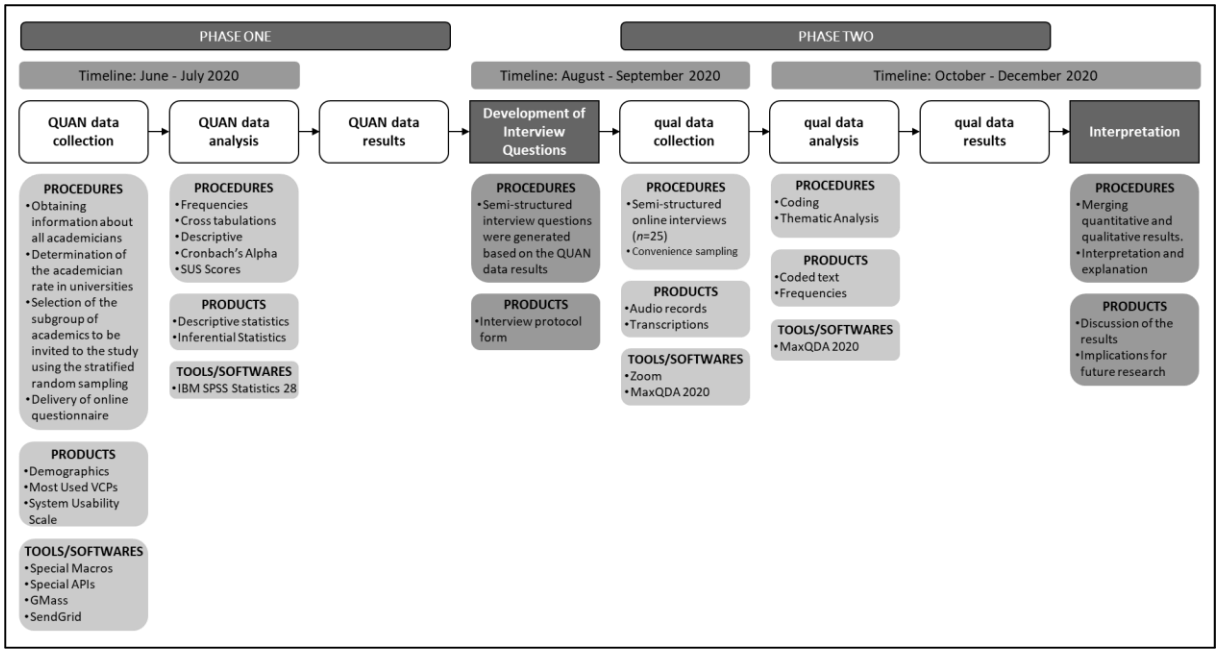

Figure 1. The Timeline and the Procedures Used in the study

Sampling

Two sampling methods were employed: stratified random sampling and convenience sampling. Researchers used the Higher Education Information System (YOKSIS) in Turkey to access the population. YOKSIS, administered by the Council of Higher Education (HEC), manages information about students and graduates in higher education institutions. Specialized macros and software were utilized to access data from YOKSIS's website (https://istatistik.yok.gov.tr/). The dataset, comprising the personal details of 175,172 faculty members from 208 universities, underwent two-sided encryption for privacy. Additionally, the dataset was securely stored and processed to prevent unauthorized access.

To ensure maximum diversity and representation within the selected sample group, the data were systematically stratified based on affiliation, gender, and academic title. The researchers considered the number of faculty members in each university and their distribution by gender and academic titles as crucial dimensions for strata development. Using these strata, 10,000 faculty members were randomly selected and invited to participate in the study. Figure 2 provides an overview of the sampling methodology and strategies employed.

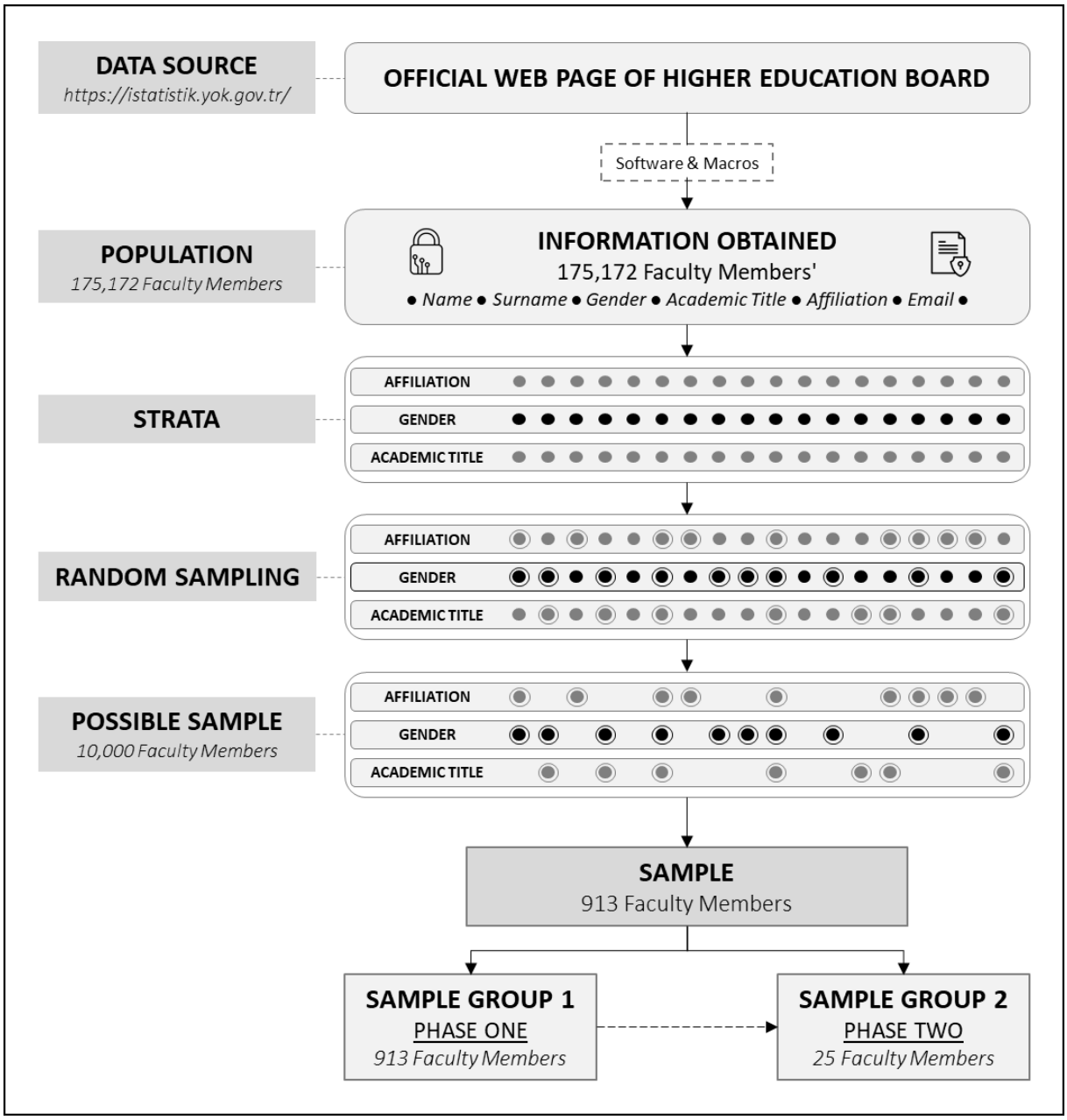

Figure 2. The Sampling Methodology Consisting of a Combination of Stratified Random Sampling and Convenience Sampling

Participants

The study's participants were 798 faculty from 167 out of 208 universities in Turkey. The study was conducted in two phases, and each phase incorporated a different sample group. Table 1 presents the demographics of each sample group.

The first sample was used in the quantitative part of the study. It consisted of 798 faculty members, aged 22 to 78 years (M = 41.90, SD = 10.12). The gender distribution was evenly distributed, with n = 387 (48.50%) female and n = 411 (51.50%) male participants. The academic titles included professor (n = 184, 23.06%), associate professor (n = 151, 18.92%), assistant professor (n = 207, 25.94%), instructor (n = 151, 18.92%), and research assistant (n = 105, 13.16%).

The second sample was used in the study's qualitative part. It consisted of 25 faculty members who were selected from the first sample on a voluntary basis. Their ages ranged from 27 to 64 years (M = 39.60, SD = 7.76), with more female participants (n = 18, 72.00%) than male participants (n = 7,

28.00%). The second sample had an equal distribution of academic titles: professors, associate professors, assistant professors, instructors, and research assistants (n = 5, 20.00% each). All participants were recruited from a variety of academic departments and institutions and provided informed consent prior to participation in the study.

Table 1.
Demographics of the Sample Groups

Variable	Sample Group 1 n = 798				Sample Group 2 n = 25			
	n	*%*	*M*	*SD*	*n*	*%*	*M*	*SD*
Age								
Young (≤ 36)	259	32.46	31.03	3.66	10	40.00	31.40	3.66
Adult (37 – 46)	274	34.34	41.23	2.64	10	40.00	41.50	2.46
Elder (47+)	265	33.21	53.95	5.31	5	20.00	52.20	4.09
Gender								
Female	387	48.50	40.32	10.10	18	72.00	37.39	6.64
Male	411	51.50	43.85	9.89	7	28.00	45.29	10.64
Academic Title								
Professor	184	23.06	52.97	6.49	5	20.00	48.80	5.45
Associate Professor	151	18.92	45.05	7.22	5	20.00	42.60	4.88
Assistant Professor	207	25.94	41.15	7.30	5	20.00	40.00	9.82
Instructor	151	18.92	35.77	7.44	5	20.00	35.00	7.00
Research Assistant	105	13.16	30.09	5.09	5	20.00	31.60	3.65

Data Collection Procedures and Analysis

First Phase

After identifying the possible sample of faculty members, the researchers sent them a personalized email using GMass and SendGrid technologies. The email contained a link to a four-section online questionnaire. To enhance the participation rate, follow-up reminder emails were dispatched at one-week intervals to faculty members who had not responded.

The online questionnaire consisted of four sections. The first section collected demographic information about the participants, including their gender, age, academic title, and university affiliation. The second section focused on identifying participants' previous distance education experiences and the VCPs they commonly used for distance education during the COVID-19 pandemic. The third section was concerned with the assessment of the usability levels of the aforementioned VCPs using the System Usability Scale (SUS). Prior authors adapted the SUS for Turkish and established its reliability and validity by confirmatory and exploratory factor analyses (Kadirhan et al., 2015). The scale comprises two factors: usable and learnable, with respective reliability scores of .79 and .60. In the fourth and final section, participants were presented with a question inquiring about their willingness to participate in follow-up interviews.

Out of 10,000 faculty members surveyed, 913 completed the questionnaire. However, 115 of these respondents indicated that they do not use any VCPs, leading to their exclusion from the study. Consequently, the effective response rate stood at 7.98%. This rate is considered high given that the sample represents about 0.46% of the total faculty population in Turkey, which is 175,172. This substantial representation makes a significant contribution to the understanding of the phenomenon being studied.

IBM SPSS 28 was utilized to analyze quantitative data using both descriptive statistics (e.g., mean, standard deviation, percentage) and inferential statistics (e.g., independent samples t-test and analysis of variance (ANOVA)). While the first one was used as a preliminary analytical tool to summarize and describe the basic characteristics of the data, the second one was utilized as a more advanced method to investigate the relationships and differences between groups at a significant level of 0.05.

Second Phase

Semi-structured interviews were conducted with 25 faculty members out of 79 who voluntarily expressed their willingness to participate through the questions included in the online questionnaire. The interview questions were developed by the authors and reviewed by a subject matter expert for content and relevance. The expert's feedback was crucial in refining the questions, ensuring that they were clear, relevant, and addressed the key aspects of participants' experiences with distance education.

Interviewees were selected based on their frequently used VCPs and academic titles, which were considered crucial in providing a comprehensive understanding of the phenomenon under investigation. Participants were verbally asked for their consent at the start of each 30–60-minute semi-structured interview, which took place online using videoconferencing technologies. Afterward, the video-recorded interviews were transcribed for data analysis. Aliases were allocated to guarantee anonymity.

Following Braun and Clarke's (2006) six-phase theme analysis framework, two researchers independently examined the video transcriptions, meticulously generating initial codes to capture key concepts and patterns. Subsequently, a collaborative review was conducted to foster in-depth discussions and exchanges of insights. Through this collaborative effort, initial themes emerged as a result of synthesizing the coded data. This iterative procedure facilitated a detailed analysis of the content, enabling the identification of overarching themes that included the depth of the participants' opinions and experiences.

System Usability Scale (SUS)

SUS is a widely used tool for measuring the usability of various systems, ranging from software applications to websites. In this study, the Turkish version of SUS was utilized to assess the perceived usability of VCPs (Kadirhan et al., 2015). The SUS is comprised of 10 statements pertaining to usability, which are rated by respondents on a 5-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree." The total SUS scores are calculated by converting the responses into a single usability score, which can range from 0 to 100. A higher score indicates better perceived usability. Researchers interpreted SUS scores for VCPs based on the following literature guidelines (also illustrated in Figure 3):

- *Excellent usability (above 80):* A SUS score of 80 or higher implies that the system is both highly usable and user-friendly (Bangor et al., 2008).
- *Acceptable usability (68-80):* A SUS score of 68 to 80 indicates acceptable usability, indicating that the system is easy to use and fits the needs of the majority of users (Brooke, 2013).
- *Poor usability (below 68):* A SUS score of less than 68 indicates poor usability, implying that the system is difficult to use and does not meet the users' needs (Lewis & Sauro, 2018).

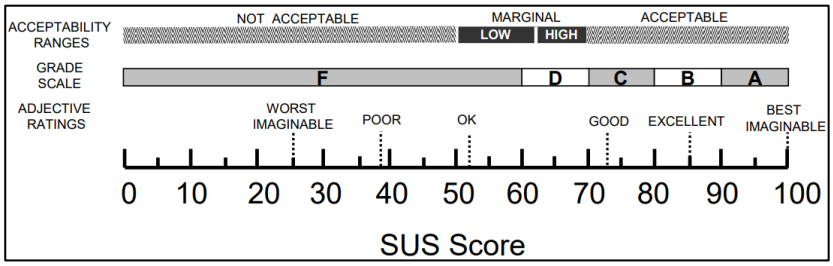

Figure 3. Interpretation of SUS Score (Bangor et al., 2009)

Findings

VCP Adoption

Study results showed that, as indicated in Table 2, among the faculty members surveyed (n = 798), Zoom emerged as the most widely utilized VCP, with 217 respondents (23.7% of the sample) choosing Zoom for their virtual classroom needs. Adobe Connect ranked as the second most used VCP, with 129 faculty members (14.1%) incorporating this platform into their teaching practices. Perculus and Microsoft Teams were also prominently employed, by 119 (13%) and 111 (12.1%) users, respectively. Google Meets, another popular platform, was utilized by 93 faculty members (10.2%). The study reflects a diverse landscape of VCP adoption, showcasing a variety of platforms, each catering to the preferences and needs of the faculty members.

Table 2.
The Most Frequently Utilized VCPs by Faculty Members

#	VCP	*f*
1	Zoom	217
2	Adobe Connect	129
3	Perculus	119
4	Microsoft Teams	111
5	Google Meets	93
6	BigBlueButton	71
7	Blackboard Collaborate	44
8	Cisco WebEx Meetings	6

VCPs by SUS Scores

The SUS scores were utilized to evaluate the experiences and satisfaction levels of faculty members regarding the diverse features of the VCPs. They were calculated for each VCP, and the reference threshold values shown in Figure 3 were used as benchmarks to gauge the platform's usability and user satisfaction levels. As indicated in the Table 3, Google Meets, Zoom, and Adobe Connect received a "B" grade, indicating "Good" usability. On the other hand, Perculus and Microsoft Teams received a "C" grade, indicating "Poor" usability. This finding indicates that Perculus and Microsoft Teams demonstrated inferior usability performance when contrasted with Google Meets, Zoom, and Adobe Connect.

Table 3.
Comparison of VCPs by SUS Scores

VCP	SUS Score				Grade	Adjective Rating
	Minimum	Maximum	Mean	SD		
Google Meets	35.00	100.00	75.54	13.52	B	Good
Zoom	27.50	100.00	72.91	13.42	B	Good
Adobe Connect	10.00	100.00	68.10	16.24	B	Good
Perculus	25.00	95.00	67.46	13.36	C	Poor
Microsoft Teams	17.50	100.00	67.32	14.47	C	Poor

Table 4.
Participants Demographics by VCP SUS Scores

	Zoom (*n* = 217)			Adobe Connect (*n* = 129)			Perculus (*n* = 119)			Microsoft Teams (*n* = 111)			Google Meets (*n* = 93)		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Gender															
Female	103	74.20	13.63	64	70.51	13.70	58	69.87	14.16	53	65.52	16.58	46	73.59	12.95
Male	114	71.75	13.19	65	65.73	18.19	61	65.16	12.22	58	68.97	12.15	47	77.45	13.92
Age															
Young (≤ 36)	70	76.14	12.54	32	67.50	13.06	49	70.20	12.72	34	65.74	16.30	34	79.51	11.49
Adult (37 – 46)	75	70.67	12.78	51	71.27	15.92	31	66.77	11.89	35	70.50	10.74	34	75.43	14.60
Elder (47+)	72	72.12	14.44	46	65.00	18.14	39	64.55	14.81	42	65.95	15.48	20	69.20	12.90
Academic Title															
Professor	50	73.45	14.32	36	66.94	15.89	23	63.26	16.61	26	66.73	13.45	12	66.73	16.53
Associate Professor	35	69.50	14.52	30	71.42	16.04	15	66.50	11.37	27	66.11	15.56	19	74.75	13.93
Assistant Professor	53	69.25	12.74	29	68.02	19.39	43	66.86	12.70	26	70.48	14.18	21	74.78	13.77
Instructor	35	76.64	12.89	22	65.57	16.56	31	71.21	12.53	16	65.63	18.15	21	79.09	12.09
Research Assistant	44	76.48	11.22	12	68.13	7.62	7	70.36	11.22	16	66.88	11.24	15	80.17	8.32
Distance Education Experience															
Yes	56	76.92	13.37	30	72.17	11.81	22	67.05	11.28	20	65.75	18.07	18	78.50	16.15
No	161	71.52	13.20	99	66.87	17.22	97	67.55	13.83	91	67.66	13.65	70	74.73	12.71
Training on VCP															
Yes	33	70.08	10.96	44	68.07	13.61	58	69.14	11.92	35	66.00	15.29	19	76.45	13.08
No	184	73.42	13.78	85	68.12	17.52	61	65.86	14.51	76	67.93	14.14	69	75.30	13.71

The effect of demographic attributes on SUS

Statistical tests were utilized to explore the influence of demographic characteristics on the perceived usability of VCPs. Table 4 presents statistics detailing demographic attributes in terms of SUS scores for each examined VCP.

SUS Scores by Gender, Distance Education Experience, and Training

Independent sample t-tests were conducted to compare the usability scores of VCPs in terms of gender, distance education experience, and VCP training. As indicated in Table 5, a significant difference was observed only for Zoom by distance education experience. More specifically, faculty members with distance learning experience reported significantly higher usability scores for Zoom compared to those without distance learning experience. Interestingly, no statistically significant differences were observed across the remaining variables under examination. These results shed light on the potential impact of prior distance education experience on the perceived usability of specific VCPs, underlining the importance of considering these factors when implementing and designing VCPs for educational purposes.

Table 5.
Results of Independent-Samples T-Tests

	t	*df*	*p*	*Cohen's d*
Zoom				
Gender	1.34	215	0.181	0.18
Distance Education Experience	2.63	215	0.009*	0.41
VCP Education	-1.32	215	0.188	0.25
Adobe Connect				
Gender	1.68	127	0.095	0.30
Distance Education Experience	1.92	69.8	0.059	0.33
VCP Education	-0.02	127	0.987	0.00
Perculus				
Gender	1.94	117	0.054	0.36
Distance Education Experience	-0.16	117	0.873	0.04
VCP Education	1.34	117	0.182	0.25
Microsoft Teams				
Gender	-1.26	109	0.212	0.24
Distance Education Experience	-0.53	109	0.594	0.13
VCP Education	-0.65	109	0.517	0.13
Google Meets				
Gender	-1.38	91	0.170	-0.29
Distance Education Experience	1.11	91	0.271	0.28
VCP Education	0.38	91	0.744	0.84

$p < 0.05$*

SUS by Age and Academic Title

A one-way ANOVA was conducted to compare the usability scores of VCPs in terms of age and academic title. As shown in Table 6, there was a significant difference in age and academic title for Zoom and Google Meets. However, no statistically significant differences were observed across the remaining variables under examination.

Follow-up post-hoc tests with an LSD (Least Significant Difference) were conducted to identify the significant difference across groups at the significant level of 0.05. The post-hoc results are reported below. The *p* values given next to the group below indicate the significant level at which the groups compared are significant on the relevant VCPs.

For *Zoom*, faculty members of a younger age reported significantly higher usability scores compared to their adult counterparts ($p = 0.014$). Furthermore, instructors indicated significantly better usability experiences with Zoom when compared to both associate professor ($p = 0.024$) and assistant professor ($p = 0.011$). Besides, research assistants demonstrated a significantly higher usability scores for Zoom in comparison to associate professor ($p = 0.020$) and assistant professor ($p = 0.008$). These results suggest that tailoring training and support for Zoom to the specific needs and responsibilities of different faculty members, particularly considering their age and professional roles, may lead to improved user experiences and overall satisfaction with the platform in an educational setting.

For *Google Meets*, young faculty ($p = 0.004$) reported significantly higher usability scores when compared to their elder counterparts. Additionally, faculty members holding the titles instructor ($p = 0.009$) and research assistant ($p = 0.008$) reported significantly higher usability scores compared to those with the title of professor. These results underscore the importance of considering the diverse technological backgrounds and professional roles of faculty members when designing and implementing virtual meeting platforms in an educational context.

Table 6.
Results of One-way ANOVA Tests

	F	*df*	*p*	η^2
Zoom				
Age	3.27	2, 214	0.040*	0.01
Academic Title	3.15	4, 212	0.015*	0.02
Adobe Connect				
Age	1.86	2, 126	0.160	0.02
Academic Title	0.48	4. 124	0.747	0.03
Perculus				
Age	2.04	2, 116	0.135	0.02
Academic Title	1.32	4, 118	0.268	0.03
Microsoft Teams				
Age	1.24	2, 108	0.293	0.02
Academic Title	0.42	4, 106	0.796	0.04
Google Meets				
Age	4.25	2, 90	0.017*	0.02
Academic Title	2.37	4, 88	0.054*	0.04

$p < 0.05$*

Qualitative Results

Qualitative data were gathered to provide in-depth and contextually appropriate understanding of the usability setting of each VCP. The analysis results presented in Table 7 outlined many aspects of VCP usability, including issues experienced by academics, positive features identified, and recommended enhancements.

Table 7.
Summary Of VCP Usability: Challenges, Positives, And Suggestions

Platform	Usability challenges	Positive Aspects	Suggestions
Zoom	Time constraints, connectivity issues, technical glitches	Ease of use, valuable for teaching	Improve instructions, simplify sharing, enhance support
Adobe Connect	Slow transfers, network issues, crashes	Effective support, rapid issue resolution	Explore alternatives, optimize video, backup strategies
Perculus	Screen sharing delays, microphone issues, compatibility	Flawless performance, user-friendly	Switch browsers, improve formats, resolve outages
Microsoft Teams	Audio disruptions, test suitability, connectivity problems	Easy lectures, responsive IT support	Enhance assessments, consider challenges, seek support
Google Meet	Minor glitches, managing large classes	Minimal issues, user-friendly, accessible support	Provide troubleshooting resources, optimize sharing

Zoom

The current research into participants' experiences with Zoom revealed a mixture of challenges and successes. While some participants praised its ease of use for distance education, others encountered numerous obstacles. Time constraints, connectivity issues, technical glitches like audio interruptions, and limited interactivity hampered smooth interactions. One participant shared their frustration: "Constant glitches and audio problems disrupt the flow of lectures, making it difficult to engage students." Security concerns were also mentioned, though details were absent. However, positive experiences existed. Participants found Zoom user-friendly and valuable for online teaching, suggesting: "More detailed and accessible instructions for specific features would greatly improve the user experience." Proposed solutions from participants included simplifying file/screen sharing, providing clearer instructions, and offering enhanced technical support. Overall, Zoom presents both potential and challenges for distance education, highlighting the need for improved user experience and addressing technical limitations.

Adobe Connect

The analysis of participants' report on Adobe Connect presents a varied perspective, emphasizing both difficulties and alternative solutions. Technical difficulties such as sluggish file transfers, network issues, audio/video disturbances, and restricted data transmission caused disruptions in certain online classrooms. As reported by one participant, "The slow upload times and frequent system crashes were frustrating and disrupted the flow of my online classes". They proposed potential remedies such as employing alternative modes of communication, optimizing video resolution, breaking up lengthy meetings, and implementing technical backup strategies. Another participant stated that "We started breaking our lectures into shorter, more manageable segments, which reduced the load on the platform". The tech personnel and coordinators were commended for their supporting role, with one participant expressing appreciation for the rapid resolution of issues by the IT team. Overall, while Adobe Connect faces challenges, its effectiveness hinges on both platform improvements and user strategies for mitigating technical roadblocks.

Perculus

The findings indicated that the faculties had a varied usability experience with Perculus. While several participants praise Perculus for its flawless performance and effortless connection with students, others continue to be disturbed by persistent technical problems. Satisfied participants, such as one who expressed, "Perculus functioned impeccably for my classes", praise its user-friendly nature. Nevertheless, there are other prevalent obstacles that hinder the experiences of others, encompassing intermittent delays in screen sharing, microphone complications for both instructors and learners,

incompatibility with Adobe software resulting in screen sharing difficulties, and constraints in the utilization of virtual whiteboards for drawing and annotation. A different participant conveyed his frustration: "The microphone frequently ceased to function during crucial discussions, causing interruptions in the class's progression". Several participants also emphasized the need to switch to alternative browsers, such as Explorer, to improve performance. In addition, there were complaints about the platform's insufficient support for some file formats, such as PDFs, and occasional outages during live sessions.

Microsoft Teams

The participants' experiences with Microsoft Teams were varied, showcasing both its promise and constraints. While certain participants praised its ease of use, stating that "I found it quite user-friendly for lectures, a straightforward interface for both students and teachers", others experienced technical malfunctions such as audio disruptions. Participants also expressed concerns over the suitability of online tests as full evaluations, highlighting obstacles they encountered. They indicated a preference for utilizing the university's course administration system for exams instead. Another participant voiced his apprehensions: "The platform was generally good, but we had problems with audio interruptions. I also agree that it's not ideal for high-stakes exams; the course management system offers better security". Furthermore, there were concerns expressed on the constraints of distance education and the difficulties in guaranteeing active student participation and deterring academic dishonesty during online examinations. While several participants successfully adjusted to the platform, others encountered difficulties pertaining to internet connectivity and hardware. Specifically, assistance from the university's IT department was often seen as beneficial in resolving technological difficulties. A participant recounted his experience, highlighting the IT department's rapid and effective response in resolving connectivity issues, noting that "the IT department was responsive and helped with connectivity issues promptly".

Google Meets

Google Meet usability feedback was mostly good. One participant said, "Google Meets has been incredibly user-friendly for me and my students; it has made distance education much smoother." Most participants reported few technical issues. However, a few participants had screen sharing or internet connectivity issues. These challenges were frequently resolved with educational videos or peer help. One participant said, "Initially, I had trouble with screen sharing, but after watching a tutorial, I was able to resolve it effortlessly. My coworkers helped me with connectivity issues". Although the site was user-friendly, several users had trouble managing large courses, sharing presentations, and using many screens at once. One participant reported reduced word size and image clarity when using multiple displays "Sharing my presentation and the Meet screen on two monitors was difficult. Font size and image quality suffered." The results show that most participants find Google Meet's user interface easy to use and its tools for fixing small issues. However, optimizing screen sharing for presentations, managing large classrooms, and ensuring screen compatibility could improve its instructional usefulness.

Discussion, Conclusion, and Suggestions

The significant impact of COVID-19 on the higher education sector worldwide pushed many universities to use VCPs for delivering lectures and conducting classes. Therefore, the usability evaluation of VCPs has become increasingly important for faculty members due to the widespread adoption of these platforms during the COVID-19 pandemic (Mastrisiswadi et al., 2023; Pal & Vanijja, 2020). The current study examined the usability of popular five VCPs, the effect of demographic attributes on the final scores of SUS, and the challenges associated with their use during COVID-19 pandemic. The study findings showed that the usability features of Google Meet, Zoom, and Adobe Connect surpassed those of Perculus and Microsoft Teams. This finding supports the research of Al-Qora'n et al. (2022) as to the usability of Zoom over Microsoft Teams and contradicts earlier research involving university students, which suggested that the usability of Microsoft Teams and Zoom were equally superior to Google Meet (Amin Rifat et al., 2022). The disparity in findings may stem from varying experiences between instructors and students in using VCPs. During COVID-19 pandemic, instructors tend to interact with these platforms from an instructional standpoint,

emphasizing features for content delivery, collaboration, and assessment. Students, on the other hand, often focus on user-friendliness, engagement, and accessibility. These distinct perspectives contribute to the nuanced assessment of usability and may explain the divergence in research outcomes.

In addition to privacy and security, usability is proven to play a critical role on the adoption of VCPs (Mastrisiswadi et al., 2023). Therefore, VCPs with high usability features are likely to be the first choice for faculty members seeking a seamless and user-friendly virtual collaboration experience (Poolsawas & Chotikakamthorn, 2023) such as Google Meet (Mastrisiswadi et al., 2023) and Zoom (Leporini et al., 2021).

It is noteworthy that during the course of the ongoing pandemic, faculty members did not fully have the autonomy to select the VCPs utilized for instructional purposes. A considerable number of educational institutions, both internationally and within Turkey, mandated the use of specific platforms to standardize online teaching and ensure consistent access across departments. In Turkey, for instance, numerous universities initially mandated the utilization of platforms such as Adobe Connect during the initial stages of the pandemic, subsequently transitioning to platforms like Google Meet or Microsoft Teams as the situation evolved. These decisions were often shaped by institutional policies rather than individual preferences or platform usability, as institutions sought to rapidly implement scalable solutions for a vast number of users. The reliance on institutionally mandated platforms necessitated that faculty members adapt to the available tools, regardless of personal preferences or usability concerns.

It is thus imperative to contextualize the findings of this study within the framework of institutional decision-making processes. Although platforms such as Google Meet and Zoom have been found to be more usable, the actual adoption of these platforms by faculty members is frequently determined by administrative mandates rather than personal preference. For instance, although Google Meet and Zoom were rated highly for ease of use and integration with instructional tools, the extensive use of platforms such as Microsoft Teams or Adobe Connect in Turkish universities was predominantly driven by administrative policies focused on scalability, licensing agreements, and technical support infrastructure. Therefore, although VCP usability was a significant factor, it was not the sole determining factor in platform adoption during the pandemic. This highlights the necessity for institutions to consider both usability and practical considerations when selecting which platforms to implement, particularly in emergency situations such as the ongoing pandemic.

It is important to note that the usability evaluation in this study focused specifically on the use of Virtual Classroom Platforms (VCPs) in educational settings, particularly within higher education. While many of these platforms were also utilized for personal or non-educational purposes during the pandemic, the findings of this study are directly related to their implementation for teaching and learning purposes. This distinction ensures that the usability assessments and the challenges identified are reflective of the unique needs and constraints of educational environments, where features like collaboration tools, content delivery, and assessment functionalities were prioritized.

The research revealed the interplay of different demographic characteristics, such as gender, age, teaching experience, and academic position, in shaping individual perceptions of VCP usability across Perculus, Zoom, and Google Meet. Interestingly, VCP training did not significantly impact reported usability. Focusing on specific platforms, gender emerged as a non significant factor on the usability of Perculus, aligning with previous research Alhadreti (2021), but contrasting with the results of Bangor et al. (2008). Furthermore, our study revealed that having prior teaching expertise in distance education plays a crucial role in determining the perceived usability of Zoom. Besides, for both Zoom and Google Meet, instructors in earlier career stages reported significantly higher usability scores, supporting previous studies (Bangor et al., 2008; Granić & Ćukušić, 2011), but contradicts the findings of Alhadreti (2021). In addition to the prior knowledge, the current study demonstrates that the academic status had a significant influence on the perceived usability of Zoom and Google Meet. These findings indicate that faculty members with more senior status may have a different perception of Zoom and Google Meet due to their greater technological experience, varying roles and needs, access to technical support, adaptability to new tools, and expectations based on their broader academic experience.

The participants' perception of the usability of VCPs are likely to be shaped by the challenges they experienced in conjunction with the VCPs. The study findings uncovered some of these challenges as technical difficulties, connectivity issues, usability concerns, security considerations, insufficient instructor knowledge, and limited adaptability and support from technical teams. This finding aligns with previous research (Vital-López et al. (2022), which identified economic challenges, training needs, and connectivity issues as the most significant effects of COVID-19 on university instructors. Some of the uncovered challenges could be due to the dynamic nature of streaming rates for VCPs as available bandwidth, session size, and mobile device conditions are prone to influence the perceived streaming quality of VCPs (Chang et al., 2022). Moreover, few areas appear to be open for usability enhancement of VCPs such as the ease of screen sharing, use of intuitive icons, and user-friendly platform designs (Zou et al., 2020). Furthermore, these challenges seem to stem from university instructors' perceived deficiencies in technological knowledge during emergency remote teaching (Çakıroğlu et al., 2023), hindering their ability to effectively accomplish their teaching objectives (Labrie et al., 2022).

These findings underscore the importance of considering demograsphics, inluding gender, prior experience with distance teaching, age, and academic status when ssessing the usability of certain VCPs. It also suggests that training efforts for VCPs might need to be tailored or enhanced to better address the unique needs and preferences of users, considering factors beyond general training. It's also worth noting that individual studies contribute to our understanding of specific contexts, and findings may vary based on factors like the study sample, methodology, and the platforms under investigation. Further research and analysis can help provide a more comprehensive understanding of the relationships between gender, teaching experience, training, and the usability of virtual teaching platforms.

In this context, assessing the usability of VCPs becomes crucial for both the academic community and institutional administrators, as it directly influences the effectiveness of online education delivery. The findings of this study highlight the importance of selecting platforms that meet the diverse needs of educators, especially during emergency remote teaching scenarios. For educators, usability features such as ease of use, accessibility, and integration with existing instructional tools are essential for facilitating engagement and ensuring a smooth teaching experience. For instance, platforms like Google Meet and Zoom, with their user-friendly interfaces and robust collaboration tools, provide clear advantages in usability over alternatives like Perculus and Microsoft Teams. Institutional administrators should consider these usability strengths when making decisions about which platforms to implement across their institutions. Moreover, regular evaluations and updates of these platforms, along with targeted training, can help address the weaknesses identified in this study, such as technical difficulties and limited support. By prioritizing the usability of VCPs, educational institutions can enhance both the quality of instruction and the overall learning experience.

Future research could expand on these findings by conducting comparative studies of various VCPs to evaluate how specific platform features—such as security, accessibility, and interactivity—affect both faculty and student experiences. Longitudinal research could also explore how usability perceptions change over time with increased exposure to distance education technologies, helping to identify the long-term effects of training and support. Investigating the role of specialized training in enhancing platform usability, particularly for platforms like Perculus and Microsoft Teams, could provide further insights into effective professional development strategies. Additionally, exploring student perspectives on VCP usability would complement faculty-focused studies, offering a more comprehensive understanding of virtual classroom experiences. Finally, research on the use of VCPs in hybrid learning models could shed light on how platforms perform when blending in-person and virtual teaching, helping educators optimize their use of technology in diverse learning environments.

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Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

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References

Alajmi, M. A., & Said Ali, M. (2022). Video-conference Platforms: Understanding the Antecedents and Consequences of Participating in or Attending Virtual Conferences in Developing Countries. *International Journal of Human–Computer Interaction*, *38*(13), 1195–1211. https://doi.org/10.1080/10447318.2021.1988237

Alanazi, A. A., Frey, B. B., Niileksela, C., Lee, S. W., Nong, A., & Alharbi, F. (2020). The Role of Task Value and Technology Satisfaction in Student Performance in Graduate-Level Online Courses. *TechTrends*, *64*(6), 922–930. https://doi.org/10.1007/s11528-020-00501-8

Alhadreti, O. (2021). Assessing Academics' Perceptions of Blackboard Usability Using SUS and CSUQ: A Case Study during the COVID-19 Pandemic. *International Journal of Human–Computer Interaction*, *37*(11), 1003–1015. https://doi.org/10.1080/10447318.2020.1861766

Alhusban, M. I., Sarhan, N., Khatatbeh, I. N., & Al Shbail, M. O. (2024). Exploring how quality dimensions enhance videoconferencing platform benefits from an information systems success perspective. *Discover Sustainability*, *5*(1), 59. https://doi.org/10.1007/s43621-024-00215-4

Al-Qora'n, L., Salem, O. A. S., & Gordon, N. (2022). Heuristic Evaluation of Microsoft Teams as an Online Teaching Platform: An Educators' Perspective. *Computers*, *11*(12), 175. https://doi.org/10.3390/computers11120175

Amin Rifat, M. Al, Md. Towhidul Alam, K., & Hassan Onik, Md. M. (2022). Privacy, Security and Usability Comparison of Online Learning Platforms in Developing Countries: A Study on Bangladeshi Universities. *2022 4th International Conference on Sustainable Technologies for Industry 4.0 (STI)*, 1–6. https://doi.org/10.1109/STI56238.2022.10103287

Bailey, D. (2022). Interactivity during Covid-19: mediation of learner interactions on social presence and expected learning outcome within videoconference EFL courses. *Journal of Computers in Education*, *9*(2), 291–313. https://doi.org/10.1007/s40692-021-00204-w

Bangor, A., Kortum, B., & Miller, J. (2009). Determining What Individual SUS Scores Mean: Adding an Adjective Rating Scale. *Journal of User Experience*, *4*(3), 114–123.

Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An Empirical Evaluation of the System Usability Scale. *International Journal of Human-Computer Interaction*, *24*(6), 574–594. https://doi.org/10.1080/10447310802205776

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brooke, J. (2013). SUS: A Retrospective. *Journal of Usability Studies*, *8*(2), 29–40.

Çakıroğlu, Ü., Aydın, M., Bahadır Kurtoğlu, Y., & Cebeci, Ü. (2023). How Instructors' TPACK Developed During Emergency Remote Teaching: Evidence From Instructors in Faculties of Education. *The International Review of Research in Open and Distributed Learning*, *24*(2), 162–188. https://doi.org/10.19173/irrodl.v24i2.7177

Chang, H., Varvello, M., Hao, F., & Mukherjee, S. (2022). A Tale of Three Videoconferencing Applications: Zoom, Webex, and Meet. *IEEE/ACM Transactions on Networking*, *30*(5), 2343–2358. https://doi.org/10.1109/TNET.2022.3171467

Chen, J., Xu, J., Tang, T., & Chen, R. (2017). WebIntera-classroom: an interaction-aware virtual learning environment for augmenting learning interactions. *Interactive Learning Environments*, *25*(6), 792–807. https://doi.org/10.1080/10494820.2016.1188829

Correia, A.-P., Liu, C., & Xu, F. (2020). Evaluating videoconferencing systems for the quality of the educational experience. *Distance Education*, *41*(4), 429–452. https://doi.org/10.1080/01587919.2020.1821607

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Pearson Education Inc.

Di Giacomo, P., & Di Paolo, C. (2021). COVID-19 and dental distance-based education: students' perceptions in an Italian University. *BMC Medical Education*, *21*(1), 414. https://doi.org/10.1186/s12909-021-02840-3

Granić, A., & Ćukušić, M. (2011). Usability testing and expert inspections complemented by educational evaluation: A case study of an e-learning platform. *Journal of Educational Technology & Society*, *14*(2), 107–123.

Grynyuk, S., Kovtun, O., Sultanova, L., Zheludenko, M., Zasluzhena, A., & Zaytseva, I. (2022). Distance Learning During the COVID-19 Pandemic: The Experience of Ukraine's Higher Education System. *Electronic Journal of E-Learning*, *20*(3), pp242-256. https://doi.org/10.34190/ejel.20.3.2198

Islam, Md. K., Sarker, Md. F. H., & Islam, M. S. (2022). Promoting student-centred blended learning in higher education: A model. *E-Learning and Digital Media*, *19*(1), 36–54. https://doi.org/10.1177/20427530211027721

Kadirhan, Z., Gul, A., & Battal, A. (2015). System Usability Scale: A Validity and Reliability Study. *Educational Sciences and Practive*, *14*(28), 149–167.

Karagöz, N., & Ağadayı, E. (2020). Behaviors and problems of a medical school students' related to distance education in pandemic medical education in the pandemic process. *The Journal of Turkish Family Physician*, *11*(4), 149–158. https://doi.org/10.15511/tjtfp.20.00449

Keegan, D. J. (1980). On defining distance education. *Distance Education*, *1*(1), 13–36. https://doi.org/10.1080/0158791800010102

Khan, R. A., Atta, K., Sajjad, M., & Jawaid, M. (2022). Twelve tips to enhance student engagement in synchronous online teaching and learning. *Medical Teacher*, *44*(6), 601–606. https://doi.org/10.1080/0142159X.2021.1912310

Labrie, A., Mok, T., Tang, A., Lui, M., Oehlberg, L., & Poretski, L. (2022). Toward Video-Conferencing Tools for Hands-On Activities in Online Teaching. *Proceedings of the ACM on Human-Computer Interaction*, *6*(GROUP), 1–22. https://doi.org/10.1145/3492829

Leporini, B., Buzzi, M., & Hersh, M. (2021). Distance meetings during the covid-19 pandemic. *Proceedings of the 18th International Web for All Conference*, 1–10. https://doi.org/10.1145/3430263.3452433

Lewis, L. R., & Sauro, J. (2018). Item Benchmarks for the System Usability Scale. *Journal of User Experience*, *13*(3), 158–167.

Li, C., & Lalani, F. (2020). The COVID-19 pandemic has changed education forever. This is how. *World Economic Forum*. https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/

Lytvyn, V., Akimova, O., Kuznetsova, H., Zenchenko, T., Stepanenko, O., & Koreneva, I. (2021). use of synchronous and asynchronous teaching methods in pedagogical education in COVID-19 terms. *International Journal of Health Sciences*, *5*(3), 617–629. https://doi.org/10.53730/ijhs.v5n3.2681

Markel, M. (1999). Distance Education and the Myth of the New Pedagogy. *Journal of Business and Technical Communication*, *13*(2), 208–222. https://doi.org/10.1177/1050651999013002005

Mastrisiswadi, H., Rahmawati, B. D., & Wibowo, A. W. A. (2023). *User preferences for video conferencing using the analytical hierarchical process (AHP)*. 030005. https://doi.org/10.1063/5.0164132

McDaniels, M., Pfund, C., & Barnicle, K. (2016). Creating Dynamic Learning Communities in Synchronous Online Courses: One Approach from the Center for the Integration of Research, Teaching and Learning (CIRTL). *Online Learning*, *20*(1). https://doi.org/10.24059/olj.v20i1.518

Mesran, M., Nasution, S. D., Suginam, S., Afriany, J., & Ramdhan, W. (2021). Optimalisasi Penggunaan Software Zoom dan Google Meet Dalam Meningkatkan Efektifitas Pembelajaran Daring. *Journal of Social Responsibility Projects by Higher Education Forum*, *2*(2), 94–97. https://doi.org/10.47065/jrespro.v2i2.987

Moore, M. G. (2000). Editorial: Technology-driven change: Where does it leave the faculty? *American Journal of Distance Education*, *14*(1), 1–6. https://doi.org/10.1080/08923640009527041

Moore, M. G., & Kearsley, G. (2011). *Distance Education: A Systems View of Online Learning* (3rd Ed.). Wadsworth Publishing.

Mutea, N., & Cullen, D. (2012). Kenya and distance education: A model to advance graduate nursing. *International Journal of Nursing Practice*, *18*(4), 417–422. https://doi.org/10.1111/j.1440-172X.2012.02043.x

Nielsen, J. (1993). *Usability Engineering.* Academic Press.

Nieuwoudt, J. E. (2020). Investigating synchronous and asynchronous class attendance as predictors of academic success in online education. *Australasian Journal of Educational Technology*, 15–25. https://doi.org/10.14742/ajet.5137

Oiwake, K., Komiya, K., Akasaki, H., & Nakajima, T. (2018). VR Classroom: Enhancing Learning Experience with Virtual Class Rooms. *2018 Eleventh International Conference on Mobile Computing and Ubiquitous Network (ICMU)*, 1–6. https://doi.org/10.23919/ICMU.2018.8653607

Pal, D., & Vanijja, V. (2020). Perceived usability evaluation of Microsoft Teams as an online learning platform during COVID-19 using system usability scale and technology acceptance model in India. *Children and Youth Services Review*, *119*, 105535. https://doi.org/10.1016/j.childyouth.2020.105535

Poolsawas, B., & Chotikakamthorn, N. (2023). *Using Mozilla Hubs for Online Teaching: A Case Study of an Innovation Design Method Course*. 7–12. https://doi.org/10.54808/IMSCI2023.01.7

Qayyum, A., & Zawacki-Richter, O. (2018). Open and distance education in a digital age. In A. Qayyum & O. Zawacki-Richter (Eds.), *Open and distance education in Australia, Europe and the Americas* (pp. 1-7). Springer.

Rehman, S. ur, & Khan, M. U. (2016). Security and Reliability Requirements for a Virtual Classroom. *Procedia Computer Science*, *94*, 447–452. https://doi.org/10.1016/j.procs.2016.08.069

Rizwan, M., & Iftikhar, I. (2019). Factors Affecting Student Satisfaction in Distance Learning: A Case Study. *The Journal of Educational Paradigms*, *1*(2), 50–56. https://doi.org/10.47609/0102012019

Schulte, M. (2011). The Foundations of Technology Distance Education: A Review of the Literature to 2001. *The Journal of Continuing Higher Education*, *59*(1), 34–44. https://doi.org/10.1080/07377363.2011.544981

Shoepe, T. C., McManus, J. F., August, S. E., Mattos, N. L., Vollucci, T. C., & Sparks, P. R. (2020). Instructor Prompts and Student Engagement in Synchronous Online Nutrition Classes. *American Journal of Distance Education*, *34*(3), 194–210. https://doi.org/10.1080/08923647.2020.1726166

Stewart, A. R., Harlow, D. B., & DeBacco, K. (2011). Students' experience of synchronous learning in distributed environments. *Distance Education*, *32*(3), 357–381. https://doi.org/10.1080/01587919.2011.610289

UNESCO. (2023). *UNESCO's education response to COVID-19*. https://www.unesco.org/en/covid-19/education-response/initiatives

Van Nuland, S. E., Eagleson, R., & Rogers, K. A. (2017). Educational software usability: Artifact or Design? *Anatomical Sciences Education*, *10*(2), 190–199. https://doi.org/10.1002/ase.1636

Vital-López, L., García-García, R., Rodríguez-Reséndíz, J., Paredes-García, W., Zamora-Antuñano, M., Oluyomi-Elufisan, T., Rodríguez Reséndiz, H., Álvarez Sánchez, A., & Cruz-Pérez, M. (2022). The Impacts of COVID-19 on Technological and Polytechnic University Teachers. *Sustainability*, *14*(8), 4593. https://doi.org/10.3390/su14084593

Zou, C., Zhao, W., & Siau, K. (2020). COVID-19 Pandemic: A Usability Study on Platforms to Support eLearning. In C. Stephanidis, M. Antona, & S. Ntoa (Eds.), *HCI International 2020 – Late Breaking Posters. HCII 2020. Communications in Computer and Information Science* (Vol. 1294, pp. 333–340). Springer. https://doi.org/10.1007/978-3-030-60703-6_43

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A Critical Evaluation of CALL and MALL Products for Learning and Teaching American English

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Abstract

Research conducted in diverse contexts revealed a general tendency among language learners and teachers toward mainstream English varieties. There is even a scientific foundation for this personal preference, suggesting that these varieties (particularly American English) are understood better. Besides, computer- and mobile-assisted technologies have fostered language education in general and the learning and teaching of these varieties. Accordingly, this study evaluated the CALL and MALL products (i.e., three websites, one mobile application, and one corpus) about American English using the adapted frameworks of Baya'a et al. (2009) and Reinders and Pegrum (2017). With a particular focus on the technical and pedagogical features and concerns, the analyses indicated potential advantages to language learners and teachers in grammar, pronunciation, vocabulary, listening, reading, intercultural awareness/competence, and pragmatic awareness at varying degrees. The evaluated products' shortcomings (e.g., insufficient assessment and feedback) were also cited. The study revealed its limitations and made recommendations for further research. It further bridged the gap in the related literature and contributed to our understanding by providing insights.

Keywords: American English, digital learning, English varieties, learning resource, mobile apps, websites

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Introduction

It is well-established that the English language originated in England (Crystal & Potter, 2022). However, it has not remained the same both linguistically (i.e., morphologically and phonologically) and geographically. It has undergone some changes throughout its development until its current state in the modern era (Al-Kadi & Ahmed, 2018). Before the emergence of the British Empire, the language had been exposed to various linguistic and cultural influences. With the ascent of the British Empire to power, the English language started to propagate. One such propagation was the settlement of the first British colony in North America. The continent was also invaded at the time by other colonist countries, including Spain, the Netherlands, Portugal, and France (Borucki et al., 2015). The extended stay of these countries undoubtedly contributed to the linguistic diversity of the English spoken in North America at the time. Toward the 19th century, the United States (US) launched a nationalist movement to eliminate the foreign impacts and establish a uniform American English (AmE) (Fishman, 1991). The late-19th century heralded the birth of a new global power – the US – and marked the beginning of the dissemination of Americanism as an ideology worldwide (Watson, 2019).

From then on, the domination of English (particularly AmE) has been established in almost every sphere of life, ranging from science (Al-Kadi & Ahmed, 2018; Elnathan, 2021) to academia (Di Bitetti & Ferreras, 2017). Even today, the number of English language speakers has reached up to 1.35 billion people, including both native and non-native speakers (Statista Research Department, 2022). A similar statistic might be given regarding English language learners (ELLs) worldwide. The British Council, a prominent state-governed organization that pursues creating international cultural and educational opportunities, holds that there are currently 1.13m ELLs (Beare, 2019). The dominion of the English language might also be observed in published language teaching materials (Rose & Galloway, 2019), especially in AmE and British English (BrE). These two English varieties have become prominent and manifested themselves in the academic realm despite the presence of others. It is reported that 14 dialects are spoken in the U.S. (Wolfram & Schilling, 2015), and 24 are prevalent in the United Kingdom (U.K.) (Hughes et al., 2013). Of these dialects, AmE is spoken by an estimated 329 million speakers (U.S. Census Bureau, 2019), whereas BrE speakers are about 67 million (Office for National Statistics, 2021).

In addition to the prominence of these two mainstream English varieties, they are regarded as the standard forms of the English language, or traditional English, referring to "a prestige variety of language used within a speech community" (Crystal, 2008, p. 450). Considering the large number of English dialects available (Grieve et al., 2019), the standardization becomes particularly significant because "standard languages/dialects/varieties cut across regional differences, providing a unified means of communication, and thus an institutionalized norm which can be used in the mass media, in teaching the language to foreigners, and so on" (Crystal, 2008, p. 450). Despite the position of the English language as a lingua franca (ELF), native English varieties, particularly AmE and BrE, are favored by language learners and teachers in diverse educational contexts (Galloway, 2014; Kung & Wang, 2019). Between these two varieties, the better and easier understandability of the AmE was vouchsafed in earlier studies (Carrie, 2017; Choe, 2016; Kang, 2015). The easiness of understandability of a speech is also referred to as comprehensibility, which pertains to "the listener's perception of the degree of difficulty encountered when trying to understand an utterance" (Munro et al., 2006, p. 112). This construct is essential for mutual intelligibility in verbal interactions. Given that (i) the ultimate goal of language learning is effective communication in the target language (Cook, 2007), (ii) comprehensible and intelligible speech (i.e., pronunciation) is essential to achieve this goal (Pennington & Rogerson-Revell, 2019), (iii) the majority of published materials for language learning and teaching is in either English variety (i.e., AmE and BrE) (Rose & Galloway, 2019), the prevalence of AmE on social media, movies, and series (Statista Research Department, 2021), and (iv) the constant demand and desire for the emulation of AmE accent by language learners and teachers (Galloway, 2014; Kung & Wang, 2019), any research conducted in this regard becomes worthy.

Concerning language teaching, technology has expedited the dissemination of materials in AmE and diversified their content and scope. With the emergence of computer and mobile technologies, such concepts as computer-assisted language learning (CALL) and mobile-assisted language learning (MALL) have entered the language teaching pedagogy (Al-Kadi & Ahmed, 2018). These modern-day pedagogies refer respectively to “the search for and study of applications of the computer in language

teaching and learning" (Levy, 1997, p.1) and language learning aided or accelerated by portable mobile devices (Chinnery, 2006). Computer software, mobile applications, websites, and other technological tools have become popular in language education. Given the so-far-held discussion, this study reviewed the CALL and MALL products, explicitly focusing on AmE. Using the adapted versions of Baya'a et al. (2009) frameworks for web-based learning environments and Reinders and Pegrum's (2017) for mobile learning resources, the acquired digital tools were evaluated, their potential pedagogical benefits were outlined, and possible pedagogical concerns were voiced. No such academic venture, to the best knowledge of the researcher, has been undertaken. This study intends to bridge this literature gap and contribute to the teaching of AmE in practical terms.

Literature Review

CALL and MALL

According to Levy (2010), language learners and teachers might interact with technology at five levels: physical, management, applications, resource, and component technology. Advancements in computer and mobile technologies have brought about the concepts of CALL and MALL, which describe the processes of using computers and mobile devices in language learning and teaching. Warscahuer (1996) divides the development of CALL into three phases: behavioristic (when computers were mainly used as tutors or delivery systems for instructional materials), communicative (when skill practice was still done via computers with increased opportunities for learner interaction and choice), and integrative (during which the internet and use of multimedia were prevalent). The evolution of technologies has also made them reduced in size (Chinnery, 2006), and "other technologies that hold the capacity for language learning include PDAs, multimedia cellular phones, MP3 players, DVD players, and digital dictionaries" (Zhao, 2005, p.447) have come into our academic lives. Portable, handheld devices have trumpeted the birth of another pedagogy called MALL within the context of mobile learning. Undoubtedly, these pedagogies have emerged in parallel with the exponential increases in the ownership of mobile and computer devices (Topal, 2021).

It is generally acknowledged that such CALL and MALL technologies benefit learners, including broader exposure to English, authentic interaction, flexible and audiovisual learning, promoting the practice of various skills, encouraging learner autonomy, providing access to engaging materials, and opportunities for different types of feedback (Bahari, 2021; Daly, 2022; Karakaya & Bozkurt, 2022; Kartal, 2024; Mihaylova et al., 2022; Richards, 2015). Teachers can also derive pedagogical gains from these technologies by creating more learner-centered teaching, taking control of mixed-level classes, expanding the learning to real life, enhancing the curriculum, increasing opportunities for monitoring, and administering assessment via learning management systems (Richards, 2015; Roh & Kim, 2019; Turnbull et al., 2021). The academic gains that might be reaped from such technologies are also valid for institutions; they can improve the school's reputation, support individualized learning, achieve better learning outcomes, allow for curricular flexibility, and facilitate administration (Collins & Halverson, 2018; Pegrum et al., 2013; Richard, 2015).

Previous studies have yielded supporting evidence for the pedagogical benefits that mobile and computer technologies offer. For instance, Golonka et al. (2014) examined the types of technology and their effectiveness. They revealed that course management systems, interactive whiteboards, e-portfolios, corpora, e-dictionaries, intelligent tutoring systems, grammar checkers, automatic speech recognition and pronunciation programs, virtual games, chats, social networking sites, blogs, internet forums, Wikis, mobile and portable devices, and smartphones were effective in language education (e.g., vocabulary, pronunciation, grammar, listening, writing, assessment) to varying degrees. In another study, Stockwell (2007) reviewed the technologies for specific language skills and found that the following tools were used in skills teaching: authoring software, courseware applications, concordancing, and chat systems for grammar; intelligent tutoring systems, hypermedia-enhanced learning environments, e-dictionaries, online activities, free/commercial software, chats, and mobile phones for vocabulary; courseware, online activities, and activities based on computer-mediated communication (CMC) for pronunciation; courseware and online activities for reading; online activities, corpora/concordancing, word processors, online dictionaries, applications, and CMC activities for writing; courseware and video texts for listening; and CMC technologies, corpora/concordancing, and courseware for speaking.

Following Stockwell's (2007) review, numerous studies were conducted on the potential impacts of CALL and MALL tools on language learning and teaching in local and international contexts. For instance, Dashtestani (2013) explored and revealed the positive effects of a MALL product on Iranian EFL learners' grammar performance. Al Qasim and Al Fadda (2013) examined and indicated the significant impact of podcasts on listening comprehension. In another study, Fouz-González (2020) reported the beneficial influence of a mobile app on improving target pronunciation features. Similarly, Çakmak et al. (2021) imparted the favorable effect of computer-enhanced flashcard programs on vocabulary retention. In a recent study, Kartal (2024) revealed the potential affordances of Whatsapp-supported curriculum for speaking improvement among EFL students. Other studies explored the perceptions of teachers and students toward CALL and MALL (Dağdeler & Demiröz, 2022; Garib, 2023; Hafour, 2022; Hoi & Mu, 2021; Kic-Drgas et al., 2023; Pérez-Paredes et al., 2018). Some studies reviewed the evolution of these two fields by incorporating recent research (Al-Kadi, 2018; Burston, 2015; Burston & Giannakou, 2022; Gillespie, 2020; Karakaya & Bozkurt, 2022; Yang, 2013; Zain & Bowles, 2021).

Recent years have witnessed the advent of artificial intelligence (AI), resulting in innovations in language education. For instance, OpenAI's ChatGPT, an advanced conversational AI specifically designed to understand and generate human-like text in response to various prompts (Topal, 2024), has been one of the most studied computer- and mobile-supported tools for language learning and teaching (Kohnke et al., 2023). Relevant research has revealed its advantages in second language writing (Barrot, 2023), vocabulary (Yüzlü, 2024), interactive language practice (Zhang, 2024), pronunciation guidance (Daungsupawong & Wiwanitkit, 2024), designing test items (Shin & Lee, 2023), reading practice (Anh et al., 2024), translation support (Fields, 2024), feedback (Teng, 2024), and assessment (Kooli & Yusuf, 2024). Similarly, Google's Bard and Microsoft's Bing Chat have been other AI-supported conversational models that have impacted language education (Meniado, 2023; Obaidoon & Wei, 2024).

American English Variety: A Succinct Description

AmE refers to "the English language as spoken in the U.S. —used especially with the implication that it is distinguishable from British English yet not so divergent as to be a separate language" (Merriam-Webster, n.d.). One of the popular mainstream English varieties, it is spoken by an estimated 329 million people (U.S. Census Bureau, 2019). The variety has distinctive characteristics. For instance, there are 43 sounds in AmE, and the full rhoticity, unrounded /ɑ/ vowel, the strut vowel in particular words, vowel mergers before intervocalic /r/, r-colored vowels, the /hw/ and /w/ merger, Yod-dropping, T-glottalization, flapping, L-velarization, conditioned /æ/ raising, and short /o/ before /r/ before a vowel (Trudgill, 2004; Becker, 2014; Boberg, 2015), are some phonological peculiarities to the AmE (or North American English).

Lexical variations are also present within the North American dialects (Boberg, 2005) and AmE and BrE (Topal, 2022). The vocabulary of AmE has less to do with apparently authoritative wordlists and more to do with the country's cultural, historical, regional, and social life, as evidenced by specialist dictionaries (Kretzschmar Jr., 1996). Various cultural interactions occurred in the history of the English language in North America, resulting in borrowing many words from different languages, such as Spanish, Dutch, Portuguese, and French (Blake, 2019). More vocabulary items (e.g., ravioli from Italian, burrito from Mexican Spanish, dim sum from Cantonese) were added to the AmE lexicon with the immigration to English-speaking countries (e.g., USA) (Blake, 2019). Enthusiasts might refer to the book published by Algeo (2006) for further details about vocabulary differences (i.e., parts of speech).

Grammatical variations can also be seen in AmE (Topal, 2022) and BrE, as well as other varieties. Algeo (2006) gave a finer description of the grammatical differences between AmE and BrE concerning syntactic constructions (i.e., complementation, mandative constructions, expanded predicates, concord, pro predicates, tag questions, and miscellaneous), determiners, pronouns, qualifiers, prepositions, and conjunctions. Greenbaum (1996) asserts that AmE "is more homogeneous than British English in vocabulary and grammar because of its shorter history and because of past migrations across the American continent and present easy mobility" (p.7). A typical grammatical idiosyncrasy of AmE can be observed in collective nouns, which tend to be perceived as a single entity and thus take a singular verb inflection (Greenbaum, 1996).

One of the most well-known characteristics of AmE is its orthographic variation from BrE. Following the nationalist movement in the 19th century, the US assumed the duty of 'Americanizing' the English language. Spelling reform has been one of the consequences of this movement (Hodges, 1964). Hodges (1964) adds that "today, spelling is probably more rigid than any other aspect of language. Any success in altering the present system will most likely be achieved from a linguistic analysis of spelling, in which phonemic principles are applied" (Hodges, 1964, p. 332). Some common spelling variations are o-ou (color-colour), er-re (center-centre), ize-ise (organize-organise), yze-yse (analyze-analyse) l-ll (traveled-travelled), e-oe (esophagus-oesaphagous), e-ae (anemia-anaemia), e-ea (likable-likeable), se-ce (defense-defence) og-ogue (dialog-dialogue) dg-dge (judgment-judgement), and one-letter difference (mom-mum) (Topal, 2022).

Previous studies have suggested an inclination toward AmE in various educational contexts. For instance, Honna and Takeshita (2014) reported that English language teaching (ELT) in Japan is predisposed toward AmE. Elyas and Picard (2010) noted that most Gulf countries, including Saudi Arabia, adopted mainly American university curricula. Another study revealed that Malaysian students and lecturers held positive attitudes toward inner-circle Englishes, including AmE (Crismore et al., 1996). Rezai et al. (2019) found that Iranian learners rated AmE and BrE accents positively. In a study investigating the listener judgments of speaker and speech traits of Asian Englishes and AmE, AmE was rated more positively (Hansen Edwards et al., 2019). Native English varieties, including AmE, were found to be correct/norm among prospective Turkish teachers of English as well (Coskun, 2011). Without handling the appropriateness of the argument about the English language norm, it is manifest that native varieties, especially AmE, are still preferred by learners and teachers across diverse educational contexts.

Given (i) the prevalent preference toward AmE, (ii) the perceived easiness of learning and teaching this English variety, and (iii) the availability of various CALL and MALL tools, this study intended to evaluate critically computer- and mobile-assisted tools explicitly designed for learning and teaching AmE.

Method

This study employs a corpus-driven approach. Corpus linguistics is used primarily to investigate language variations and change empirically and is a methodological approach (and) "… utilizes a large and principled collection of natural texts, known as a corpus, as the basis for analysis" (Biber et al., 2010, p.548). Flowerdew (2012) defines a corpus as "a collection of authentic language, either written or spoken, which has been compiled for a particular purpose" (p.3). In addition to being used for descriptive linguistic studies and descriptions of varieties, corpora might also be employed in language learning and teaching to present ideas and discuss their possible pedagogical benefits (Biber et al., 2010). That was the reason for choosing a corpus-driven approach in this study. In line with the research objectives, the following research questions were addressed in this study:

RQ (1): What CALL tools are available to learn and teach AmE?

RQ (2): What MALL tools are available to learn and teach AmE?

Criteria for Corpus Selection

This study adopted Sinclair's (2004) recommendations for corpus design: (i) text mode (spoken and written), (ii) text type (computer and mobile technologies), (iii) text domain (academic), (iv) text language (English), and (v) representativeness (AmE) and Flowerdew's (2004) guidelines for building a specialized corpus that considers the purpose for building a specialized corpus, genre to be investigated, size of the corpus, representativeness of the genre, data collection method, corpus tagging, and the suitability of reference corpus to contrast with the specialized corpus.

The reason for building this small corpus (comprising five products) is to critically evaluate the technological resources to determine the potential pedagogical benefits of teaching and learning AmE. In all the resources, additional criteria were sought: pertinence to AmE, being a CALL and MALL product, and having potential pedagogical benefits for language education. The corpus analysis revealed four categories in which the resources were grouped: websites, mobile applications, digital textbook

components, and corpora. These resources refer to the utilization of technology at the applications and resource levels (Levy, 2010).

A quick online search revealed 16 relevant tools. Pronunciation (https://pronuncian.com/), Sounds: The Pronunciation App, English accent coach (https://www.englishaccentcoach.com/), ELSA Speak (https://elsaspeak.com/en/), Merriam-Webster dictionary (https://www.merriam-webster.com/), Vocabulary.com (https://www.vocabulary.com/), Grammarly (https://www.grammarly.com/), ReadTheory (https://readtheory.org/), Newsela (https://newsela.com/), Rosetta Stone (https://eu.rosettastone.com/), FluentU (https://www.fluentu.com/), Sounds American YouTube channel (https://www.youtube.com/c/SoundsAmerican) and website (https://soundsamerican.net/), Voice of America (VOA) News Learning English (https://learningenglish.voanews.com/), Corpus of Contemporary American English (COCA) (https://www.english-corpora.org/coca/), American English podcast on Spotify (https://open.spotify.com/show/4hlKt74aPrqA03YQNVgpdX?si=2320048a0c1b4855), American English File (2nd ed.) (Latham-Koenig et al., 2013)

Out of these resources available, the selected samples were included in each group (i.e., three websites, one mobile app, one digital textbook component, and one corpus) for practicality and usability. In this respect, the selected resources were the Sounds American YouTube channel and website, Voice of America (VOA) News Learning English for web-based resources, American English podcast on Spotify for mobile apps, American English File (2nd ed.) (Latham-Koenig et al., 2013) for digital textbook component, and Corpus of Contemporary American English (COCA) for corpus.

Evaluation Criteria for CALL and MALL Products

The adapted versions of Baya'a et al. (2009) framework (i.e., usability, content, educational value, and vividness) for evaluating web-based learning environments and Reinders and Pegrum's (2017) framework (i.e., educational affordances, general pedagogical design, L2 pedagogical design, SLA design, and affective design) for evaluating mobile learning resources were utilized in this study. The first framework comprises usability (i.e., purpose, homepage, navigation, design, enjoyment, and readability), content (i.e., authority, accuracy, relevance, sufficiency, and appropriateness), educational value (i.e., learning activities, activity plan, resources, communication, feedback, rubric, and help tools), and vividness (i.e., links and updating). The second framework, on the other hand, consists of five criteria: educational affordances, general pedagogical design, L2 pedagogical design, SLA design, and affective design. Since the two cited frameworks are too sophisticated, they were simplified. Both mobile and web-based resources were reviewed in terms of technical and pedagogical features and concerns. In other words, the technological tools were assessed based on the pedagogical gains they offered, their technical features, and their technical/pedagogical limitations.

Data Analysis

The CALL and MALL products selected according to the cited criteria were evaluated by three experts using the two evaluation frameworks. The raters were all English language instructors working at the College of Foreign Languages of a major state university in Türkiye. All raters held their Ph.D in English language teaching, with a minimum of 10 years of working experience. The raters gathered before and after the evaluation process for cross-checking. Agreement on the nature of the evaluation was established before the procedure. The raters were asked to evaluate the selected tools using the web and mobile tool evaluation rubrics developed by Baya'a et al. (2009) and Reinders and Pegrum (2017). They were also asked to list the evaluated tools' potential pedagogical affordances, technical features, and pedagogical/technical concerns. Later, they convened for a second time for peer debriefing since it enhanced validity/reliability and increased reflexivity in qualitative research (Spall, 1998). Findings were reported after complete agreement was established between the raters.

Findings and Discussion

The findings were presented in the following order: VOA news site, Sounds American website and YouTube channel, podcast, digital textbook component, and corpus.

VOA News Learning English

The *VOA News Learning English* (given this title in 2014), continuing as the VOA Special English, was founded in 1959. The purpose, benefit, and importance of the website were clearly defined on the

website (see About). It is manifest that the website provides multimedia news broadcasts and information at beginning, intermediate, and advanced levels for language learners worldwide. The homepage has a clear table of contents (i.e., test your English, beginning level, intermediate level, advanced level, and US history), with an easy-to-use interface for navigation. The sections were displayed on the website with appropriate multimedia, making it suitable for design, enjoyment, and readability.

Concerning content, the beginning level includes *Let's Learn English* (Levels 1 and 2) for beginning-level learners of English. The course follows a schedule (52 weeks for Level 1, 30 weeks for Level 2) designed by certified teachers. Such skills as vocabulary, pronunciation, speaking, and writing are addressed in this course through videos. The lessons are shareable and printable on manifold social media platforms. Printable worksheets, lesson plans, and assessments are available for English learners and teachers. The beginning level also has features like *Ask a Teacher*, which includes teacher answers to various learner questions in audio and text forms, and *News Words*, which introduces a word in an authentic news broadcast highlighting the target word. The intermediate level presents news stories on diverse topics in audio and text forms, with a list of target vocabulary at the end of each story. This level also houses such programs as English in *A Minute, English @ the Movies, Everyday Grammar TV*, and *Learning English TV*. These programs are captioned videos that might help strengthen learners' vocabulary, listening, grammar, and pronunciation. The advanced level provides classic literature pieces in American Stories, idioms and expressions in W*ords and Their Stories*, study materials in *Everyday Grammar,* and online training materials for advanced learners and teachers of *English in News Literacy* and *Let's Teach English*.

The website also allows users to interact with community members through *TALK2US*, scheduled on Mondays, Wednesdays, and Fridays. Learners might join and talk to the VOA News Learning English program specialists. Additionally, informative texts and audio about American culture are available on the websites of A*merica's National Parks and America's Presidents*. The news stories are also accessible in categories such as *Arts & Culture, As It Is, Education, Health & Lifestyle,* and *Science & Technology*. Users might also find listening materials such as *Learning English Broadcast*, which uses limited vocabulary at a slower pace, and W*hat It Takes*, a podcast presenting conversations with people from diverse backgrounds. In addition, *How to Pronounce* provides learners with a series of videos teaching AmE pronunciation.

Overall, it is manifest that the *VOA News Learning English* website might contribute to language learners' reading, listening, vocabulary, pronunciation, and grammar development through the authentic and multimedia materials available. This website mainly focuses on news stories, the benefits of which were reported in previous research. For instance, Park (2011) found that news articles from the New Yorker contributed to developing critical literacy in Korean EFL learners. In another study, Hsu (2019) revealed that the VOA news provided adequate input for learning mid-frequency words. Gómez-Rodríguez (2018) reported that EFL learners might enhance their intercultural competence through international news. The contribution of reading aloud through news stories to increasing self-confidence in verbal utterances was also reported (Chong, 2021). The positive impact of news stories (e.g., VOA) was also narrated in previous research (Bayani et al., 2018). Barella and Linarshi (2022) suggested that news websites might help improve pronunciation through extensive listening practice. In another study, Berardo (2006) recommended that newspapers might assist with developing reading skills in EFL learners. Lastly, online news articles were shown to promote grammar learning (Khodabandeh & Tahririan, 2020). Given the support from previous research, it is plausible to assert that *VOA News Learning English* might offer academic gains at variable degrees concerning grammar, vocabulary, pronunciation, reading, speaking, and listening. However, the website does not adequately assess the mentioned language areas. Due to this shortcoming, the website might address mostly autonomous learners and teachers of English.

Sounds American Website and YouTube Channel

The YouTube channel of *Sounds American* has been in service since 2015. The channel tackles AmE pronunciation and shares related videos. The created playlists allow users to navigate the channel quickly. The channel provides such playlists as consonants, vowels, diphthongs, r-colored sounds, IPA illustrated, AmE pronunciation for Spanish speakers of English, contrastive sounds/pronunciation

exercises, most common words, and places of articulation (i.e., affricate, nasal, stop, fricative, glide, and liquid). The videos usually follow the same course: introduction to the target sound, how to make the target sound, pronunciation exercises about it, and spelling for the target sound. The videos resemble interactive and virtual pronunciation lessons for autonomous learners or self-paced learning. All videos include captions, along with audiovisual material. It is manifest that the channel focuses solely on pronunciation's segmental features, thus excluding suprasegmentals. The literature provides evidence about the effectiveness of both features for comprehensibility and intelligibility (Levis, 2018; Suzukida & Saito, 2021). However, the lack of suprasegmental features might be understandable since these features pertain to one variety of English and the English language. Hence, the channel might be deemed satisfactory in terms of segmental pronunciation.

The website, on the other hand, was launched in 2022. It is easy for users to navigate the website thanks to a clear table of contents (i.e., IPA chart, vowels, consonants, and blog). The website has interactive buttons for the American IPA chart that displays all consonants, vowels, and diphthongs in this variety. There is also the visual of a fictional character that shows the place of articulation for the selected sounds. The sections for the vowels and consonants present example words with the target sound in different word positions (initial, medial, and final). The articulation diagram with further details on the mouth, lips, and tongue positions follows this. Next, the most common spelling for the target sound is shown, supported by an interactive diagram and examples. Subsequently, a list of the most common words, including the target sound, is provided. A YouTube video including a mnemonic phrase (i.e., contextualized use of the target sound) is presented afterward. Finally, the video lesson about the target sound can be accessed. The videos on the website are retrieved from the community's YouTube channel. Users can log in to the website, comment, and share the content on numerous social media platforms. In the blog section, users might find additional and valuable information on various topics, such as the number of words required for fluency and the catch between the pronunciations of apple and maple.

Overall, it is reasonable to claim that the website and the channel offer much for AmE pronunciation self-study. Both sites' interactive and multimedia materials make them valuable pronunciation resources. Phonemes are the most significant sounds that might cause semantic shifts (Carley & Mees, 2020). Both resources for self-study attend to the phonemes in AmE. The differences between specific sounds matter more than those between others (Carley & Mees, 2020). In this sense, providing videos about the contrasting phonemes on the channel is an advantage to this learning resource. Comprehending abstract sounds might be challenging for learners. These sounds are visualized in phonemic/transcription through the symbols in the IPA chart, which is available in both learning resources. Given the relationship between spelling and pronunciation (Brown, 2014), the presence of the IPA chart and the most common spelling for the target sounds might be beneficial to raising learners' awareness. Introducing pronunciation features through multimodal means (e.g., texts, images, diagrams, and audio incorporated in videos) on these learning websites might be promising and constructive for pronunciation improvement (Brinton, 2014; Celce-Murcia et al., 2010). Ultimately, the presentation of target sounds in mnemonic phrases embedded in videos is another advantage of these resources, considering the positive impact of mnemonics on recall (Samuel, 2010).

Additionally, a recent study suggested the effectiveness of YouTube videos for self-regulated pronunciation practice (Al-Jarf, 2022), implying the potential benefits that might be reaped from the YouTube channel Sounds American. Also, autonomous pronunciation learning might help increase learners' confidence and motivation, thus resulting in pronunciation improvement (Ou et al., 2020). The examined pronunciation resources for self-study might yield promising benefits for segmental pronunciation features, spelling, phonemic transcription, and phonemic awareness. However, the two websites need more assessment despite being self-study materials. More feedback and assessment methods might be included in the websites.

American English Podcast

Created by Shana Thompson, this podcast series appeals to intermediate-advanced learners of English interested in AmE and US history and culture. It comprises such playlists as *Culture and History, Expressions, Chats with Shana, 5-minute English, Conversations, and Pronunciation*. The series takes listeners on a cultural journey through common expressions, pronunciation tips, and exciting stories and excerpts. The length of the podcasts varies from 6 to 50 minutes. The podcast also comes in premium

content at $119. The premium content includes four courses (60 lessons) based on the podcast episodes (currently 128). Listening and pronunciation practice and assessment are also available in the premium content. Premium users can further access downloadable transcripts and MP3s. The first three courses pertain to US culture and history and comprise 15 weeks each, whereas the fourth course is about the 5-minute English audio presented in 12 lessons.

McBride (2009) argues that podcasts might foster listening comprehension and intercultural competence. The benefits of podcasting projects for improving language skills were also reported by Lord (2008). In this regard, the cultural and historical stories about the US might help develop intercultural awareness and competence. Podcasts are omnipresent and authentic extracurricular learning resources (Thorne & Payne, 2005) that might enhance learner autonomy (Yaman, 2016). In his study conducted with Saudi EFL students, Al-Ahdal (2020) found that podcasts contributed considerably to pronunciation improvement. In another study, Kafes and Caner (2020) revealed the positive attitudes of Turkish-speaking teacher trainees of English toward learner-created pronunciation podcasts due to the spatial-temporal convenience they provided. Similar findings were reported in Ducate and Lomicka's (2009) study conducted with German- and French-speaking learners of English. Fouz-González (2019) maintained that podcast-based pronunciation instruction might assist with enhancing segmental phonemes in Spanish EFL learners. All these findings suggest the potential benefits of pronunciation podcasts for learners from diverse linguistic and cultural backgrounds. Despite the advantages, mere dependence on podcasting projects might result in passive learning (Palmer & Devitt, 2007). Nevertheless, it is crystal clear that podcasts provide rich and authentic aural input and thus carry critical importance for language learning. In this sense, the American English podcast series might offer potential concerning listening, pronunciation, vocabulary, and intercultural awareness and competence.

American English File Course Book Series

The second edition of the course book series (Latham-Koenig et al., 2013) by Oxford University Press comprises six levels (A1-C1). It includes resources, such as audio, video, classroom presentation tools, online practice, and worksheets. Within the scope of the research, only digital components of the course book series were examined. The audio pertains to the exercises in the student's book and workbook and contains AmE pronunciation. The videos in the Starter level are comprised of practical English videos—and short movies. The videos in the Level 1-3 course books consist of three parts: on the street, short film, and practical English. The first part (i.e., on the street) reveals videos, including English speakers' authentic use of textbook expressions on the street. The second part involves short movies about various themes, including American culture and history. The third part includes excerpts from the real lives of American characters, although the venues might be in the UK. The Level 4 course book videos comprise *Colloquial English- Interviews*, *Colloquial English- On the Street*, and short movies. Finally, the Level 5 course book videos also have *Colloquial English- Interviews Colloquial English- On the Street.* All videos are captioned and supported by additional practice. The course book series also grants students online practice (mostly grammar and vocabulary in the form of progress checks) about the units in each book.

The digital book components are easy to access and use. Learners are exposed to authentic language input through audio and videos from real life. However, the course book series analysis revealed that AmE was only thematically and partially handled since some audio and videos include articulation in other varieties. Nonetheless, the digital components of the series are believed to foster vocabulary (e.g., colloquial expressions), grammar, pronunciation, and listening to varying degrees. Sufficient practice and immersion in these language skills are claimed to establish a solid foundation for speaking. This claim was supported by Haghverdi and Ghasemi (2013), who analyzed the series and found that the classroom activities in the books promoted learner involvement and encouraged them to use the language.

Additionally, visuals (e.g., images and captions) contributed to listening comprehension (Hsieh & Huang, 2020). However, Park and Lee (2021) found the superiority of printed textbooks over digital ones concerning reading comprehension and grammatical knowledge. That suggests the impact of contextual factors on the effectiveness of digital course books. The course book series does not entirely reflect American culture or AmE.

Corpus of Contemporary American English

Comprising one billion words in 485,202 texts (https://www.english-corpora.org/coca/), The COCA is one of the most extensive and representative corpora of AmE across such genres as blogs (125m), web pages (130m), TV/Movie subtitles (128m), spoken (127m), fiction (120m), popular magazines (127m), newspapers (123m), and academic journals (121m). Registration is required to use the corpora. The website allows users to do queries and customize their search according to list, chart, word, browse, collocate, and compare keywords in context. There is even an academic vocabulary list (AVL) (Gardner & Davies, 2014) compiled from the COCA. The AVL contains 3,000 top lemmas and differs from the Academic Word List (AWL) (Coxhead, 2000). Some differences pertain to corpus size and novelty, coverage of academic English, usability, and the amount of information about meaning/use. The AVL is accessible from another website (https://www.academicvocabulary.info/). The COCA allows users to search for phrases and strings, a frequency list, individual words, and random words, enter whole texts, and browse through the AVL. Using COCA might assist learners with vocabulary, grammar, and pragmatics, particularly AmE.

Corpora was endorsed in language education contexts for data-driven learning and an enriched understanding of authentic language use (Huang, 2011). Yusu (2011) showed that the COCA might be utilized to teach and learn parts of speech, collocations, morphology, and word comparison. In another study, Rafatbakhsh and Ahmadi (2020) designed lists of frequent idioms in five genres using the COCA. One of the critical uses of corpora is vocabulary teaching. Hou (2014) demonstrated that specialized corpora incorporated into vocabulary teaching might improve content and linguistic knowledge. Similar findings were also reported by Lee et al. (2019), who found an impact of corpora on in-depth lexical expertise with a large effect size. The use of corpora for teaching grammatical structures was also endorsed in previous research (Godwin-Jones, 2017). Overall, the COCA might be useful in teaching specific lexical, orthographic, and grammatical differences in AmE.

Conclusion

This study evaluated CALL and MALL products designed explicitly for AmE. As a result of the corpus-driven analysis, three websites, one mobile app, one textbook series, and one corpus were evaluated in terms of technical and pedagogical features and concerns. The findings revealed that VOA News Learning English might be proper for reading, listening, vocabulary, pronunciation, and grammar, thanks to the authentic and multimedia materials on the website. However, the website was found to need more assessment options. Similarly, the Sounds American YouTube channel and website included interactive and multimedia materials. Therefore, they were considered beneficial for learning and teaching segmental pronunciation features, spelling, phonemic transcription, and phonemic awareness. Like the VOA website, the Sounds American website needed more assessment despite being a self-study resource. Another product that was reviewed was the American English podcast on Spotify. The rich and authentic aural and cultural input enhanced listening, pronunciation, vocabulary, and intercultural awareness/competence. The American English File course book series was another evaluated product. The study revealed that the course book series might help improve grammar, vocabulary, pronunciation, and listening. However, the series was found to handle AmE thematically and partially. The last product evaluated was the COCA. The corpus was claimed to differ in size, novelty, coverage of academic English, usability, extensive information about meaning/use, and the AVL. Given these qualities, the corpus might assist with improving vocabulary, grammar, and pragmatic use of lexical/grammatical structures.

Limitations and Further Research

Since this study introduced selective CALL and MALL products about AmE, the selection might reflect the researcher's intuition despite using a corpus-driven approach and frameworks for evaluation. For this reason, future studies are recommended to examine other products using a more objective method. Also, the study only presented and evaluated the products above. However, due to its focus, the analysis did not delve into an experimental examination. Prospective studies might investigate the effectiveness of these products in the claimed language areas. Despite the references to a few such studies in the present study, more research might be necessary for generalization. Consequently, the present study might lay the foundation for future studies about AmE, particularly within the context of computer- and mobile-assisted products.

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Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics".

Conflict of interest

I declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

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References

Ahn, J., Lee, J., & Son, M. (2024). ChatGPT in ELT: disruptor? Or well-trained teaching assistant?. *ELT Journal*, *78*(3), 345-355. https://doi.org/10.1093/elt/ccae017

Al Qasim, N., & Al Fadda, H. (2013). From Call to Mall: The effectiveness of podcast on EFL higher education students' listening comprehension. *English Language Teaching*, *6*(9), 30-41. https://doi.org/10.5539/elt.v6n9p30

Al-Ahdal, A. (2020). Overcoming pronunciation hurdles in EFL settings: An evaluation of podcasts as a learning tool at Qassim University Saudi Arabia. *Asian EFL Journal Research Articles*, *27*(1), 86–101. https://ssrn.com/abstract=3570621

Algeo, J. (2006). *British or American English?: A handbook of word and grammar patterns.* Cambridge University Press.

Al-Jarf, R. (2022). YouTube videos as a resource for self-regulated pronunciation practice in EFL distance learning environments. *Journal of English Language Teaching and Applied Linguistics*, *4*(2), 44–52. https://doi.org/10.32996/jeltal.2022.4.2.4

Al-Kadi, A. (2018). A review of technology integration in ELT: From CALL to MALL. *Language Teaching and Educational Research*, *1*(1), 1-12. https://dergipark.org.tr/en/download/article-file/481310

Al-Kadi, A. & Ahmed, R. (2018). Evolution of English in the Internet age. *Indonesian Journal of Applied Linguistics*, *7*(3), 727-736. https://doi.org/10.17509/ijal.v7i3.9823

Bahari, A. (2021). Computer-assisted language proficiency assessment tools and strategies. *Open Learning: The Journal of Open, Distance and e-Learning*, *36*(1), 61-87. https://doi.org/10.1080/02680513.2020.1726738

Barella, Y., & Linarsih, A. (2020). Extensive listening practice in EFL classroom with variety of news websites. Pedagogy: *Journal of English Language Teaching*, *8*(1), 43-50. https://doi.org/10.32332/pedagogy.v8i1.1961

Barrot, J. S. (2023). Using ChatGPT for second language writing: Pitfalls and potentials. *Assessing Writing*, *57*, 100745. https://doi.org/10.1016/j.asw.2023.100745

Baya'a, N., Shehade, H. M. A., & Baya'a, A. R. (2009). A rubric for evaluating web-based learning environments. *British Journal of Educational Technology*, *40*(4), 761-763. http://dx.doi.org/10.1111/j.1467-8535.2008.00864.x

Bayani, M., Masnun, T., & Priajana, N. (2018). The effectiveness of Voice of America news video as the teaching media of listening ability at First Grade of Sman 1 Babakan. ELT Echo: *The Journal of English Language Teaching in Foreign Language Context*, *3*(2), 159–168. http://dx.doi.org/10.24235/eltecho.v3i2.3633

Beare, K. (2019). How many people speak English? *ThoughtCo*. https://www.thoughtco.com/how-many-people-learn-english-globally-1210367

Becker, K. (2014). (r) we there yet? The change to rhoticity in New York City English. *Language Variation and Change*, *26*(2), 141–168. https://doi.org/10.1017/S0954394514000064

Berardo, S. A. (2006). The use of authentic materials in the teaching of reading. *The Reading Matrix*, *6*(2), 60-69. https://readingmatrix.com/articles/berardo/article.pdf

Biber, D., Reppen, R., & Friginal, E. (2010). Research in corpus linguistics. In R. B. Kaplan (Ed.), *The Oxford handbook of applied linguistics* (pp. 548-567). Oxford University Press.

Blake, B. (2019). *English vocabulary today: Into the 21st century*. Routledge.

Boberg, C. (2005). The North American regional vocabulary survey: New variables and methods in the study of North American English. *American Speech*, *80*(1), 22–60. https://doi.org/10.1215/00031283-80-1-22

Boberg, C. (2015). North American English. In M. Reed & J. M. Levis (Eds.), *The Handbook of English pronunciation* (pp. 229–250). Wiley-Blackwell.

Borucki, A., Eltis, D., & Wheat, D. (2015). Atlantic history and the slave trade to Spanish America. *The American Historical Review*, *120*(2), 433–461. https://doi.org/10.1093/ahr/120.2.433

Brinton, D. M. (2014). Epilogue to the myths: Best practices for teachers. In L. Grant 8Ed.), *Pronunciation myths: Applying second language research to classroom teaching* (pp. 225–242). University of Michigan Press.

Brown, A. (2014). *Pronunciation and phonetics: A practical guide for English language teachers.* Routledge.

Burston, J. (2015). Twenty years of MALL project implementation: A meta-analysis of learning outcomes. *ReCALL, 27*(1), 4-20. https://doi.org/10.1017/S0958344014000159

Burston, J., & Giannakou, K. (2022). MALL language learning outcomes: A comprehensive meta-analysis 1994–2019. *ReCALL, 34*(2), 147-168. https://doi.org/10.1017/S0958344021000240

Çakmak, F., Namaziandost, E., & Kumar, T. (2021). CALL-enhanced L2 vocabulary learning: Using spaced exposure through CALL to enhance L2 vocabulary retention. *Education Research International*, *2021*(1), 5848525, https://doi.org/10.1155/2021/5848525

Carley, P., & Mees, I. (2020). *American English phonetics and pronunciation practice.* Routledge.

Carrie, E. (2017). 'British is professional, American is urban': attitudes towards English reference accents in Spain. *International Journal of Applied Linguistics*, *27*(2), 427–447. https://doi.org/10.1111/ijal.12139

Celce-Murcia, M., Brinton, D., & Goodwin, J. M. (2010). *Teaching pronunciation: A reference for teachers of English to speakers of other languages* (2nd ed.). Cambridge University Press.

Chinnery, G. M. (2006). Emerging technologies: Going to the MALL (Mobile Assisted Language Learning.). *Language Learning & Technology, 10*(1), 9–16. http://dx.doi.org/10125/44040

Choe, H. (2016). Identity formation of Filipino ESL teachers teaching Korean students in the Philippines: How negative and positive identities shape ELT in the Outer Circle. *English Today, 32*(1), 5–11. https://doi.org/10.1017/S0266078415000553

Chong, C. M. (2021). A case study on reading aloud using English TV news. *Journal of English Teaching through Movies and Media, 22*(1), 1–18. https://doi.org/10.16875/stem.2021.22.1.1

Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology: The digital revolution and schooling in America*. Teachers College Press.

Cook, V. (2007). The goals of ELT. In J. Cummins & C. Davison (Eds.), *International handbook of English language teaching* (pp. 237–248). Springer.

Coskun, A. (2011). Future English teachers' attitudes towards EIL pronunciation. *Journal of English as an International Language, 6*(2), 46–68. https://www.eilj.com/wp-content/uploads/2013/12/eil-nov-2011_v2.pdf

Coxhead, A. (2000). A new academic word list. *TESOL Quarterly, 34*(2), 213–238. https://doi.org/10.2307/3587951

Crismore, A., Ngeow, K. Y. H., & Soo, K. S. (1996). Attitudes toward English in Malaysia. *World Englishes, 15*(3), 319–335. https://doi.org/10.1111/j.1467-971X.1996.tb00118.x

Crystal, D. (2006). *A dictionary of linguistics and phonetics* (6th ed.). Blackwell.

Crystal, D., & Potter, S. (2022). English language. *Encyclopedia Britannica.* https://www.britannica.com/topic/English-language

Dağdeler, K. O., & Demiröz, H. (2022). EFL instructors' perceptions of utilizing mobile-assisted language learning in Higher Education. *Acta Educationis Generalis*, *12*(2), 22-40. https://doi.org/10.2478/atd-2022-0012

Daly, N. P. (2022). Investigating learner autonomy and vocabulary learning efficiency with MALL. *Language Learning & Technology, 26*(1), 1-30. https://doi.org/10125/73469

Dashtestani, R. (2013). Implementing mobile-assisted language learning (MALL) in an EFL context: Iranian EFL teachers' perspectives on challenges and affordances. *JALT CALL Journal*, *9*(2), 149-168. https://doi.org/10.29140/jaltcall.v9n2.j153

Daungsupawong, H., & Wiwanitkit, V. (2024). ChatGPT and dyslexia: correspondence. *Disability and Rehabilitation: Assistive Technology*, *19*(6), 2413-2414. https://doi.org/10.1080/17483107.2023.2287162

Di Bitetti, M. S., & Ferreras, J. A. (2017). Publish (in English) or perish: The effect on citation rate of using languages other than English in scientific publications. *Ambio*, *46*, 121-127. https://doi.org/10.1007/s13280-016-0820-7

Ducate, L., & Lomicka, L. (2009). Podcasting: An effective tool for honing language students' pronunciation? *Language Learning & Technology, 13*(3), 66-86. http://dx.doi.org/10125/44192

Elnathan, R. (2021). English is the language of science, but precision is tough for a non-native speaker. *Nature*. https://doi.org/10.1038/d41586-021-00899-y

Elyas, T., & Picard, M. (2010). Saudi Arabian educational history: Impacts on English language teaching. *Education, Business, and Society: Contemporary Middle Eastern Issues, 3*(2), 136-145. https://doi.org/10.1108/17537981011047961

Fields, A. N. (2024). *AI-assisted college composition for non-native speakers of English -A course design* (Unpublished doctoral dissertation), Murray State University, USA. https://digitalcommons.murraystate.edu/daeng/5

Fishman, J. A. (1991). *Reversing language shift: Theoretical and empirical foundations of assistance to threatened languages* (Vol. 76). Multilingual Matters.

Flowerdew, L. (2004). The argument for using English-specialized corpora to understand academic and professional language. In U. Connor & T.A. Upton (Eds.), *Discourse in the professions: Perspectives from corpus linguistics* (pp. 11-33). John Benjamins.

Flowerdew, L. (2012). Definition, purposes, and applications of corpora. In C. N. Candlin & D. R. Hall (Eds.), *Corpora and Language education* (pp. 81-110). Palgrave Macmillan.

Fouz-González J (2020) Using apps for pronunciation training: An empirical evaluation of the English file pronunciation app. Langu*age Learning & Technology 24*(1), 62–85. https://doi.org/10125/44709

Fouz-González, J. (2019). Podcast-based pronunciation training: Enhancing FL learners' perception and production of fossilised segmental features. *ReCALL, 31*(2), 150-169. https://doi.org/10.1017/S0958344018000174

Galloway, N. (2014). "I get paid for my American accent": The story of one multilingual English teacher (MET) in Japan. *Englishes in Practice, 1*(1), 1–30. https://doi.org/10.2478/eip-2014-0001

Gardner, D., & Davies, M. (2014). A new academic vocabulary list. *Applied Linguistics, 35*(3), 305–327. https://doi.org/10.1093/applin/amt015

Garib, A. (2023). "Actually, it's real work": EFL teachers' perceptions of technology-assisted project-based language learning in Lebanon, Libya, and Syria. *TESOL Quarterly*, *57*(4), 1434-1462. https://doi.org/10.1002/tesq.3202

Gillespie, J. (2020). CALL research: Where are we now?. *ReCALL*, *32*(2), 127-144. https://doi.org/10.1017/S0958344020000051

Godwin-Jones, R. (2017). Data-informed language learning. *Language Learning & Technology, 21*(3), 9–27. https://doi.org/10125/44629

Golonka, E. M., Bowles, A. R., Frank, V. M., Richardson, D. L., & Freynik, S. (2014). Technologies for foreign language learning: A review of technology types and their effectiveness. *Computer-Assisted Language Learning, 27*(1), 70–105. https://doi.org/10.1080/09588221.2012.700315

Gómez-Rodríguez, L. F. (2018). EFL learners' intercultural competence development through international news. *GIST–Education and Learning Research Journal, 16*, 185-208. https://doi.org/10.26817/16925777.431

Greenbaum, S. (1996). *English grammar*. Oxford University Press.

Grieve, J., Montgomery, C., Nini, A., Murakami, A., & Guo, D. (2019). Mapping lexical dialect variation in British English using Twitter. *Frontiers in Artificial Intelligence, 2*, 1–18. https://doi.org/10.3389/frai.2019.00011

Hafour, M. F. (2022). The effects of MALL training on preservice and in-service EFL teachers' perceptions and use of mobile technology. *ReCALL*, *34*(3), 274-290. https://doi.org/10.1017/S0958344022000015

Haghverdi, H. R., & Ghasemi, B. (2013). American English file series evaluation based on Littlejohn's evaluative framework. *International Journal of Foreign Language Teaching and Research, 1*(1), 106-120. https://journals.iau.ir/article_550503_cf11268d75922d7603bf9565675d7b96.pdf

Hansen Edwards, J. G., Zampini, M. L., & Cunningham, C. (2019). Listener judgments of speaker and speech traits of varieties of Asian English. *Journal of Multilingual and Multicultural Development, 4*0(8), 691–706. https://doi.org/10.1080/01434632.2018.1549057

Hodges, R. E. (1964). A short history of spelling reform in the United States. *The Phi Delta Kappan*, *45*(7), 330–332. https://www.jstor.org/stable/20343148

Hoi, V. N., & Mu, G. M. (2021). Perceived teacher support and students' acceptance of mobile-assisted language learning: Evidence from Vietnamese higher education context. *British Journal of Educational Technology*, *52*(2), 879-898. https://doi.org/10.1111/bjet.13044

Honna, N., & Takeshita, Y. (2014). English as an international language and three challenging issues in English language teaching in Japan. In R. Marlina, & R. A. Giri (Eds.), *The pedagogy of English as an international language* (pp. 65–77). Springer.

Hou, H. I. (2014). Teaching specialized vocabulary by integrating a corpus-based approach: Implications for ESP course design at the university level. *English Language Teaching*, *7*(5), 26-37. http://dx.doi.org/10.5539/elt.v7n5p26

Hsieh, Y., & Huang, S. (2020). Using an E-book in the secondary English classroom: Effects on EFL reading and listening. *Education and Information Technologies*, *25*(2), 1285–1301. https://doi.org/10.1007/s10639-019-10036-y

Hsu, W. (2019). Voice of America news as voluminous reading material for mid-frequency vocabulary learning. *RELC Journal, 50*(3), 408–421. https://doi.org/10.1177/0033688218764460

Huang, L. S. (2011). Corpus-aided language learning. *ELT Journal*, *65*(4), 481-484. https://doi.org/10.1093/elt/ccr031

Hughes, A., Trudgill, P., & Watt, D. (2019). *English accents and dialects: An introduction to social and regional varieties of English in the British Isles* (5th ed.). Routledge.

Kafes, H., & Caner, M. (2020). Impact of podcasting on pronunciation skills of pre-service EFL teachers. *Turkish Online Journal of Distance Education, 21*(3), 36-47. https://doi.org/10.17718/tojde.762022

Kang, O. (2015). Learners' perceptions toward pronunciation instruction in three circles of world Englishes. *TESOL Journal, 6*(1), 59–80. https://doi.org/10.1002/tesj.146

Karakaya, K., & Bozkurt, A. (2022). Mobile-assisted language learning (MALL) research trends and patterns through bibliometric analysis: Empowering language learners through ubiquitous educational technologies. *System*, *110*, 102925. https://doi.org/10.1016/j.system.2022.102925

Kartal, G. (2024). Evaluating a mobile instant messaging tool for efficient large-class speaking instruction. *Computer Assisted Language Learning*, *37*(5-6), 1252-1280. https://doi.org/10.1080/09588221.2022.2074463

Khodabandeh, F., & Tharirian, M. H. (2020). Exploring the impact of blended, flipped, and traditional teaching strategies for teaching grammar on Iranian EFL learners through English newspaper articles. *Teaching English as a Second Language Quarterly (Formerly Journal of Teaching Language Skills)*, *39*(3.1), 89-129. https://doi.org/10.22099/jtls.2020.38443.2883

Kic-Drgas, J., Seferoğlu, G., Kılıçkaya, F., & Pereira, R. (2023). Polish, Portuguese, and Turkish EFL teachers' perceptions on the use of OER language processing technologies in MALL: A replication study. *ReCALL*, *35*(2), 143-159. https://doi.org/10.1017/S0958344023000058

Kohnke, L., Moorhouse, B. L., & Zou, D. (2023). ChatGPT for language teaching and learning. *RELC Journal*, *54*(2), 537-550. https://doi.org/10.1177/00336882231162868

Kooli, C., & Yusuf, N. (2024). Transforming educational assessment: Insights into the use of ChatGPT and large language models in grading. *International Journal of Human–Computer Interaction*, 1-12. https://doi.org/10.1080/10447318.2024.2338330

Kretzschmar Jr, W. A. (1996). Dimensions of variation in American English vocabulary. *English World-Wide*, *17*(2), 189-211. https://doi.org/10.1075/eww.17.2.04kre

Kung, F. W., & Wang, X. (2019). Exploring EFL learners' accent preferences for effective ELF communication. *RELC Journal*, *50*(3), 394-407. https://doi.org/10.1177/0033688218765306

Latham-Koenig, C., Oxenden, C., & Seligson, P (2013). *American English file* (2nd ed.). Oxford University Press.

Lee, H., Warschauer, M., & Lee, J. H. (2019). The effects of corpus use on second language vocabulary learning: A multilevel meta-analysis. *Applied Linguistics*, *40*(5), 721-753. https://doi.org/10.1093/applin/amy012

Lee, J. S., & Chen Hsieh, J. (2018). University students' perceptions of English as an International Language (EIL) in Taiwan and South Korea. *Journal of Multilingual and Multicultural Development*, *39*(9), 789-802. https://doi.org/10.1080/01434632.2018.1438448

Levis, J. M. (2018). *Intelligibility, oral communication, and the teaching of pronunciation.* Cambridge University Press.

Levy, M. (1997). *Computer-assisted language learning: Context and conceptualization.* Oxford University Press.

Levy, M. (2010). Developing the language skills: Aligning the technological tool to the pedagogical purpose. In C. Ward (Ed.), *The impact of technology on language learning and teaching: What, how, and why* (pp. 16–27). Regional Language Centre.

Lord, G. (2008). Podcasting communities and second language pronunciation. *Foreign Language Annals, 41(*2), 364–379. https://doi.org/10.1111/j.1944-9720.2008.tb03297.x

McBride, K. (2009). Promoting listening comprehension and intercultural competence. In L. Abraham & L. Williams (Eds.), *Electronic discourse in language learning and teaching* (pp. 153–167). John Benjamins.

Meniado, J. C. (2023). Digital language teaching 5.0: Technologies, trends and competencies. *RELC Journal*, *54*(2), 461-473. https://doi.org/10.1177/00336882231160610

Merriam-Webster. (n.d.). "American English" Retrieved 16.9.2024, from https://www.merriam-webster.com/dictionary/American%20English

Mihaylova, M., Gorin, S., Reber, T. P., & Rothen, N. (2022). A meta-analysis on mobile-assisted language learning applications: benefits and risks. *Psychologica Belgica*, *62*(1), 252-271. https://doi.org/10.5334/pb.1146

Munro, M. J., Derwing, T. M., & Morton, S. L. (2006). The mutual intelligibility of L2 speech. *Studies in Second Language Acquisition, 28*(1), 111–131. https://doi.org/10.1017/S0272263106060049

Obaidoon, S., & Wei, H. (2024). ChatGPT, Bard, Bing Chat, and Claude generate feedback for Chinese as foreign language writing: A comparative case study. *Future in Educational Research* (early view). https://doi.org/10.1002/fer3.39

Office for National Statistics. (2021). United Kingdom population mid-year estimate, *Office for National Statistics.* Retrieved 16.9.24, from https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/timeseries/ukpop/pop

Ou, C., Zhao, K., Li, X., & Jia, L. (2021). A study on the autonomous learning model of English pronunciation for business English major students. In C. Pang, Y. Gao, G. Chen, E. Popescu, L. Chen, T. Hao, B. Zhang, S.M.B. Navarro, & Q. Li (Eds.), *Learning Technologies and Systems. SETE ICWL 2020. Lecture notes in computer science* (pp. 318–326). Springer.

Palmer, E. J., & Devitt, P. G. (2007). A method for creating interactive content for the iPod, and its potential use as a learning tool: Technical advances. *BMC Medical Education*, *7*(1), 1-10. https://doi.org/10.1186/1472-6920-7-32

Park, J., & Lee, J. (2021). Effects of e-books and printed books on EFL learners' reading comprehension and grammatical knowledge. *English Teaching*, *76*(3), 35-61. http://dx.doi.org/10.15858/engtea.76.3.202109.35

Park, Y. (2011). Using news articles to build a critical literacy classroom in an EFL setting. *TESOL Journal, 2*(1), 24–51. https://doi.org/10.5054/tj.2011.244134

Pegrum, M., Oakley, G., & Faulkner, R. (2013). Schools going mobile: A study of the adoption of mobile handheld technologies in Western Australian independent schools. *Australasian Journal of Educational Technology*, *29*(1), 66-81. https://doi.org/10.14742/ajet.64

Pennington, M. C., & Rogerson-Revell, P. (2019). *English pronunciation teaching and research.* Palgrave MacMillan.

Pérez-Paredes, P., Ordoñana Guillamón, C., & Aguado Jiménez, P. (2018). Language teachers' perceptions on the use of OER language processing technologies in MALL. *Computer Assisted Language Learning*, *31*(5-6), 522-545. https://doi.org/10.1080/09588221.2017.1418754

Rafatbakhsh, E., & Ahmadi, A. (2020). The most frequent idioms used in contemporary American English: A corpus-based study. *Applied Research on English Language*, *9*(2), 205-228. https://doi.org/10.22108/are.2019.114449.1389

Reinders, H., & Pegrum, M. (2017). Supporting language learning on the move. In B. Tomlinson (Ed.), *SLA research and materials development for language learning* (pp. 219–232). Routledge.

Richards, J. C. (2015). *Key issues in language teaching.* Cambridge University Press.

Roh, J., & Kim, T. (2019). Fostering learner autonomy through CALL and MALL in a Korean class: A case study. *Journal of Interactive Learning Research*, *30*(2), 215-254. https://www.learntechlib.org/primary/p/181300/

Rose, H., & Galloway, N. (2019). *Global Englishes for language teaching.* Cambridge University Press.

Samuel, C. (2010). Pronunciation pegs. *TESL Canada Journal, 27*(2), 103–103. https://doi.org/10.18806/tesl.v27i2.1051

Shin, D., & Lee, J. H. (2023). Can ChatGPT make reading comprehension testing items on par with human experts? *Language Learning & Technology, 27*(3), 27–40. *https://hdl.handle.net/10125/73530*

Sinclair, J. M. (2004). *How to use corpora in language teaching.* John Benjamins.

Spall, S. (1998). Peer debriefing in qualitative research: Emerging operational models. *Qualitative Inquiry, 4*(2), 280–292. https://doi.org/10.1177/107780049800400208

Statista Research Department. (2021). The most spoken languages worldwide. *Statista*. Retrieved 16.9.24, from https://www.statista.com/statistics/266808/the-most-spoken-languages-worldwide/

Statista Research Department. (2022). Most common languages used on the internet. *Statista*, Retrieved 16.9.24, from https://www.statista.com/statistics/262946/most-common-languages-on-the-internet/

Stockwell, G. (2007). A review of technology choice for teaching language skills and areas in the CALL literature. *ReCALL, 19*(2), 105–120. https://doi.org/10.1017/S0958344007000225

Suzukida, Y., & Saito, K. (2021). Which segmental features matter for successful L2 comprehensibility? Revisiting and generalizing the pedagogical value of the functional load principle. *Language Teaching Research, 25*(3), 431-450. https://doi.org/10.1177/1362168819858246

Tajeddin, Z., Alemi, M., & Pashmforoosh, R. (2018). Idealized native-speaker linguistic and pragmatic norms in English as an international language: Exploring the perceptions of non-native English teachers. *Language and Intercultural Communication, 18*(3), 300–314. https://doi.org/10.1080/14708477.2017.1413105

Teng, M. F. (2024). "ChatGPT is the companion, not enemies": EFL learners' perceptions and experiences in using ChatGPT for feedback in writing. *Computers and Education: Artificial Intelligence, 7*, 100270. https://doi.org/10.1016/j.caeai.2024.100270

Thorne, S. L., & Payne, J. S. (2005). Evolutionary trajectories, Internet-mediated expression, and language education. *CALICO Journal, 22*(3), 371–397. https://doi.org/10.1558/cj.v22i3.371-397

Topal, İ. H. (2021). *A critical evaluation of VoScreen as a microlearning tool for English language learning and teaching*. 1. uluslararası yabancı dil eğitimi sempozyumu (YABDİLSEM) [1st international foreign language education symposium], Ankara, Türkiye.

Topal, I. H. (2022). A small-scale corpus-based study for the varietal differences in American and British English: Implications for language education. *Language Related Research, 13*(3), 199–226. http://dx.doi.org/10.52547/LRR.13.3.9

Topal, İ. H. (2024). ChatGPT: A critical evaluation: https://chat. openai. com. *TESOL Journal, 15*(3), e810. https://doi.org/10.1002/tesj.810

Trudgill, P. (2004). *New-dialect formation: The inevitability of colonial Englishes.* Oxford University Press.

Turnbull, D., Chugh, R., & Luck, J. (2021). Learning management systems: A review of the research methodology literature in Australia and China. *International Journal of Research & Method in Education, 44*(2), 164-178. https://doi.org/10.1080/1743727X.2020.1737002

U.S. Census Bureau. (2019). Quick facts. United States, *U.S. Census Bureau*. Retrieved 16.9.24, from https://www.census.gov/quickfacts/fact/table/US/PST045219

Watson, D. (2019). Fordism: A review essay. *Labor History, 60*(2), 144–159. https://doi.org/10.1080/0023656X.2019.1537031

Wolfram, W., & Schilling, N. (2015). *American English: Dialects and variation* (3rd ed.). Wiley-Blackwell.

Yaman, I. (2016). The potential benefits of podcasts for language learning. *Journal of Educational and Instructional Studies in the World, 6*(1), 60–66. https://arastirmax.com/en/system/files/dergiler/116392/makaleler/6/1/arastirmax-potential-benefits-podcasts-language-learning.pdf

Yang, J. (2013). Mobile assisted language learning: Review of the recent applications of emerging mobile technologies. *English Language Teaching*, *6*(7), 19-25. https://doi.org/10.5539/elt.v6n7p19

Yusu, X. (2014). On the application of corpus of contemporary American English in vocabulary instruction. *International Education Studies, 7*(8), 68–73. https://doi.org/10.5539/ies.v7n8p68

Yüzlü, M. Y. (2024). The impact of ChatGPT on vocabulary learning in L3 German class. *Journal of Higher Education and Science*, *14*(2), 339-348. https://doi.org/10.5961/highereducsci.1417301

Zain, D. S. M., & Bowles, F. A. (2021). Mobile-assisted language learning (MALL) for higher education instructional practices in EFL/ESL contexts: A recent review of literature. *Computer-Assisted Language Learning Electronic Journal*, *22*(1), 283-307. https://callej.org/index.php/journal/article/view/332/263

Zhang, Z. (2024). New communicative language teaching methods: How ChatGPT is used in English teaching and its impacts. *Journal of Education, Humanities and Social Sciences*, *32*, 74-78. https://doi.org/10.54097/c7x09e25

Zhao, Y. (2005). The future of research in technology and second language education. In Y. Zhao (Ed.), *Research in technology and second language learning: Developments and directions* (pp. 445–457). Information Age Publishing.

e-Kafkas Journal of Educational Research e-KJER Research Article

The Effect of Quantum Learning Model on Attitude, Anxiety, and Achievement of Middle School Students Towards Mathematics[1]

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Abstract

We conducted this research to investigate the impact of the Quantum Learning Model (QLM) on the academic achievement, attitudes toward mathematics, and anxiety levels of seventh-grade middle school students. A total of fifty-six 7th-grade students participated in the research. The research used a quasi-experimental model with a pretest-posttest control group. The experimental group used QLM during the research process, while the control group used the current learning approach. We conducted the research for 28 lesson hours. We collected data using attitude, anxiety scale, and academic achievement tests. We applied tests to both groups before and after the experimental procedure. We used independent-samples-T-tests and paired-samples-T tests in the analyses. We also evaluated the journals of students and the researcher. Accordingly, QLM had a positive effect on middle school students' academic achievement in mathematics. The posttest mean scores of attitudes decreased significantly in the control group. The experimental group experienced a decrease in post-test mean scores of anxiety, which was not statistically significant, whereas the control group experienced a statistically significant increase in post-test scores. Students and teachers have expressed positive opinions about the use of note-taking and mind maps, which enhance the durability of learning, the establishment of a classroom environment and atmosphere conducive to QLM, and the implementation of celebration activities.

Keywords: Quantum learning model, achievement, attitude, anxiety, mathematics.

[1] This study was produced from a part of the first author's master's thesis under the supervision of Prof. M. Bahaddin Acat.

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Introduction

Learning takes place permanently and meaningfully through the effective use of the current process in accordance with theories, models, strategies, techniques, styles, and teaching tools. Learning and teaching activities require multiple contexts. Teachers should adjust this versatile context in teaching to the individual psychosocial development, learning styles, and characteristics of the students. In other words, they should apply the appropriate principles of the theories following the learning-teaching conditions and variables (Duman, 2004).

Today's teaching methods and techniques widely incorporate student-centered approaches. Quantum learning, rooted in the principles of metacognition and permanent learning, empowers individuals to actualize their potential by facilitating the development of their personalized learning framework. Our education system's goal is to raise such individuals. Individuals with this characteristic can create something new that is beneficial to society (Ministry of National Education, 2018). Quantum learning will also make the person self-confident, as it enables him to learn on his own. In this way, people will look at events without prejudice and try to solve problems (DePorter & Hernacki, 1992). The bias that exists towards mathematics is one of the critical problems in our system of education. This research aims to demonstrate that mathematics is an approachable and achievable subject and to foster positive attitudes towards mathematics. Therefore, this research aims to experimentally illustrate this concept, considering the principles of QLM, and contribute to the expanding body of research on this subject.

Quantum Learning

Quantum learning's foundations are based on quantum physics. Quantum physics is a sub-branch of physics that investigates what particles exist in the material entities that exist around us and in the universe, what events occur there, and, in short, the laws that govern this universe, which we call the micro-universe (Erol, 2010). Quantum physics expresses the results with probabilities, not with certainty and clarity. The uncertainty relation is one of quantum theory's important discoveries. Obtaining accurate data is almost impossible. Relationships are non-linear, and there is reciprocal causality. In quantum systems, diversity, openness, complexity, mutual causality, and uncertainty reflect qualitative rather than quantitative changes. Since the quantum paradigm is holistic, it sees entities and systems as a whole (Demirel et al., 2004).

The rise of quantum theory necessitated a paradigm shift. The changing paradigm emphasizes that science is not a process of producing objective knowledge, but that the scientific process is a process based on the relativity of the world (Yıldırım & Şimşek, 2005). In the social sciences, where the Newtonian paradigm is predominant, recent advancements have rendered change unavoidable. Given the fundamental changes in the quantum paradigm, it is believed that educational programs will better explain these changes (Demirel, 2009).

The optional and probabilistic goals of a quantum-referenced education program can provide significant support to the individual in preserving differences in education, openness to innovations, creativity, and coping with the complexity of life. The content of the quantum program, which includes both proven and yet unproven information, can offer the individual opportunities to freely create his reality. In a quantum program, the educational situation emphasizes "learning" based on interaction rather than "teaching," which evokes objectivity. A quantum-based program bases its measurement approach on the principle that one cannot observe individual behavior independently of context. Thus, a measurement approach that considers the process and results together, based on the integrity of the observer (participant), method, tool, and observed, comes to the fore (Akpınar & Aydın, 2009).

Related Research

"Learning Forum" an international education company, initiated Quantum Learning to enhance academic and personal skills in "SuperCamps" (DePorter, 1992). The program's goal is to increase students' academic success by improving their characteristics through applied quantum learning methods. Vos-Groenendal conducted a doctoral study on the results that he collected from the SuperCamp program between 1983 and 1989. This study included qualitative and quantitative data on 6042 participants aged between 12 and 22. Based on the research findings, the average motivation scores of students who took part in Supercamps showed a 68% rise compared to their scores on the

pre-tests, 73% in their academic achievement scores, 84% in their self-esteem measurements, and 96% in their positive attitudes towards learning. The findings illustrated quantum learning's remarkable success and suggested its widespread adoption as a model. (DePorter, 1992).

Schools providing formal education carried out experimental studies with QLM applications at different grade levels and in various disciplines in the following years. For example, Nourie (1998) determined that, in a study in which 600 high school students participated, 67% of the students who were taught QLM passed the mathematics course, although the mathematics course passing rate in regular classes was 62%. Furthermore, Nourie (1998) observed positive developments in the students' high self-confidence, memory skills, dedication to the lesson, and ability to follow their teachers' example. Similarly, Myer (2005) discovered in his study with third graders that implementing quantum learning instruction led to an improvement in both reading and mathematical skills, hence enhancing mathematics accomplishment at the primary school level.

Several studies examined the results of students who applied QLM in national standard achievement tests. In Barlas et al.'s (2002) study, QLM resulted in a significant improvement in problem-solving abilities among middle school students who fulfilled academic standards but had difficulties in the classroom. In a similar vein, Benn et al. (2003) investigated the impact of the QLM on students' performance in fundamental academic courses. Based on the research findings, the implementation of the QLM had a beneficial effect on the success of students enrolled in 18 schools throughout four states. The assessments demonstrated a statistically significant and educationally meaningful improvement in academic achievement, mathematical proficiency, reading comprehension, and writing skills among students who attended quantum learning instruction, as opposed to those who did not receive such training.

In Turkey, there are various studies investigating the effects of the QLM on success and affective characteristics. For example, Demirel et al. (2004) determined that quantum learning education positively affected the learning behavior of 5th-grade students. Similarly, in his study investigating secondary school students' attitudes towards learning, Demir (2006) concluded that it had a beneficial impact on students' self-perceptions, school, learning, and course. While students' self-confidence, motivation, and reading speed increased, their stress and anxiety decreased.

Studies using the QLM are common in our country, particularly in the field of science. As an illustration, Güllü (2010) conducted a study to examine the impact of physics instruction using the QLM on the achievement, learning interest, learning styles, and brain profiles of secondary school students. The research results showed that the QLM positively impacted secondary school students' academic successes and learning desires, but it did not affect their learning styles or brain profiles. In their study, Acat and Ay (2014) investigated the impact of science and technology education, specifically using the QLM approach, on the academic performance, attitude, and self-learning skills of primary school children. These findings demonstrate the positive impact of the QLM on academic success. It has been observed that the QLM has a positive effect on the attitude towards the science course. The evaluation of teacher and student opinions concluded that quantum learning positively impacted motivation, attitude towards the lesson, group work, active participation, effective and fast learning, and the acquisition of skills. Similarly, Yilgen (2014), Alaca (2014), and Şimşek (2016) found that students' success increased in science education organized according to quantum learning. In foreign language education as a different discipline, Hanbay (2009) found in his study that the application of the "QLM" and "learning by teaching" methods together made a positive contribution to learning German as a second foreign language.

In addition to the implementation of quantum learning to primary and secondary school students, studies have also been conducted with teacher candidates. For instance, studies (Karamustafaoglu & Karamustafaoglu, 2018; Sarıgöz et al., 2015) investigate the opinions of pre-service and in-service teachers about QLM. In a similar study, Çakır (2016) examined the perceptions of primary school mathematics teacher candidates regarding the blended learning course design supported by the quantum learning cycle. Teacher candidates have a positive consensus regarding the process and are happy to take part in activities in which they are active. A study conducted by Afacan and Gürel (2019) found that quantum learning enhances the communication abilities of pre-service science

teachers. In a different study, prospective teachers did not have sufficient information about the characteristics of the QLM, but they used some of the basic features of the model in their lives without being aware of them (Sarıgöz et al., 2015).

Along with these studies, analyses were also made in which national-level studies on quantum learning were examined and evaluated together (e.g., Çağlı et al., 2020; Güler & Yazıcı, 2018; Kanadlı et al., 2015; Kazu & Kaplan, 2023). For instance, Kanadlı et al. (2015) performed a meta-analysis of quantitative studies investigating the impact of the QLM on academic performance. The study found that educational environments structured based on the QLM showed a beneficial, although slight, impact on academic achievement. Güler and Yazıcı (2018), Çağlı et al. (2020), and Kuzu and Kaplan (2023) revealed that the most examined variable in quantum learning studies is academic success. In addition, these studies appear to be based on experimental models and improve the student's academic success as well as affective characteristics such as motivation, attitude, and anxiety (Güler & Yazıcı, 2018). Çağlı et al. (2020) showed that studies were generally conducted with primary school students and concentrated on science education. As a matter of fact, Kuzu and Kaplan (2023) achieved similar results regarding the QLM; qualitative research methods suggested further investigation, considering various school levels and variables.

Quantum Learning Scheme

Le Tellier and DePorter (2002) assert that Bobbi DePorter's model is a holistic approach that integrates the most effective educational practices, fosters rich classroom learning experiences, and encourages teachers to create unique teaching models. The model's holistic nature stems from its incorporation of "brain-based learning," "accelerated learning," "neurolinguistic programming," "suggestopedia," "multiple intelligence theory," "emotional intelligence," "dual and triple brain theory," and "holistic learning." This is because it includes different theories and models, such as "learning styles (visual, auditory, and kinesthetic)" (Güllü, 2010). In the QLM, which includes many approaches and models, learners use their cognitive, affective, and psychomotor features (Bakır & Koç-Akran, 2019).

According to DePorter and Hernacki (1992), quantum learning encompasses a comprehensive set of learning methods and philosophies that have demonstrated their effectiveness in both school and business settings. The structure of quantum learning revolves around the foundations, atmosphere, design, and environment. Principles, beliefs, agreements, and guidelines form its fundamentals. Its atmosphere creates honesty, trust, and personal feelings. While defining a dynamic and interesting educational program, the environment is a structure that will increase and support learning (Ayvaz, 2007).

The elements of the QLM can be grouped into two groups: context and content. Using an orchestra analogy, we can explain these elements. The magnificence of the orchestra hall (environment), the passion of the musicians and the conductor (ambiance/atmosphere), the harmony of the instruments and their collaboration (infrastructure), and the masterful interpretation of the musical piece (pattern) create the context. The combination of all these elements determines our musical experience. The other part is content, which is as important as context. People think music is just notes on paper, but it's more. For instance, the conductor's role in facilitating the orchestra's performance, the musical abilities of each musician, and the potential of each instrument all play a significant role. When we look at it from the perspective of quantum teaching, just like in the orchestra, the teacher must act as the conductor of student learning and pay attention to the context and content arrangement (Ayvaz et al., 2007).

The quantum learning scheme consists of six interrelated stages. This process consists of the stages of enrollment, association with experiences, label, demonstration, repetition, and celebration (DePorter et al., 1999):

•The enrollment phase activates students' prior knowledge and increases their desire to conduct research (DePorter et al., 1999). At this stage, we aim to capture students' attention by providing a general introduction to the course, beginning with an opening story that stimulates their curiosity without overwhelming them with relevant information (Usta, 2006). At this stage, intriguing and attention-grabbing questions, pantomimes, skits, role-playing games, videos, and stories can be used.

•During the association stage, the brain is stimulated to explore, enabling students to learn through experiences and prior knowledge. Making associations allows you to activate the student's existing knowledge and increase their sense of curiosity. Games, simulations, role-playing, group studies, mind maps, and activities that activate prior knowledge can be performed.

•The labeling phase initiates the brain's desire to label, sort, and identify. It builds new knowledge on top of the student's prior knowledge. At this stage, educators can employ graphics, quantum note-taking, memory techniques, informative posters, analogies, and presentations.

•The demonstration phase allows the student to acquire and apply new knowledge. The student incorporates the knowledge they acquire at this stage into their learning and life experiences. The demonstration stage allows for the use of sketches, videos, games, songs, and graphic presentations.

•During the repetition phase, it strengthens the nerve connections in the brain and creates a sense of self-confidence in the student. Therefore, it is important to incorporate different activities into repetition, considering the various types of intelligence and senses. During this phase, we can implement activities that allow students to impart the knowledge they've learned to a different class, students from various age groups, a teacher, an expert, or a well-known individual, as well as reinforce their learning through group studies.

•Celebration concludes the learning process by appreciating the effort, dedication, and achievement. We can use multi-profit competitions to both entertain and enable students to enjoy the new knowledge they have gained at the end of the course (Ay, 2010).

When teaching mathematics based on the stages of the quantum learning cycle, the enrollment and association stage considers the student's existing knowledge and prepares them to absorb new concepts. Additionally, associating mathematics with daily life can help students develop positive attitudes toward mathematics. At the label stage, the introduction of new concepts necessitates the use of effective note-taking techniques, informative posters, and presentations to cement the learned concepts and ensure their permanence. Students use their self-learning skills during the demonstration phase, which supports the discovery and creation process of mathematics. In the repetition phase, students can engage in activities to cement their learning. The celebration phase helps students learn and increases their motivation. These stages may also positively affect the student's attitude towards mathematics and reduce their anxiety. Quantum learning techniques can be used to facilitate collaborative group activities across all stages.

Significance

QLM’s elements highlight four basic concepts in mathematics teaching: student creation of knowledge, self-regulation skills, learning in context, and cooperative learning. We understand that by dedicating the necessary effort to these elements, other details will naturally emerge, leading to the goal of enhancing mathematical tendency through process acquisition (Altun, 2007). The QLM outlines the principles required to achieve this goal. With its quantum learning atmosphere and design principle, the QLM provides a classroom environment that will motivate and support students, develop their self-learning skills, and serve as a place where students can structure and discover knowledge. The foundations and eight keys of excellence (integrity, failure leads to success, speaking with good purpose, attention to the present moment, commitment, ownership, flexibility, and balance) support the student's self-confidence, self-development, positive thinking, and determination, encouraging student participation in the learning process and boosting their motivation to study and be creative (Demir, 2006). Indeed, the studies (Benn et al., 2003; Myer, 2005; Nourie, 1998) showed that students who received quantum learning instruction improved their academic achievement, mathematical proficiency, reading comprehension, and writing skills more than those who did not.

According to Çağlı et al. (2020), most studies focused on science education with primary school children. The findings of the studies (e.g., Acat & Ay, 2014; Alaca, 2014; Güllü, 2010; Şimşek, 2016; Yilgen, 2014) show that the QLM improves academic performance, science course attitudes, motivation, group work, active involvement, effective learning, and skill acquisition. In fact, Kuzu and Kaplan (2023) suggested further investigation in different disciplines. Thus, we endeavored to contribute to the literature by using QLM in teaching mathematics.

Several studies (e.g., Demir, 2006; Demirel et al., 2004) have examined the effects of the QLM on affective characteristics. They observed that while students' self-esteem, motivation, self-learning, and self-confidence increased, their tension and anxiety reduced. Consequently, students trained with QLM approach situations impartially and strive to find solutions. One of the significant challenges in our educational system is the prejudice against mathematics. This research aims to demonstrate that mathematics is a subject that is both understandable and achievable and to support transforming negative perceptions about mathematics into positive ones. This research holds significance as it aims to empirically prove this by examining the principles of the quantum learning approach, thereby adding to the growing body of research on this topic. Therefore, the research topic focuses on the achievement, attitude, and anxiety levels of middle school students when they are taught mathematics courses using the QLM. The research questions are:

i. Is there a significant difference between the experimental and control group students' academic achievement, attitude, and anxiety scores in mathematics?
ii. Is there a significant difference between the experimental and control group students' gain scores of academic achievement, attitude, and anxiety in mathematics?
iii. What are the opinions of the instructor and students about the QLM?

Method

The current research employs an experimental model to investigate the impact of QLM in the mathematics course on the academic achievement, attitudes, and anxiety of seventh-graders, using a pretest-posttest quasi-experimental design with a control group. The goal of the study was to find out the efficacy of the independent variables (quantum learning and the current program method) on the paired variables (academic success, attitude, and anxiety towards the mathematics course). We created an experimental and a control group. We applied QLM to the experimental group but did not intervene with the current teaching method in the control group. We administered the Academic Achievement Test (AAT), the Attitude Scale Towards Mathematics (ASTM), and the Mathematics Anxiety Scale (MAS) to both groups as pre-tests and post-tests.

Participants

The study group for this research consists of students of two 7th-grade classes (7/C and 7/D) attending a public middle school. Variable control is the most important aspect in determining the cause-and-effect relationship in experimental models. The goal of variable control is to promote internal validity and make sure the result will be acquired only from the independent variable investigated (Karasar, 2015). To achieve this, the study attempted to equalize the experimental and control groups concerning different variables (gender, mathematics grade, cumulative grade point average [CGPA]). Each group has 28 students. The control group consisted of 13 girls (23.21%) and 15 boys (26.78%); the experimental group consisted of 14 girls (25%) and 14 boys (25%). We conducted an independent samples T-test to investigate the equivalence of other variables. We compared the gender of the experimental and control groups' students, the mathematics grades (p=-.572), the CGPA (p=.175), the AAT pre-test scores (p=.475), the ASTM pre-test scores (p=-1.622), the MAS pre-test scores, and the sub-factor pre-test scores (p=.127), and found that the experimental and control groups were statistically equivalent. While exemplifying student thoughts, which are qualitative data, students are represented with (S) and a number as S1, S2, ….

Data Collection Process

We implemented distinct teaching methods for the two groups based on the objectives of the study. The researcher is the role of the instructor in the experimental group, whereas the mathematics teacher teaches in the control group. Figure 1 shows the procedures in the experimental group:

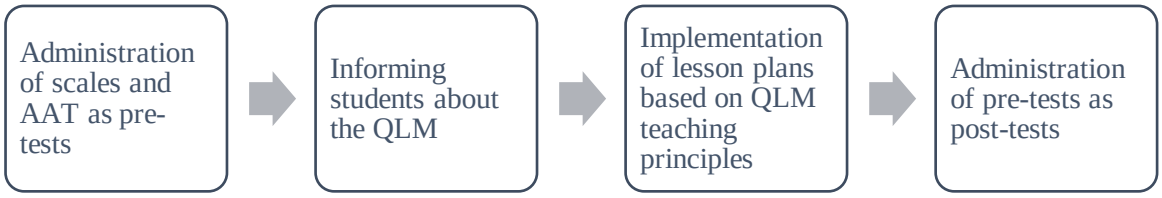

Figure 1. Procedures in the experimental group

The researcher announced that the 7/D class, designated as the experimental group, would receive instruction based on the QLM. The researcher asked students to bring a notebook and colored pencils to the lesson before starting the implementation. The implementation also required them to maintain a diary of the mathematics lesson. We have made efforts to prepare the classroom environment for quantum learning. We have arranged the desks for group work and prepared the board for activities. The implementation incorporates activities and pictures designed to enhance motivation. We employed quantum note-taking, reading, writing, and memory techniques throughout the experimental process. Additionally, the QLM covered techniques and methods such as problem-solving, brainstorming, and discussion. Music was used during some events. An example of the lesson plans used in the experimental group is provided in Appendix 1. We completed the experimental procedure in 7 weeks, adhering to the Ministry of Education curriculum.

We administered the control group to the students as pre-tests for two class hours before commencing the teaching session. According to the current program, which is based on the constructivist approach, the teacher reminds students of preliminary information about the subject and provides an environment where students can structure new information. The teacher employed techniques like question-answering, discussion, brainstorming, and narration in this environment. We reapplied the pretests as the posttest at the unit's conclusion.

Data Collection Tools

We used AAT, which consists of 22 questions; ASTM, which consists of 30 items; and MAS, which consists of 22 items in the current study. We also utilized student diaries, notebooks, and the researcher’s diaries to gather qualitative data.

Academic Achievement Test (AAT)

Achievement tests are tests that measure how much a person has learned during an educational process or, in a broader sense, under environmental conditions (Tekin, 2008). We first determined the objectives related to the curriculum to prepare for the achievement test. We have prepared a multiple-choice test consisting of 44 questions. We investigated the content validity of the achievement test. Making a specification table containing subject-behavior comparisons for achievement tests gives important clues for content validity (Büyüköztürk et al., 2010). The table of specifications is a two-dimensional table that lists objectives with their behavioral aspects in one dimension and related questions in the second dimension (Turgut, 1995). The table of specifications determined the questions for the achievement test in this research, which measures the program's objectives (see Appendix 2). Experts reviewed the prepared test, administered it to 93 students not part of the study group, and conducted a statistical analysis of the results. We ranked the students' test scores from lowest to highest, thereby determining the 27% lower and upper groups. We applied an independent-samples-T test for the item analysis, eliminating and removing items (2nd, 8th, 12th, 15th, and 44th questions) that did not exhibit a meaningful difference in the ability to differentiate between the lower and upper groups. We examined the option distributions of the multiple-choice questions in the achievement test to determine the distracting power of the distractors. We entered the students' answers into the software. Item analysis was performed. We removed questions loaded with incorrect options (1, 14, 24, 27, 35, 36, 40) from the test. We used the most appropriate distractors in the test, leaving two questions for each outcome. We created an achievement test with 22 multiple-choice questions, determining their validity and reliability. Establishing validity is the first step toward seeking reliability. According to Yıldırım (1999), reliability refers to the accuracy with which a test or measurement tool measures its intended subject. The reliability analysis revealed a KR.20 reliability coefficient of .78 for this test.

Attitude Scale Towards Mathematics (ASTM)

We implemented ACTM, which was devised by Baykul (1990). The scale is a five-point Likert-type scale that is one-dimensional and comprises a collective sum of 30 items, 15 of which are positive and 15 of which are negative. For each item on the scale, five options will help determine the opinion regarding this question. These options include: "I totally agree (5 points)," "I agree (4 points)," "I am undecided (3 points)", "I disagree (2 points)," and "I totally disagree (1 point)." A minimum score of 30 and a maximum score of 150 are the results of the scale. We reapplied the scale as an attitude test to 56 non-participant students to retest its reliability and found the reliability coefficient to be .93.

Mathematics Anxiety Scale (MAS)

We used the MAS, which Şentürk (2010) developed. This is a 22-item, 5-point Likert-type scale used to measure mathematics anxiety. The possibilities for defining the level of anxiety on the scale items include "I always worry (5 points)," "I often worry (4 points)," "Sometimes I worry (3 points)," "I rarely worry (2 points)," and "I never worry (1 point)." The sum of these scores represents the student's mathematics anxiety score. Sub-factors are anxiety arising from attitude towards mathematics (1, 2, 3, 4), anxiety arising from lack of self-confidence (5, 6, 7, 8, 9), anxiety arising from lack of field knowledge (10, 11, 12, 13), anxiety towards learning (14, 15, 16, 17), and exam anxiety (18, 19, 20, 21, 22). To retest the scale's reliability, we reapplied it as an anxiety test to 56 non-participant students before the application and found the reliability coefficient as .90.

Data Analysis

We employed a significance level of .05 for the data analysis. We conducted an independent-samples-T-test to equalize the experimental and control groups and assessed the statistical significance of the difference between their means. We employed a paired-samples T-test to assess the mean differences between the pre-test and post-test scores within both the experimental and control groups. Then, we assessed the significance of the differences between the average scores of the post-tests and pre-tests.

Findings

1. Comparison of Achievement, Attitude, and Anxiety Variables in Experimental and Control Groups

Table 1 presents the independent-samples T-test results of the experimental and control groups.

Table 1.
Independent-Samples T Test Results for Achievement, Attitude, and Anxiety Post-tests Score Averages

Groups	N	$\overline{X}$	ss	SD	t	p
Experiment -Achievement	28	10.535	4.925			
Control-Achievement	28	7.785	3.326	54	2.448	.018*
Experiment- Attitude	28	94.678	27.794			
Control- Attitude	28	101.107	18.663	54	-1.016	.314
Experiment- Anxiety	28	53.642	19.955			
Control- Anxiety	28	56.321	12.504	54	-.602	.550

* $p < 0.05$

In Table 1, there is a difference of 2.750 points in favor of the experimental group. When examining the p-value to ascertain the significance of the difference, p=.018. Since p<.05 is within the 95% confidence interval, the post-test scores exhibit a statistically significant difference. As a result, the high mean indicates a significant difference favoring the experimental group over the control group. In this case, it appears that the QLM is effective for academic achievement in the experimental group. In other terms, the QLM is more effective than the current approach for academic success.

Table 1 indicates that there is no statistically significant difference between the two groups' attitude post-test mean scores, as p=0.314>0.05 within the 95% confidence interval. Consequently, the post-test means scores of the groups in the attitudes show no notable distinction. Thus, we can infer that the QLM does not effectively modify attitudes towards mathematics lessons.

Table 1 presents that there is no statistically significant difference between the two groups' anxiety post-tests mean scores, as p=.550>.05 within the 95% confidence interval. As a result, the

experimental group's low average score is in favor of the experimental group in terms of mathematics anxiety. However, the lack of a statistically significant difference suggests that the QLM does not effectively reduce mathematics anxiety.

2. Comparison of Gain Scores of Experimental and Control Groups

First, we investigated the differences between the achievement, attitude, and anxiety pre-test and post-test scores of the groups. Next, we compared the gain scores of each group for each variable.

Comparison of Achievement Scores

Table 2 presents the groups' pre-tests and post-test scores of achievements regarding the paired-samples T-test results:

Table 2.
Paired-samples T Test Results Regarding Academic Achievement

Groups	N	$\bar{X}$	ss	SD	t	p
Experiment (pretest)	28	5.714	3.740			
Experiment (posttest)	28	10.535	4.925	27	-5.495	.001*
Control (pretest)	28	5.250	3.575			
Control (posttest)	28	7.785	3.326	27	-5.957	.001*

*p<0.05

According to Table 2, there is a statistically significant difference between the pre-test and post-test scores averages of both the experimental group and the control group, as $p<0.05$ within the 95% confidence interval.

The experimental and control groups' academic achievements increased significantly. We examined whether there was a significant difference between the gain scores of the two groups. To calculate gain scores, we took the difference between the post-test and pre-test scores. We conducted an independent-samples T-test with the gain scores (see Table 3):

Table 3.
Independent-samples T Test Results Regarding Achievement Gain Scores of Groups

Groups	N	$\bar{X}$	ss	SD	t	p
Experiment	28	4.821	4.643			
Control	28	2.535	2.252	54	2.344	.024*

*p<0.05

In Table 3, the experimental group has a 2.286 score advantage in terms of the post-test averages of the groups. When looking at the p-value to decide whether this difference is significant or not, $p=0.024$. Since $p<0.05$ is in the 95% confidence interval, there is a statistically significant difference between the gain scores of the groups. The results show that the experimental group has a significant advantage over the control group due to its high mean. In this case, it appears that the QLM is effective in terms of achievement in the experimental group. To put it another way, the QLM outperforms the current approach in terms of achievement.

Comparison of Attitude Gain Scores

Table 4 shows the groups' pre-test and post-test scores of attitudes regarding the paired-samples T-test results.

Table 4.
Paired-samples T Test Results Regarding Attitude

Groups	N	$\bar{X}$	ss	SD	t	p
Experiment (pretest)	28	94.321	25.704			
Experiment (posttest)	28	94.678	27.794	27	-.200	.843
Control (pretest)	28	104.000	18.338			
Control (posttest)	28	101.107	18.663	27	2.619	.014*

*p<0.05

In Table 4, there is no statistically significant difference between the pre-test and post-test score averages of the experimental group, as p=0.843>0.05 within the 95% confidence interval. In the control group, there is a statistically significant difference between the pre-test and post-test score averages (p=0.014<0.05) within the 95% confidence interval. There is a difference of 2.893 between the pre-test and post-test averages in favor of the pre-test in the control group. In this instance, the current approach led to a statistically significant decrease in the average mathematics attitude score of the control group. The control group's low post-test mean score suggests a negative impact on their attitudes toward mathematics. We may attribute this negative effect to the control group's approach and the content that was taught.

We examined whether the attitude gain scores of the experimental and control groups showed a significant difference. We calculated the gain scores by taking the difference between the groups' post-test and pre-test scores. We conducted an independent-samples T-test with the gain scores. Table 5 presents the results.

Table 5.
Independent-samples T Test Results Regarding Attitude Gain Scores of Groups

Groups	N	$\bar{X}$	ss	SD	T	p
Experiment	28	.3571	9.452			
Control	28	-2.892	5.845	54	1.547	.128

According to Table 5, there is no statistically significant difference between the scores of the groups' attitude gain, as p=0.128>0.05 within the 95% confidence interval.

Comparison of Anxiety Gain Scores

Table 6 shows the groups' pre-test and post-test scores of anxiety regarding the paired-samples T-test results.

Table 6.
Paired-samples T-test Results Regarding Anxiety

Groups	N	$\bar{X}$	ss	SD	t	p
Experiment (pretest)	28	53.964	16.192			
Experiment (posttest)	28	53.642	19.955	27	.334	.741
Control (pretest)	28	53.464	13.237			
Control (posttest)	28	56.321	12.504	27	-3.845	.001*

*p<0.05

Table 6 shows that there is no statistically significant difference between the experimental group's pre-test and post-test score averages, as p=0.741>0.05 within the 95% confidence interval. Again, according to Table 6, the pre-test and post-test averages have a difference of 2.857 in favor of the post-test in the control group. Since p=0.001<0.05 within the 95% confidence interval, there is a statistically significant difference between the pre-test and post-test score averages of the control group.

In this case, the implementation of QLM in the experimental group resulted in a decrease in the average mathematics anxiety score, but this decrease was not statistically significant. The current approach significantly increased the average mathematics anxiety score of the control group. A high post-test mean score in the control group indicates increased anxiety. If students have learning difficulties with the contents of the unit, this may cause their anxiety to increase.

We examined whether the anxiety gain scores of the experimental and control groups differed significantly. We calculated the gain scores by taking the difference between the groups' post-test and pre-test scores. We conducted an independent-samples T-test with the gain scores. We present these results in Table 7.

Table 7.
Independent-samples T Test Results Regarding Anxiety Gain Scores of Groups

Groups	N	$\overline{X}$	ss	SD	T	p
Experiment	28	-.321	9.452			
Control	28	2.857	5.845	54	-2.612	.012*

*p<0.05

Table 7 shows a 3.178 difference between the experimental group's average gain score and the control group's average gain score in favor of the control group. There is a statistically significant difference between the post-test scores of the experimental and control groups (p=0.012<0.05) within the 95% confidence interval. In this case, the control group has a higher average mathematics anxiety score than the experimental group. This result indicates an increase in mathematics anxiety and a negative impact on the control group.

The Anxiety Scale for Primary School Mathematics Students consists of five sub-factors. Table 8 presents the results of the QLM's impact on the sub-factors in both the two groups.

Table 8.
Independent-samples T Test Results Regarding Anxiety Sub-factors' Gain Scores of Groups

Sub-Factors*	Group	N	$\overline{X}$	ss	SD	t	p
ARATM	Experiment	28	-.392	2.183	54	-.946	.349
	Control	28	.357	3.581			
AOSC	Experiment	28	.642	4.778	54	.726	.473
	Control	28	-.071	2.071			
AOSK	Experiment	28	-1.071	3.126	54	-1.259	.214
	Control	28	.035	3.447			
LA	Experiment	28	-.428	4.375	54	-1.696	.096
	Control	28	1.535	4.290			
EA	Experiment	28	.928	3.609	54	-.069	.945
	Control	28	1.000	4.100			

* ARATM=Anxiety Resulting from Attitude Towards Mathematics, AOSC=Anxiety Originating from Self-Confidence, AOSK=Anxiety Originating from Subject Knowledge, LA=Leaning Anxiety, EA=Exam Anxiety.

According to the analysis, there is no statistically significant difference between the average scores of the experimental and control groups on the sub-factors.

3. Instructor and Students' Opinions about the QLM

Throughout the implementation process, we asked students to keep diaries in which they expressed their feelings and thoughts about the mathematics course. Examining the student diaries revealed that students generally began to enjoy the mathematics lesson and found it fun. Students attributed this to the implementation of diverse activities like mind mapping, competitions, and poster preparation, which were absent in earlier courses. For example, S23 stated that the mathematics lesson went well and S28 indicated that completing the story was nice:

> Today's third and fourth lessons focused on mathematics. In mathematics, we use something called the quantum technique. Today, our teacher drew and colored fractions on paper. We selected two students from each group. Without speaking, one of our friends used fraction cards and hand signs to explain our teacher's multi-step process, while the other recorded his understanding on the board. That's it for this day. It was very nice. (S23)

> I'm very excited today. It was a very interesting lesson. I was in class for the second time today. We did a lot of activities today. We completed the story and drew numbers from the bag. How nice it would be if all classes were like this! (S28)

S27 emphasized playing games at the celebration phase "In today's lesson, we wrote our last writing about the coordinate system and played Admiral Sank. We had a good lesson, as always".

Upon examining the unfavorable comments in certain student diaries, it became evident that students encountered challenges in comprehending specific subjects. Since most of the activities were in the form of group work, not being able to speak was sometimes a problem for students who liked to work individually. For example, S21 and S8 stated that the subject was difficult. S21 stated, *"*We solved problems in math class again today. Then we moved on to another topic. But the questions were very difficult for me. I gained a basic understanding of the content". Similarly, S8 indicated "Today is a new topic, a new curiosity. The issue confused me from the very beginning. But then it felt fun... If only I could have the right to speak!"

In her diary, the instructor/researcher stated that students' interest and motivation in the course increased. She asserted that students' active participation in the course process and their use of note-taking techniques were highly beneficial for their learning:

> In today's lesson, we made a mind map for the first time. Since we were doing it for the first time, I prepared a draft mind map with the main branches. The students completed the sub-branches of the map, albeit with difficulty. I then told them that they could enrich this map with any shapes, symbols, signs, and colors they wanted. At the end of the lesson, very beautiful mind maps emerged. The students appear to be interested in quantum learning. However, the fact that the class is crowded and there are seven groups in the class makes classroom management difficult. I can acknowledge that there are challenges associated with group activities. Over time, I believe they will become accustomed to group work (Friday, March 4).
>
> Students can now effectively use quantum learning's note-taking techniques. Competition events bring them immense joy, and they take great pleasure in receiving awards during the celebration phase. Making posters is another activity they enjoy. Students enjoy creating a product in groups and displaying it on the board (Wednesday, April 6).

Figure 2 shows an example of students' mind maps and note-taking techniques:

(a) Example of mind map *(b) Example of note-taking technique*

Figure 2. Examples of Students' Mind Maps and Note-taking Techniques

Discussion, Conclusion, and Suggestions

The current research examined the effect of the QLM on mathematics teaching. We examined the significant difference in the academic achievement variable obtaining positive results in favor of the experimental group. The results of the current study align with the results of other investigations documented in the literature (e.g., Acat & Ay, 2014; Barlas, 2002; Benn, 2003; Demir, 2006; Güllü, 2010; Hanbay, 2009; Myer, 2005). This study demonstrates the effectiveness of effective note-taking techniques, mind maps, effective group work, and problem-solving skills. This may be due to its impact on academic achievement. Indeed, the studies (e.g., Ay, 2010; Demir, 2006; Güllü, 2010;

Hanbay, 2009) suggest that the activities, group studies, and effective note-taking techniques conducted within the framework of quantum learning may have enhanced students' metacognitive learning strategies more than the current mathematics curriculum. Bakır and Koç-Akran (2019), who investigated the effect of the QLM on students' problem-solving skills, discovered that the experimental group exhibited substantially superior problem-solving abilities in comparison to the control group. Ökmen et al. (2023) integrated the procedures of the problem-based learning approach with the quantum learning cycle. They stated that this model, which they applied to teacher candidates, was effective in helping the candidates gain teaching and thinking skills.

There was no significant difference in terms of attitude towards the mathematics course post-tests between the experimental and control groups, the difference between the pre-test and post-test within the groups, or gain scores. However, the post-test mean score decreased significantly in the control group. The decline observed in the control group may be attributed to the subject matter addressed in the unit. Regarding gain scores, there was no significant difference between the groups. Similarly, Şöhretli (2014), in his study using the QLM for teaching fractions, found a positive effect of the model on academic achievement but did not find a significant difference in students' attitudes towards mathematics.

There was no significant difference in terms of post-test anxiety towards the mathematics course between the experimental and control groups, the difference between pre-test and post-test within the groups, or gain scores. The experimental group experienced a decrease in post-test mean scores, which was not statistically significant, whereas the control group experienced a statistically significant increase in post-test scores. In other words, the implementation in the control group significantly increased the anxiety level of the group. We found a significant difference in gain scores between the groups. The experimental group's anxiety level did not suffer as much as the control group's due to the classroom environment's ability to motivate students, boost their self-confidence, and make the lesson enjoyable. Demir (2006) and Hanbay (2009) conducted a study that found an increase in students' interest in the course, an increase in their self-confidence, and a decrease in their learning anxiety. These results align with the findings of the study.

The students and the teachers have expressed positive opinions about the use of note-taking techniques and mind maps, which enhance the durability of learning, the establishment of a classroom environment and atmosphere conducive to QLM, and the implementation of celebration activities. Demirel (2004) and Ay (2010) found that the QLM positively affects learning behaviors. Several studies (e.g., Demir, 2006; Güllü, 2010; Hanbay, 2009) have found that it has a beneficial impact on the students' views of the course, school, learning, and themselves. In Bakır and Koç-Akran's (2019) study, students stated that thanks to quantum learning activities, the lessons were more fun, they took their notes, and thus their problem-solving, emotional intelligence, and collaborative learning skills improved. According to Alaca (2014), the note-taking technique, mind maps, listening to music, group activities, and games used in the quantum learning process make learning fun.

The teachers also expressed similar views as students. In Ay's (2010) study, the teachers stated that QLM had a positive influence on students' motivation, active participation in the lesson process, speed of understanding, and learning to learn. Additionally, according to Barlas (2002), teachers who engaged in this practice were more effective than traditional teachers because they enhanced the learning environment, incorporated a greater amount of music compared to traditional classrooms, acknowledged their students' learning achievements, and utilized visuals to facilitate students' thinking and memory retention. The negative views regarding quantum learning may be that students are not sufficiently accustomed to group work and that some contents in the unit require high-level cognitive skills such as problem-solving and reasoning.

The researcher’s observations show that the QLM effectively may increase students' academic success. Activities must be well structured to prevent loss of time in the quantum learning process. It may take time for students to adopt the QLM during the transition. To facilitate this transition, it is crucial to motivate students, focus on the celebration phase, and arrange the classroom environment with posters that enhance their learning. In the QLM, the enrollment and association stages play a crucial role in grabbing students' attention. During these stages, one can incorporate discussions and

watch presentations and videos. Creating mind maps that remind us of preliminary knowledge can be effective, especially at the association stage. Mind maps enable the establishment of relationships between key concepts and words, thus storing, organizing, and organizing information (Gömleksiz & Fidan, 2013). During the labeling phase, students can enjoy using effective note-taking techniques, which also ensures permanent learning.

In addition to the QLM's impact on students' cognitive and affective skills, Wajdi (2017) asserts that QLM has the potential to modify the behavior of children suffering from behavior disorders. The QLM would also enhance pre-service teachers' capacity to enhance their academic performance by engaging more of their brain functions, uncovering their learning strategies, and strengthening their knowledge. Nevertheless, it is imperative to instruct teacher candidates in QLM by providing them with efficient teaching approaches, it enables them to effectively instruct their students and aids in the retention of gained knowledge (Afacan & Güler, 2019).

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Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of any ethical violations.

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References

Acat, M. B., & Ay, Y. (2014). An investigation the effect of quantum learning approach on primary school 7th grade students' science achievement, retention and attitude. *The International Journal of Research in Teacher Education, 5*(2), 11-23.

Afacan, Ö., & Gürel, İ. (2019). The effect of quantum learning model on science teacher candidates' self-efficacy and communication skills. *Journal of Education and Training Studies, 7*(4), 86-95. doi:10.11114/jets.v7i4.4026

Akpınar, B. & Aydın, K. (2009). Reflections of quantum paradigm on curricula. *Journal of Milli Eğitim, 38*(182), 299-313.

Alaca, Ö. (2014). *Kuantum öğrenme modeline dayalı fen bilimleri öğretiminin ortaokul öğrencilerinin akademik başarı, tutum ve öğrenmenin kalıcılığı üzerine etkisi (*Unpublished Master's Thesis). Çanakkale Onsekiz Mart Üniversitesi, Çanakkale.

Altun, M. (2007). *Eğitim fakülteleri ve matematik öğretmenleri için ortaöğretimde matematik öğretimi*. Bursa: Aktüel Publication.

Ay, Y. (2010). *Kuantum öğrenme modeline dayalı fen ve teknoloji eğitiminin ilköğretim öğrencilerinin akademik başarı, derse yönelik tutum ve kendi kendine öğrenme becerileri üzerine etkisi* (Unpublished Master's Thesis). Eskişehir Osmangazi Üniversitesi, Eskişehir.

Ayvaz, A. (2007). *Kuantum Öğrenme. In Ö.Demirel (Ed), Eğitimde Yeni Yönelimler*, (p.p. 280-292), Ankara: Pegem A Yayıncılık.

Bakır, B. & Koç Akran, S. (2019). Effects of the learning on students metacognitive learning strategies and problem-solving skills for 7th grade students in math lesson. *Bolu Abant Izzet Baysal University Journal of Faculty of Education, 19*(1), 67-85. doi: 10.17240/aibuefd.2019.19.43815-441478

Baykul, Y. (2004). *İlköğretimde matematik öğretimi 6.-8. sınıflar İçin.* İkinci Basım, Ankara: Pegem A Yayıncılık.

Barlas, L., Campbell, A. & Weeks H. (2002). *Quantum learning effects on student attitudes toward learning and academic achievement* (Unpublished Master's Thesis). Aurora University, Chicago.

Benn, W., (2003). *Evaluation study of quantum learning's impact on achievement in multiple settings* (Unpublished Master's Thesis). California University, California.

Büyüköztürk, Ş., Çakmak, K. E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2010). *Bilimsel araştırma yöntemleri, 5th ed.* Ankara: Pegem A Publication.

Çağlı, A. & Sıvacı, S. Y. (2020). Investigation of graduate theses conducted on quantum learning in Turkey. *TAY Journal, 4*(1), 31-54.

Demir, S. (2006). *Kuantum öğrenme modelinin ortaöğretim düzeyinde öğrenci başarısına etkisi (Gaziantep örneği) (*Unpublished Doctoral Dissertation). Gaziantep Üniversitesi, Gaziantep.

Demirel Ö. (2009). *Kuramdan uygulamaya eğitimde program geliştirme, 12th ed.*. Ankara: Pegem A Publication.

Demirel, Ö., Yalın M., Ayvaz, Z., & Kontaş, H. (2004). Kuantum öğrenmenin öğrenme öğretme sürecine etkisi. Paper presented at *XIII. Ulusal Eğitim Bilimleri Kurultayı,* İnönü Üniversitesi, Malatya.

DePorter, B. (2000). *The 8 keys of excellence- principles to live by.* Oceanside, California, USA: Learning Forum Publications.

DePorter, B. & Hernacki M. (1992). *Quantum learning: unleashing the genius in you.* Dell Publishing Group.

DePorter, B., Reardon M. & Nourie S. S. (1999). *Quantum teaching-teaching orchestrating student success*. A Viacom Company.

Duman, B. (2004). *Öğrenme-öğretme kuramları ve süreç temelli öğrenme.* Ankara: Anı Yayıncılık.

Güler, M. & Yazıcı, M. (2018). A thematic content analysis on studies related to quantum learning approach. *Journal of Bayburt Education Faculty. 13*(25), 93-108

Erol, M. (2010). *Kuantum fiziği ve düşünce dünyamızın kontrolü*, Retrieved 2010, 17 August, from http://kisi.deu.edu.tr/mustafa.erol/kuantum%20fizigi%20ve%20dusunce%20dunyamizin%20kontrolu.html

Hanbay, O. (2009). Kuantum öğrenme temelli öğreterek öğrenme yönteminin ikinci yabancı dil olarak Almanca'nın öğrenilmesine etkisi. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi* Dergisi, *12*, 17–27.

Gömleksiz, M.N. & Fidan, E.K. (2013). Fen ve teknoloji dersinde bilgisayar destekli zihin haritası tekniğinin öğrencilerin akademik başarısına, tutumlarına ve kalıcılığa etkisi. *Gaziantep Üniversitesi Sosyal Bilimler Dergisi, 12*(3), 403-426.

Güllü, A. (2010). *Kuantum öğrenme modelinin ortaöğretim düzeyinde öğrenci başarısına etkisi (Konya örneği)* (Unpublished Master's Thesis). Selçuk Üniversitesi, Konya.

Kanadlı, S., Ünal, K. & Karakuş, F. (2015). The Effect of Quantum Learning Model on Academic Achievement: A Meta-Analysis Study. *Mustafa Kemal University Journal of Social Sciences Institute, 12*(32), 136-157.

Karamustafaoğlu, O. & Karamustafaoğlu, S. (2018). Teacher's views about "How does light propagation?" activity developed based on quantum learning model. *Journal of The International Scientific Researches, 3*(2), 528-536. doi: 10.21733/ibad.429258

Karasar, N. (2015). *Bilimsel araştırma yöntemi*. Ankara: Nobel Akademik Yayıncılık.

Kazu, H., & Kaplan, A. (2023). Thematical investigation of graduate thesis related to the quantum learning model in Turkey. *International Journal of Social and Humanities Sciences Research (JSHSR), 10*(91), 85–95. doi: 10.26450/jshsr.3426

LeTellier, P. J. and DePorter, B. (2002). *Quantum Learning for Teacher*. Oceanside, California: Learning Forum Publication.

Learning for the 21st century. (2005). Retrieved 2010, 30 July, from http://www.p21.org/downloads/P21_Report.pdf

Meier, D. (2000). *The accelerated learning handbook*. New York: McGraw-Hill.

Millî Eğitim Bakanlığı (2018). *Matematik dersi öğretim programı* (İlkokul ve Ortaokul 1, 2, 3, 4, 5, 6, 7 ve 8. Sınıflar). Erişim adresi: https://mufredat.meb.gov.tr/Dosyalar/201813017165445-MATEMAT%C4%B0K%20%C3%96%C4%9ERET%C4%B0M%20PROGRAMI%202018v.pdf 30.08.2020.

Myer, K. (2005). *Quantum learning impact in three third grade classes at Buena Vista Enhanced Option School*, Nashville. Retrieved 2011, 6 January from http://www.iqln.com/Downloads/

Nourie, S.S. (1998). *Results of implementing quantum learning in the Thornton Township High School Districit (*Unpublished Master's Thesis). Saint Xavier University, Chicago.

Ökmen, B., Şahin, Ş., & Kiliç, A. (2023). Proje tabanli 6E ile problem temelli kuantum öğrenmenin öğrenci görüşleri doğrultusunda değerlendirilmesi. In *International Education Congress 2023 Conference Proceedings* (pp. 113-126), 20-23 September, Ankara University.

Ökmen, B., Şahin, Ş., & Kılıç, A. (2023). A model that can be applied in both distance oath face-to-face education: Problem based-QLM. *Journal of Balıkesir University Social Sciences Institute, 26*(50), 579-600.

Sarıgöz, O., Cengiz, M. Ş., & Koca, M. (2015). The evaluation of attitudes and views of preservice teachers on quantum-based learning. *Internatıonal Peer-Reviewed Journal of Humanities and Academic Science, 4*(12), 114-128.

Şentürk, B. (2010). *İlköğretim beşinci sınıf öğrencilerinin genel başarıları, matematik başarıları, matematik dersine yönelik tutumları ve matematik kaygıları arasındaki ilişki* (Unpublished Master's Thesis). Afyon Kocatepe University, Afyon.

Şimşek, F. (2016). *Fen ve teknoloji dersinde kuantum öğrenme modelinin, öğrencilerin akademik başarısı, Fen ve Teknoloji dersine yönelik tutumu, motivasyon ve bilgilerin kalıcılığı üzerine etkisi* (Unpublished Master's Thesis). Kahramanmaraş Sütçü İmam Üniversitesi, Kahramanmaraş.

Şöhretli, G. (2014). *Kuantum çğrenme modelinin ilkokul 4. sınıf öğrencilerinin akademik başarıları bilimsel süreç becerileri ve matematiğe ilişkin tutumları üzerine etkisi* (Unpublished Master's Thesis). Mustafa Kemal Üniversitesi, Hatay.

Usta, E. (2006). Kuantum öğrenme: Öğretmenlere ve öğrencilere. *İlköğretmen Eğitimci Dergisi, 4*, 20–25.

Tekin, H. (2008). *Eğitimde ölçme ve değerlendirme*. Ankara: Yargı Yayıncılık.

Turgut, M. F. (1995). *Eğitimde ölçme ve değerlendirme metotları (10.Basım)*. Ankara: Gül Yayıncılık.

Vos-Groenendal, J. (1991). *Research of participants' perceptions after attending supercamp (*Doctoral Dissertation). Northern Arizona University, Flagstaff Arizona. Retrieved 2010, 17 August, from http://www.onlinefizik.com/content/view/860/120/

Wajdi, M. B. N. (2017). Optimization of game character education based on traditional physical education of children with behavior and emotional problems through learning model quantum learning. *International Journal of Psychology, 1*(1), 25-32.

Yıldırım, C. (1999). *Eğitimde ölçme ve değerlendirme.* Ankara: ÖSYM Yayıncılık.

Yıldırım, A. & Şimşek, H. (2005). *Nitel araştırma yöntemleri*. Ankara: Seçkin Yayıncılık.

Yilgen, A. (2014). *Kuantum öğrenme modeline dayalı fen eğitiminin öğrencilerin akademik başarılarına etkisi* (Unpublished Master's Thesis). Fırat University, Elazığ.

Appendices

Appendix 1. An Example of Lesson Plans Utilized in the Experimental Group

Grade: 7
Objective: Solves and poses problems related to rational numbers.
Recommended Duration: 3 Lesson Hours

Quantum Learning-Teaching Process Analysis:

Skills / Phases	Enrolling	Association	Labeling	Demonstration	Repetition	Celebration
Quantum work		x	x			
Quantum reading	x					
Quantum writing		x				
Quantum note taking/mind maps			x			
Quantum memory					x	
Eight keys of excellence		x				x
Communication skills				X		x
Problem solving		x	x			
Self-confidence		x			x	x
Leadership				X		
Responsibility						
Motivation	x				x	x
Outdoor lesson						x

Phase 1 Enrolling:

This stage starts with a reading about the history of rational numbers (Music during this stage can be used). This reading passage provides brief information regarding the use of rational numbers by the Egyptians, Romans, and Greeks. Following the reading, the teacher poses the questions to the students,

- "Is the use of rational numbers, which were also prevalent in past eras, truly essential? Today, where do we use rational numbers? Can we use rational numbers to solve the problems we face in our daily lives?

Phase 2 Association:

The teacher asks students to remember how to perform multi-step operations with rational numbers. She emphasizes that "the order is crucial, as it determines where to begin the operation. This order is also important when solving problems with rational numbers".

- Quantum Writing Exercise: Students are required to respond to the following questions:

1. What is a problem?
2. What is a mathematical problem?
3. What conditions must a situation meet in order to be a problem?
4. How do you plan to solve a problem?
5. Can you create a problem with rational numbers?

The students express their own thoughts by using their prior knowledge to answer the questions. They practice quantum writing while listening to background music. The teacher asks the volunteer students to read what they have written.

- Next, the teacher presents the below example and poses the following questions:

"A group of friends are looking for a place to camp in Uzungöl. They think that this campsite is suitable for one person. The fee is 25 TL. The applied tariff offers a discount as the number of days stays increases. We will apply a discount of 1/20 of the total fee if you stay more than 5 days, and a discount of 1/10 of the total fee if you stay more than 10 days. Here, a group is planning to stay for 7 days makes their payments on the first day. Then they decide to extend their stay for a few more days".

- Is this situation a problem?

The students must answer the following questions in order for a situation to be considered a problem:
1. Is there a clearly stated situation?
2. Is there a clear and unambiguous goal?
3. Do we have all the information to reach the goal?

Accordingly, the students are expected to explain that that there is a clearly stated situation but not a goal. The teacher provides the following example as a potential goal:
Goal: How much more would each group member have to pay according to the new plan?
The investigation then focuses on the answer to Question 3. We know the daily rate, the discount tariff, and that they pay for 7 days, but we don't know how long they extend the period afterwards. For example, we rephrase the problem by assuming that they have decided to extend it by 4 days. Therefore, the teacher explains that it is a problem.

Phase 3 Labeling:

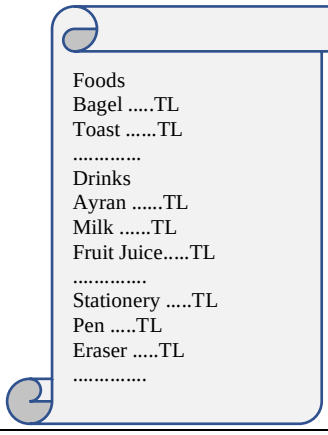
The teacher instructs students to use the quantum note technique to take notes in their notebooks.

Task 1: Layers of the Atmosphere
The teacher provides the following information with details about the layers of the atmosphere.
"The atmosphere persists up to approximately 10,000 km above the ground. The layers of the atmosphere, as well as the height of some layers above the ground, are shown below.
1. The height above the ground of the upper limit of the troposphere is 1/625 times the height above the ground of the upper limit of the atmosphere.
2. The height above the ground of the upper boundary of the stratosphere is 3/1000 times the height above the ground of the upper atmosphere.
3. The height above the ground of the upper limit of the shemosphere is 9/1000 times the height above the ground of the upper limit of the atmosphere.
4. The height above the ground of the upper boundary of the ionosphere is 3/100 times the height above the ground of the upper boundary of the atmosphere."

The information above instructs students to solve the following problems in accordance with the stages of problem solving. Stages of problem solving:
Expressing in our own words
Identifying what is given
Planning-strategizing
Implement the plan
Verifying the solution

- Problem 1: How many kilometers above the ground is the height of the troposphere's upper boundary?
- Problem 2: How many km higher is the height of the upper boundary of the ionosphere above the ground than the height of the upper boundary of the stratosphere above the ground?

Task 2: How do we spend a day?
- Divide into groups of 4.
- Write down the activities you did during the day.
- Based on the fact that a day is 24 hours, express the time allocated to the activities as a rational number by proportioning it to 24.
- Show all activities on a table.
- Create one problem using these data,
- Ask (volunteer students) to solve the problems.

Phase 4 Demonstration:	Task 3: What can I buy in the canteen?  - Divide into groups of 4. - Find out the prices of some foods in the canteen at break and prepare a list. - Show different options how a student with 12TL can spend his/her money in such a way that he/she spends at most 1/3 of it on food, at most 1/6 of it on drinks, at most 1/4 of it on stationery, and the rest on other things he/she needs or on savings. - Pose a problem with this data. - Make a presentation as a group.
Phase 5 Repetition:	The teacher asks the students to summarize the prerequisites for a situation to be a problem, and the steps of a problem-solving process. She asks students to write a quatrain on the subject to make it more permanent and enjoyable. Example: Let problems fear me. I'll solve them in no time. First I make my plan. Then I'll carry out my plan Every statement I make is clear. I have a goal, too. All of the necessary information is also available. What can be done to solve this problem?
Phase 6 Celebration:	The teacher thanks the students for their efforts in the activities and encourage them to study. With reading the quatrains they have fun in the classroom.

Appendix 2. Table of Specifications

Objectives*	Questions																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1.Performs multi-step operations with rational numbers.	x	x																				
2. Solves and poses problems related to rational numbers.			x	x																		
3. Describes linear equations.					x	x																
4. Explains and uses the Cartesian coordinate system.							x	x														
5. Draws the graph of linear equations.									x	x												
6. Finds the factorials of whole numbers.											x	x										
7. Explains the concept of permutation and calculates it.													x	x								
8. Determines the experiment, sample space and event of dependent and independent events.															x	x						
9. Explains the dependent and independent events.																	x	x				
10. Calculates the probability of dependent and independent events.																			x	x		
11. Calculates the probability of an event using geometry.																					x	x

* The objectives were included in the Ministry of National Education's 2011 Middle School Mathematics Curriculum.

e-Kafkas Journal of Educational Research e-KJER Research Article

Developing High School Prep Class Students' Verbal Skils by Using Web 2.0 Application

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Abstract

With the importance of learning English and being able to communicate in the learned language, language education has become a considerable issue in all age groups. This important subject has become more difficult to implement with the Covid-19 pandemic. During the distance education which has applied in long period, students have experienced various problems in the lessons. In this study, it was tried to find the reasons, solutions and alternative ways of student's unwillingness and hesitation of English speaking during lessons. With the aim of finding these concerns an action research method, a qualitative research method, was used. From a province of Turkey, 33 high school prep students attended to study. During and at the end of the applications, data were collected by teacher diaries, students diaries and semi-structured interview form. Content analysis was used. At the end of the content analysis, codes and themes of focus group were determined. As a result of data re-coding by the co-observer, the agreement was found to be 86 percent. When the applied action research data were anaylzed, it was determined that the students were embarrassed in the lessons and because of their speaking anxiety, they participated less in the activities. It was concluded that the willingness to speak increased with Web 2.0 applications and the lessons that include more dialogues, reading-listening activities, games and movies have high potential to promote students' motivation.

Keywords: Web 2.0 applications, reluctance to speak English, distance education.

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Introduction

Information and communication technologies have developed at an unprecedented pace and their utilization has become extremely widespread. Web 2.0 technology provides users with the opportunity to communicate and to share among themselves, it has also been widely used in the field of distance education, especially during the epidemic.

With the importance of using technology in education, different searches have been made in the language learning and teaching process. Web 2.0 tools are found appropriate with the purpose of getting the most benefit in education, for being suitable for every budget and could be used by everyone (Batıbay, 2019) and these aspects of communication-centered tools make the education process easier. Web 2.0 tools are the second generation internet technology that allows two-way communication between the learner and the teacher (Çenesiz & Özdemir, 2021). With the use of this technology in the lessons, it is thought that students will not only consume information but also produce ideas (Kaynar, 2019). By using Web 2.0 tools, it will be possible to increase students' motivation in the classroom, to make mutual interaction more effective, to increase learner participation and to make the learning proccess fun.

Since it is one of the lifelong learning skills, learning a foreign language and communicating in this language has become very important today. Especially English, one of the foreign languages spoken around the world, is spoken by more and more people day by day (Crystal, 2003). Learning English and communicating in this language has become so important. With in the same direction of importance of learning language, language teaching gain importance in all age levels. The language teaching process brings various difficulties and conveniences along with its importance. Especially in Türkiye, while language teaching, which is equivalent to English teaching and starts in the early years of education, is an easy experience for some students, it can be a very difficult phenomenon for the others. Language learning difficulties experienced by students can also be seen in the four basic sub-branches of the target language, namely reading, writing, listening and speaking (Karakoyun, 2014). However, as Öztürk and Gürbüz (2014) stated, the most difficult of these four headings by students is speaking, due to the high level of anxiety. There are variables that can positively or negatively affect speaking in a foreign language, which learners of all age groups often have difficulties. One of them is the teaching method used by the teacher in the classroom, and the visual and auditory course materials (Ertürk, 2006). Since the course material used in the learning environment can seriously affect students motivation and classroom atmosphere, it is necessary to pay attention while planning of the courses. Because it can be stated that the learner's positive feelings and the positive communication perception improve both academic and social skills in the learning environment (İnal & Arslanbaş, 2021). It is obvious that when the learners have fun, they learn more effectively and permanently (Ağaoğlu, 2020). Due to the effects seen and mentioned in the education process, it is important that the teaching method and selected materials should be carefully prepared and put into practice by considering many factors.

Another fact that should be taken into consideration while planning lesson is that changes in people's lives must also change the education, and it has to differ according to the expectations of learners and teachers. In particular, the increase in the interaction of the Z generation and Alpha generation, which are called also ''Digital Native'', with technology has made it inseparable whole in learning situations (Prensky, 2001). The effects of this situation have made it even more important to emphasize the importance of technology- enriched education and training in the development of the skills necessary to exist in the fast-changing world (Domalewska, 2014). It has been necessary to include technology in education in order to make the education-teaching process, more specifically the lessons interesting for the students and to offer convenience to both the teacher and the learner. Because it is thought that technology, which is so active in all areas of life, will increase success in education (Özerbaş & Akın Mart, 2017). At the same time, the increase in the student's motivation, the positive effect of the importance that the learner attaches to the learning process, the learner's appreciation of this process, the increase in his belief that he can learn and the attention to the process will increase the learner's effective learning and remembering level (Senemoğlu, 2000). Considering the positive effects of the inclusion of technology in education, the effect and necessity of use in the education process has become an undeniable reality.

In these days, the Covid-19 pandemic has suddenly transformed education from face-to-face education into distance education. With the implementation of distance education, learners and teachers are able to communicate through digital environments by using certain programs. This sudden change in the education system and the situation of receiving or giving education in front of the screen brought along many needs. In order to meet these needs, it was necessary to employ various technology based in-class plans, practices and directions. It is seen that various applications such as Web 2.0 tools as output of this obligation are used more frequently by trainers and teachers in distance education. It is known that these applications were used both in face-to-face training and distance education even before the pandemic period. When the literature on Web 2.0 applications used in classrooms is scanned and their effects on students are investigated, there are few studies examining the effects of Web 2.0 tools on the desire to speak English. But there are different studies on the contribution of Web 2.0 tools on student motivation and success in English language teaching and foreign language teaching. Tatlı and Aksoy (2017) conducted a study on English speaking education by using digital storytelling technique. Kaynar (2019) examined the effect of using Web 2.0 tools in order to eliminate the existing problems in foreign language teaching and to facilitate teaching in his master thesis. Strobl (2014) investigated the effects of Web 2.0 tools on collaborative writing in a foreign language, and Peeters (2018) conducted a study measuring the effect of Web 2.0 tools in a foreign language classroom.

It is known that it is important to integrate the use of technology, which has a great place in daily life, into education. The pandemic process has also accelerated this integration. As a result, distance education has become the reality of the education process and it has been observed that students' participation in speaking activities in English lessons is also affected by this situation. It is a fact that language teaching supported by technology will be more permanent and language learning will become more enjoyable. For this reason, it has been tried to increase the willingness of high school prep class students to speak in English lessons with Web 2.0 tools. With this study, an application has been made on how high school prep class students are affected by this situation in distance education courses and how their willingness to speak English can be increased. With the action plans implemented at the end of the study, it is expected that the students' willingness to speak in English classes will increase. In this regard, answers to following research questions are sought in the study;

1- What is the success of the action plans in solving the students' speaking problems in English lessons?
2- What are the reasons for students' reluctance to speak in English classes?
3- How did English lessons taught with Web 2.0 tools affect students' speaking desires?
4- What can be done diffrently to increase students' desire to speak English in class with the use of Web 2.0 tools?

Method

Research Design

The research was conducted with the action research method. Action research, also known as teacher research, is one of the types of research that educators can carry out in order to find solutions to the problems they face or to improve an existing situation (Ocak & Akkaş Baysal, 2021). Action research is a type of research that can be applied by one or more researchers to find a solution to a determined problem (Jefferson, 2014). The reason why action research was chosen as the research design in this study is that action research combined with real situations from life and gives useful and actionable feedback (Joyce, 2012). It was observed by the English teacher and the researcher who attended the lessons of the study group that the students were reluctant in speaking activities during the lessons. And this situation affected the flow and efficiency of the lessons. It was discussed how to find a solution to the problem of observed students' unwillingness to participate in speaking activities during English lessons. As a result of these discussions, it was decided to implement an action research in order to increase the students' willingness and motivation to speaking. Implementation steps were developed upon the decision taken, and the data obtained after each step was analyzed, and possible improvements were emphasized and next action plans were designed.

Study Group

The study group of the research consisted of the students of one of the three prep classes studying at the social sciences high school located in a province of Turkey. There were 33 students, 9 boys and 24 girls, aged 14-15. While the distribution of the students according to the provinces varies as different cities and provinces in Turkey. While 14 of the 33 students were staying in the school dormitory, the remaining 19 students were living with their parents. The general socio-economic level of the families was expressed as middle class, except for a students with a very low financial income. It was known that the general livelihoods of the students' families were trade, farming or animal husbandry. Parents' education status, on the other hand, were generally middle school-high school graduates, except for a few university graduate parents.

The English readiness levels of the students were determined as low as a result of the observations of the teachers during the lessons and the students' scores in the written exam. Especially, it was stated that the situation of 10 students was very bad, the readiness of 20 students was at moderate levels, and the level of 3 students was good.

Table 1.
Demographic Characteristics of the Students

Characteristics	Group	f	%
Gender	Female	24	72.72
	Male	9	27.28
Accommodation	Dormitory	14	42.43
	Family House	19	57.57
Economic Status	Low	10	30.30
	Middle	20	60.60
	High	3	9.10

Data Collection

Within the scope of the study, the data were obtained from three different sources by making data diversification during the data collection phase, that is, the triangulation method was used. Because the validity and reliability of the study can be increased with the triangulation method (Johnson, 1997). In this research data were obtained from students diaries, teacher diaries and focus group interview outputs in order to increase the validity and reliability. After each action plan was implemented, students were asked to keep lesson diaries. In the student diaries, they were expected to evaluate the process, talk about its positive and negative aspects, and think reflectively. Both student and teacher diaries were reviewed after each action plan. At the end of the examinations made in the light of the information obtained from the students and teacher diaries, a new action plan to be implemented with the cooperation of the researcher and the course teacher was decided. In total, four action plans were implemented. At the end of the implementation of the four action plans, a focus group meeting was held with 5 students from the study group who volunteered to participate. Due to the Covid-19 pandemic measures, the interview was conducted using an online application. In the focus group interview, semi-structured interview form questions prepared by the researcher and evaluated by two experts were asked to the students. It was observed that the students hesitated to talk individually in the lessons and gave short answers to the questions generally asked. Focus group meeting and online data collection were preferred in order to prevent the negative effects of this situation on the assumption that this situation could also be experienced in the data collection process. The interview with the students' permission was recorded and then transcribed by the researcher. In addition to the focus group interviews, data were obtained from the teacher diaries kept by the researcher and the course teacher. Detailed notes were kept on subjects such as the situations encountered in the course, the effects of the applications on the students, and the effectiveness of the Web 2.0 tools applied in the teacher diaries. The data of this action research were obtained through students diaries, teacher diaries and focus group interviews collected both during and at the end of the process.

Data Analysis

In the study, diaries were requested from the students and teachers after each action plan. After the data collection process at the end of the each lesson, findings guided the following lesson details and lesson

plans. In the findings section, direct quotations were given while sharing the student and teacher diaries were included. The focus group interview was conducted with ten students selected from the study group by simple random sampling method. The focus group interview data was analyzed with content analysis. Because in the focus group meeting, participants gave detailed information about the process. It was necessary to organize and analyze these data within a certain system (Bengston, 2016). The transcribed focus group interview data was divided into codes. The same process was carried out by an another expert in the curriculum and instruction. Both analysis results were gathered together. Frequently encountered codes were merged under the themes, opinion compatibility examined and formed the findings of the study. For example, in line with the answers given by the students to the question of what can be done to increase students' willingness to speak English in the classroom by using Web 2.0 tools, the theme of student suggestions and the codes of activity, dialog, movie and game were added under this theme.

Trustworthiness

Some precautions were taken to ensure the validity and trustworthiness of the study. In order to ensure validity in the study; the research method, study group, sampling type, data collection tools, data collection process, data analysis and how the findings were organized were described in detail (Yıldırım ve Şimşek, 2013). Other measures taken are triangulation and diversification. Triangulation is the use of many and varied sources (Guba and Lincoln, 1985) and Data diversity is a method used to ensure the reliability of data (Patton,1987). So in this study data diversification and triangulation was made by taking teacher and student diaries, expert and student opinions. Also thick descriptions were given during the finding. Because detailed paticipants' own words and ideas strengths the trustworthiness of the study (Efron and Ravid, 2013). Before data analysis were shared member checking was applied. Transcripts of the interviews were shared with the participants. Besides member check is alson an effective method for the trustworthiness of the study (Guba and Lincoln, 1985) and it was used before obtaining the results of the anaylsis. Objectivity was tried to be ensured by an analysis made by an expert outside the study (Creswell and Creswell, 2018). With an external investigator trustworthiness of the study strengthed. Miles and Huberman (1994) intercoder reliability formula was used to control the reliability of the data obtained through the focus group interview. The formula is Reliability= Number of agrements / (number of agrements+disaggrements) x 100. According to formula, the agreement between researchers was calculated as 86%. Also, direct quotations from the students' opinions were given to increase reliability.

Implementation

In this study, which was conducted to increase the willingness of high school prepatory class student to speak in English lessons, four different action plans were applied. In the process, the subjects in the textbooks that the students were currently using and the activities prepared using Web 2.0 tools were used. After each action plan, students and teachers were asked to write a lesson diary. After the analysis of the data, the researchers decided on the next action plan. Each action plan consisted of two sessions, 30+30 minutes, 60 minutes in total and via an online application. While the applications were being applied, there was a technical problem in the 2nd action plan and the lessons had to be reorganized. After the fourth action plan was implemented, the study was concluded with a focus group interview.

Findings

In the study, the data obtained from the action plans were analyzed and given under the relevant research question. In addition, at the end of the process the data collected by taking the opinions of the students were given in tables.

What is the success of the action plans in solving the students' speaking problems in English lessons?

First Action Plan

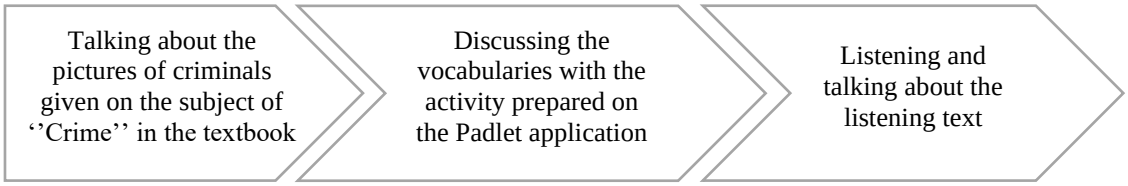

Figure 1. First Action Plan Chart

Students' Diaries Analysis

At the end of the lesson, 4 students out of 6 students who participated in the lesson shared the diaries they wrote after the lesson. According to data obtained from the student diaries they had fun in the lesson. They did not want to answer the questions asked in the lesson for different reasons and they expected answers from their friends first. They stated that the Padlet activity, which is a Web 2.0 application used in the course, was easy, useful and fun, but the waiting time was long. Some samples from the student diaries were given as follows;

''The Padlet activity we used in the lesson was useful. Although I used such an activity for the firt time in class, I did not have much difficulty. But I got a little bored while waiting for everyone (S1).''

''I think this app was useful. It was like a fun digital page where I could create my own notes during the lesson. I did not have any difficulties while using the application (S4).''

Teachers' Diaries

The lesson was started through a different distance education course application, not thrıugh the EBA (Milistery of Education education portal) at the time when the students regularly use each week. When the class started, there were 6 students. Later, the number increased to 8, but at the end of the lesson, it had decreased to 6 students again. The pictures of 3 different criminals given in the book were reflected to the students and various questions were asked to talk about it. However, they did not want to answer these questions. The link of the word activity prepared on Padlet was shared so that students could internalize existing words and use them more effectively while discussing. While 4 students were connected easily, we had difficulty in getting the answers of 2 students due to their internet connection problems. It took a long time for the students to understand the program and write down their answers. A few students typed their answers quickly, while others were not so fast. Four of the students who were able to connect did not write any answers at all. It was tried to talk to the students about what they wrote. While the students who wrote their answers quickly wanted to speak first, the students who did not share their answers in the application did not want to speak even though they were asked a question. At the end of the discussion, a listening activity was held on the subject. Crimes and criminals were discussed over the recording and the lesson was ended (Teacher's Diary,1).

According to the student and teacher diaries obtained from the 1st action plan, it was concluded that the area where students could write their comments in the Padlet application might be complex. At the same time, with the thought that students who wrote fast answers were disconnected from the lesson while waiting for the rest of the class. With the help of these results, it was concluded that it would be more approprite to continue with another applications that would continue with more instant answers and where answers could be shared while continuing the discussion.

Second Action Plan

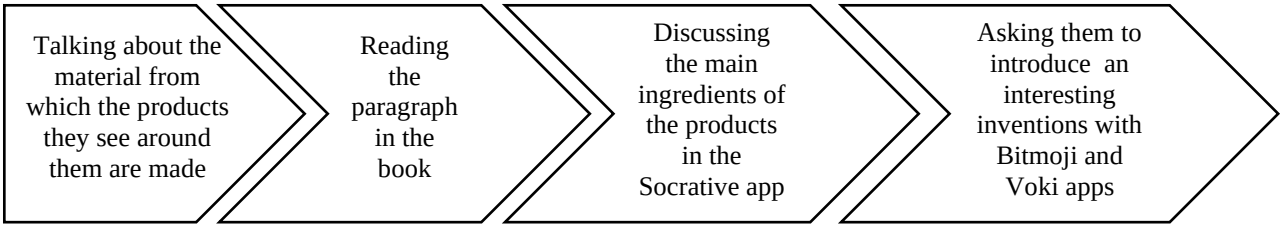

Figure 2: Second Action Plan Chart

Students' Diaries Analysis

After the second action plan was implemented, 3 of the 6 students who attended the lesson shared their diaries. They stated that the students did not want to speak until they were asked. They were able to form sentences when they spoke and this situation motivated them for speaking. They stated that they were familiar with many of the words in the Socrative application from previous lessons and from the previous reading text. But they did not know some words. They also stated that the presence of unknown words affected their own learning in a negative way. Instead of such activities, discussion-centered practices based on question-answer would encourage them to speak more. Some samples from the diaries were given as follows;

'' I was familiar with the most of the words in the Socrative application from previous lessons. I realized that I was missing only a few words and I learned them (S5)''

''We made vocabulary activities with the Socrative application, but the words I learned before were predominantly. Instead of this application, we could use an application where we can discuss in detail what the words mean (S3)''

Teachers' Diaries

The lesson started at the time specified in the lesson plans of the students. There were 6 students in the class again. While four of them were the same, the other two students were new students who had not attended the previous lesson. First, the students were given voice. When any answer received, questions were asked one by one. They were asked to talk where they are now, what's going on in the room and the materials of the items. Compared to previous lesson, the sentences were longer and more detailed. One of the students answered all questions as ''I don't know''. Another one of the students' voice could also be heard towards to end of the lesson because of the internet connection problem. After the discussion was concluded, a text related to the subject was read from the textbook and the characters, subject of the text were emphasized. There was a detailed exchange of information. After receiving the answers, the Socrative application was started. They were asked to share the answers in their minds under the questions about the vocabulary. While they were writing the answers, the questions of the teacher continued and the discussion followed these steps (Teacher's Diary 2).

According to the data obtained during the second action plan process, it was clear that the students did not participate in the conversation voluntarily as in the previous lesson. They participated with the encouragement of the teacher. It was observed that they were more active in responding both verbally and in writing while using Socrative. Sometimes they didn't respond some discussion questions even if they were guided by the teacher. In order to improve the action plan for Web 2.0 applications to create the desired effects, it was decided to use discussion-centered applications rather than word-based applications. This decision was made by considering the expression in the student diaries that the unknown words in the application make student unwilling to speak, so the third action plan was prepared in the light of this information.

Third Action Plan

Figure 3: Third Action Plan Chart

Students' Diaries Analysis

Out of three students, two of them who attended the lesson submitted their diaries. Students stated that they liked this kind of online applications and these applications encouraged them to speak. Also, the less number of the students in the class made them feel comfortable. They reported that they had opportunity to talk more during the discussions. There were students who stated that the application was not very effective and expanding application's scope would be beneficial. Some quotations of student diaries were given as follows;

''I found this application very entartaining. Although I am hesitant at first to adapt and warm up with such applications, I can explain myself more easily in the following minutes. Therefore, the application was very entartaining in terms of providing speaking practice (S1)''

''I think more complex application could have been used instead of this application (S2)''

Teachers' Diaries

The lesson started on the same day and time determined. There were 3 students during the lesson. Talking about what to do if a product breaks down was discussed with the students attending the class. Unlike the previous lessons, without the need for the teacher to ask student a question by name, the students asked for speaking one by one and expressed their thoughts. One student even said that she did not understand the question in Turkish, and when the teacher repeated the question in a simpler language, she was able to express her thoughts in a clear way. Since there were 3 students in the class, they had a lot of chance to speak and they were able to continue this fluently. They then logged into the Mentimeter application. They were asked to write a few of the technological products they use most in their daily routines on this application. The resulting Word Cloud could not be very rich due to the a couple of participant. The prominent answers written by the students were ''laptop'' and ''mobile phone''. We had a conversational discussion, focusing on why they wrote them and where they mostly used these devices. After the discussion, we talked about what they can do if these devices break down and what kind of process they can follow. After completing dialogues, the listening text in the textbook on this subject was listened. After discussing whether the process in the rest was the same as what was spoken and the differences were discussed and the lesson was ended (Teacher's Diary 3).

According to student and teacher diaries, the Web 2.0 tool could have been more effective if there were more participants. However, because of the few participants, the activity stayed limited in its scope. However, the small number of students allowed them to have more opportunity to speak and express themselves. According to feedbacks from the students diaries, 4th action plan was prepared and more interactive, less writing activities were added.

Fourth Action Plan

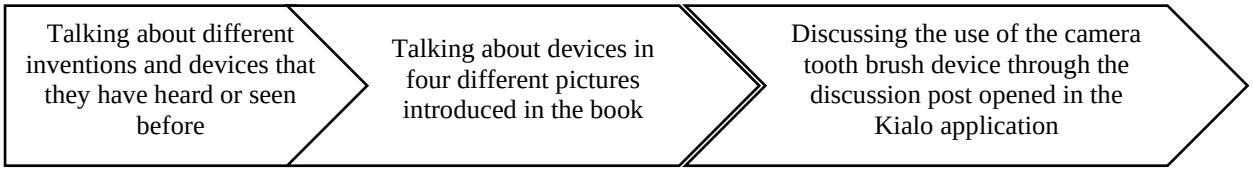

Figure 4: Fourth Action Plan Chart

Students' Diaries Analysis

At the end of the applied course, 3 of the 9 students who attended the course submitted a course diary. When the diaries were examined, it was understood that students' attitudes towards the lesson were positively affected. They developed positive attitudes towards speaking activities. The students stated that they felt more comfortable during the discussion and they enjoyed speaking. It was observed that all of the students attended the lesson actively. Speaking with the help of Web 2.0 application made the lesson amusing.

'' The discussion-oriented practice was a lot of fun. For a moment, I felt like I was in a class abroad. Everyone was talking actively and we could explain our ideas in detail (S1)''

''Kialo was a lot of fun to practice. It provided the opportunity to share ideas with friends. In addition, the fact that the subject of discussion is a situation that can happen to us in our daily life allowed us to talk more. (S6)''

''I liked this application so much because it allowed us to express our ideas comfortably. (S7)''

Teachers' Diaries

It started with 5 students at the beginning of the lesson, which was applied at the day and time of the stıdents' time schedule. In the following, 9 students attended and the course ended with 8 students. The students were asked if there were any interesting inventions that they had encountered, seen or read before. After being asked to talk about these, for the first time, there were students who wanted to speak without teacher guidance. After talking about the inventions that were different to them, other students were also asked question, but due to the connection and sound problems of the two students, any answer could be received from them. Afterwards, four different inventios shown in the book were discussed. It was mentioned where and how they can be used and whether they make our life easier or not. The student who did not want to speak in the previous sessions and gave the answer 'I don't know', was also asked a question in this lesson and received the same answer. They, by talking about the devices currently in his room and how they can be differentiated, questions related to daily life were asked and the student answered them. In this way, answers containing different perspectives were gathered from all students who participated in the course. After discussing different inventions, a question was asked about whether the use of a toothbrush with a camera would be beneficial in a discussion post opened on the Kialo application. It was stated to the students that they could write more than one thought supporting or not under this post. After the answers received, a discussion topic was started verbally about why they supported and why they did not. While they had the opportunity to comment on each other's posts both verbally and in written way, the students preferred to make verbal comments on each other's ideas. (Teacher's Diary 4).

According to data obtained during the 4. Action plan, this course was an effective and well-attended one in terms of speaking. Students' willingness to speak by themselves, their explanatory answers, and their comment on each other's answers created a positive atmosphere during the online session. Throughout this course, the researcher generally took the role of problem solver for the connection problems and guidance for the discussions.

What are the reasons for students' reluctance to speak in English classes?

Table 2.
Reasons for Reluctance to Speak at Lessons

Theme	Codes	f
Reasons for reluctance to speak at lessons	*Fear of making mistake	3
	*Excitement	2
	*Shyness	2
	*Lack of vocabualry-pronunciation	1
	*Boring subject	1

In the focus group interview, the students were asked what it felt like to use speaking activities in the lessons. When the answers were examined, it was seen that the most common answer was the fear of making mistake. They stated that they remained silent because they were afraid of saying the wrong

thing at the time of speaking. In addition to the fear of making mistakes, they mentioned that they were excited when they were going to speak in English, and that they could not express themselves because they lacked vocabulary on the subject. The students also expressed embrassment and boring subject as the reasons that affect their willingness to speak.

Examples of student opinions on the determined code and themes are as follows:

'' I am an excited person. I think this excitement stems from the fact that I am a shy person. When excitement and shyness come together, naturally, the fear of doing something wrong comes into play (S3)''

''Sometimes when my teacher gives to turn to me, I get nervous that I'll give the wrong answer. Sometimes, when someone else says the sentence I think and want to say, my enthusiasm goes away (S2)''

''Sometimes I can't think of and answer about that subject or there are times when I don't participate because I don't know the English equivalent of that answer. At the same time, I am obsessed with correct pronounciation in English. After all, like Turkish, it is not a language that is read as it is written, so I think that it is necessary to pay attention to the pronounciation in order to be understood corretly. I hesitate to speak when there are words that I do not know how to pronounce or that I may mispronounce (S1)''

How did English lessons taught with Web 2.0 tools affect students' speaking desires?

Table 3.
Contributions of Web 2.0 Applications

Theme	Codes	f
Impact of Web 2.0 tools on reluctance to speak	* Academic contribution	3
	*Making the lesson fun and attractive	2
	*Teaching the new vocabulary and pronounciation	2
	*Increasing self-confidence	1

The students were asked whether various Web 2.0 tools used in the lessons contributed to their speaking requests in the lessons. Each interviewee stated that the activities contributed positively to their willingness to speak. Students especially focused on the contribution of applications to their academic success. They stated that the use of Web 2.0 tools made the lessons more fun and attractive. They were more eager to participate in the activities thanks to these activities. At the same time, they also stated that the participation of other students in the course in speaking activities was encouraging for the student. In addition to all these expressions, they stated that they learned new words and pronounciation of words with the activities in which the applications were used, and that learning improved their self-confidence.

Examples of student views on the determined code and themes are as follows:

''Digital applications create a nice atmosphere in the lessons. It helps us learn and improve more. In addition, digital applications increase our willingness to speak and improve our self-confidence (S1)''

''The applications used save the lesson from monotony, create a different atmosphere, make it more fun, and everyone in the lesson wants to talk. When this happens, my desire to talk with my other friends also increases (S4)''

''I want to participate in all of them because the applications are fun. Thanks to the applications, we can learn concretely and visually new words and their pronounciation permanently. This, ,in turn, improves our pronounciation of words and our speaking by making more beautiful sentences (S3)''

What can be done diffrently to increase students' desire to speak English in class with the use of Web 2.0 tools?

Table 4.
Suggestions for Improving Conversation Skills with Applications

Theme	Codes	f
Students' suggestions	*Include more activities in the lessons	3
	*More encouragement of dialogue	2
	*Combining with movie or game	1

In the interview, the participants were asked what could be done to improve their English speaking desires in the lessons. The participants presented the idea that using applications more frequently in the lessons would increase their willigness to speak. They also stated that in addition to these activities, reading texts, listening passages and various writing activities could be effective on speaking. In addition to these suggestions, they stated that increasing their willigness to speak would be possible with the establishment of more dialogue, that is, with practices that would encourage mutual conversation. Apart from the activities to be used in the lessons, it would be beneficial to use different games and films in foreign languages during the lesson.

'' This kind of digital applications should continue to be intensively included in the lessons. Because those applications teach with fun. Starting from the basic level, speaking, listening and writing practices should be included in every subject (S4)''

''Just as writing skills developed by pen pals and reading skills by reading boks, speaking skills can be improved by establishing mutual dialogues. Fort his reason, I think that more frequent dialogue and conversation activities should be included in the lessons (S1)''

''My interest in games and foreign films is very much, I think that my other friends are in the same way. Foreign TV series have been popular lately. Since the lines in movies and TV series are remembered together with the scene, more place can be given to TV series and movie line (S3)''

Discussion, Conclusion, and Suggestions

Speaking is one of the four basic skills and it is very important for the language learned to be used and reflected in real life. Speaking skill is one of the most disrupted skills in distance education with socialization. For this reason, it was aimed to eliminate the reluctance of prepatory class students to speak in the distance education process with Web 2.0 technology applications. So, the study did not include just a single action plan or a single activity. During the study, it was used four action plans, more activities and many different applications. During each action plan, student diaries and researcher diaries were kept, and new action plans were developed by analyzing the data obtained. At the end of the process, opinions about the applications were taken from the students who participated in the activities.

Discussion-based practices were emphasized after the 3rd action plan because students did not want to speak when they encountered words they did not know in the action plans. With the discussion-based Mentimeter application, the lesson became fun and they had the opportunity to practice speaking more. In the Kialo application, it was determined that the students with plenty of participation took the floor, gave explanatory answers and commented on each other's answers. In the study, while it was aimed to eliminate students' reluctance to speak in the lessons with Web 2.0 technologies, the effects of these applications were also examined. In the analysis of data collected during the action plan process, it was determined that the applications included questions contributed to the academic success of the students. In the same direction of that studies' findings, Strobl (2014) and Peeters (2018) revealed in their studies that Web 2.0 tools have positive effects on students. The use of applications in the lessons made them more fun. Because it could be said that the use of technology-supported applicaitons in lessons is more effective, and the use of auditory and visual perception together by appealing to more than one sensory organ increases success (Erhan &Şen, 2019). Morkoç and Erdönmez (2014) stated in their study that the use of Web 2.0 technologies in lessons is more effective and more interesting.

In the study, the most prominent finding among the reasons why the students did not want to talk in the lessons was the fear of making mistakes. Students, who were afraid of making mistakes while speaking, were encouraged to talk with their friends' conversations in the lessons taugth with the Web 2.0 tools

used. At the end of the process they stated that they overcame this problem. In other words, when the students saw that everyone was participating in the lesson, they thought that they could speak, as well. By this way, they overcame these fears throughout the study and started to speak more actively during the lessons. It was concluded that the Web 2.0 applications used in the lessons also reduced the excitement of the students who were excited and embrassed while talking, and they could speak more easily. As a result of the work of Tatlı and Aksoy (2017) with digital storytelling, one of the Web 2.0 tools, the lessons became fun, attractive and it motivated the students. As it was stated in Kaynar's (2019) study, attractiveness of the lessons taught with the Web 2.0 tools encouraged students who did not want to talk in the lesson because of the boring subjects. In addition, it was concluded that the students who did not want to speak in the lesson due to the lack of vocabulary, learning new words and the pronounciation through the applications, increased participation and indirectly the self-confidence of the students.

In another result of the study, it could be said that one of the biggest handicaps of the students lack of vocabulary and pronounciation background. Gan (2012) emphasized this point in his study and stated that the most important obstacle in front of English speaking skills is the lack of vocabulary. However, interaction is one of the important factors in learning in any educational or language field and is one of the most important structures in distance education research (McIsaac & Gunawardena, 1996). It was determined that students prefer Web 2.0 applications to eliminate their vocabulary deficiencies due to their features such as learning words, repetition, seeing in sentences and pronouncing them.

The students stated that the courses created with Web 2.0 tools were fun and that affected them positively. Web 2.0 applications appealed to many different senses and make the lessons more enjoyable due to the options such as audio and video beyond the traditional course materials such as paper and pictures (Shon&Smith, 2011;Kappers& Cutler,2015; Noel, Stover& McNutt, 2015). In addition to these applications, they thought that presenting all parts of English reading, listening, writing and speaking in a harmonious interaction, rather than just improving the speaking area, will be beneficial for their learning and effective use of the language. The participants also suggested that opportunities for practice should be included in order to increase their English speaking skills by including conversational lines. Horzum (2010) emphasized the use of activities such as increasing dialogue, autonomy and interaction in order to reduce the distance students perceive in distance education. The use of dialogues in English lessons is important in terms of identifying the difficulties encountered by teachers in the learning process, as it reflects a kind of product. Rose and Sookraj (2015) stated that the most important teaching techniques that improve students' speaking skills in foreign language teaching are presentation and discussion techniques. In the literature, there is a limited number of studies on the effect of dialogues in language teaching through distance education, and these studies are mostly conducted on undergraduate students. It was thought that this study for the prepatory classes, where students receive intensive one year English education, would contribute to the literature. Another point that students emphasized in increasing their speaking skills is the use of movies and games. Ur (1996) suggested in his study to use interactive teaching techniques and to include applications such as movies and games that allow the student to speak. Especially in the digital age we live in, it will be a very useful approach to use digital games both to appeal to young people and to use them in their teaching. Berns et all. (2013) and Neville (2015) achieved successful results in language learning with digital games in their studies.

In sum, a solution was found to the problem of students who were unwilling to speak in English classes by using Web 2.0 tools in the lessons. At the end of the process, the students' unwilligness decreased and they started to take right to speak more actively during lessons anto express themselves. For further studies, Web 2.0 tools and studies on English listening, reading and writing proficiency can be recommended. In addition, with the use of Web 2.0 tools built on the mutual dialogue system, the effects on the student's speaking situation can be observed.

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References

Ağaoğlu, A. (2020). *Uzaktan eğitimde oyunlaştırma uygulamalarının üniversite öğrencilerinin İngilizce derslerindeki akademik başarı ve motivasyonlarına etkisi* [Unpublished master's thesis]. İnönü Üniversitesi.

Baltacı, A. (2019). Nitel araştırma süreci: nitel bir araştırma nasıl yapılır? *Ahi Evran Üniversitesi Sosyal Bilimler Enstitüsü Dergisi (AEÜSBED), 5*, 368-388.

Batıbay, E. F. (2019). *Web 2.0 uygulamalarının Türkçe dersinde motivasyona ve başarıya etkisi: Kahoot örneği.* [Unpublished master's thesis]. Hacettepe Üniversitesi.

Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. *NursingPlus Open, 2*, 8-14.

Berns, A., Palomo-Duarte, M., Dodero, J. M., & Valero-Franco, C. (2013). *Using a 3D online game to assess students' foreign language acquisition and communicative competence.* In D. Hernández-Leo, T. Ley, R. Klamma, & A. Harrer (Eds.), European Conference on Technology Enhanced Learning (pp. 19-31). Heidelberg: Springer. https://doi.org/10.1007/978-3-642-40814-4_3

Crystal, D. (2003). *English as a global language.* Cambridge University Press.

Creswell, J. W. & Creswell, J. D. (2018). *Research design qualitative, quantitative, and mixed methods approaches* (5th edition). SAGE Publications.

Çenesiz, M. & Özdemir, M. A. (2021). The effect of WEB 2.0 tools on academic success on topography and rocks in high school 10th grade geography. *International Journal of Geography and Geography Education (IGGE), 43*, 39-53. https://doi.org/10.32003/igge.750323

Domalewska, D. (2014). Technology-supported classroom for collaborative learning: Blogging in the foreign language classroom. *International Journal of Education and Development using Information and Communication Technology (IJEDICT), 10*, 21-30.

Efron, S.E. & Ravid, R. (2013). *Action research in education a practical guide*. The Guilford Press.

Erhan, M., & Şen, Ü. S. (2019). İlköğretim 7. sınıf müzik öğretiminde teknoloji destekli materyal kullanımının akademik başarıya etkisi. *Atatürk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 23*, 2113-2139.

Ertürk, H. (2006). *İngilizce öğretiminde konuşma becerisinin kazandırılmasında yazılı-görsel öğretim materyallerinin erişiye etkisi*. [Unpublished master's thesis]. Hacettepe Üniversitesi.

Gan, Z. (2012). Understanding L2 speaking problems implications for ESL curriculum development in a teacher training institution in Hong Kong. *Australian Journal of Teacher Education, 37*, 43-59. http://ro.ecu.edu.au/ajte/vol37/iss1/3

Guba, E.G. & Lincoln, Y. S. (1985). *Naturalistic inquiry*. SAGE Publications.

İnal, E. & Arslanbaş, F. (2021). Türkçenin yabancı dil olarak uzaktan öğretiminde iletişim odaklı Web 2.0 araçları ve uygulama örnekleri. *Bayburt Eğitim Fakültesi Dergisi, 16*, 228-249. https://doi.org/10.35675/befdergi.850781

Jefferson, Renée N. (2014). Action research: theory and applications. *New Review of Academic Librarianship, 20*, 91–116. https://doi.org/10.1080/13614533.2014.921536

Johnson, R. B. (1997). Examining the validity structure of qualitative research. *Education, 118*, 282-292.

Joyce, P. (2012) Action learning – a process which supports organisational change initiatives, *Action Learning: Research and Practice, 9*, 29-36, https://doi.org/10.1080/14767333.2012.656888

Karakoyun, F. (2014). *Çevrimiçi ortamda oluşturulan dijital öyküleme etkinliklerine ilişkin öğretmen adayları ve ilköğretim öğrencilerinin görüşlerinin incelenmesi.* [Doctoral Thesis]. Anadolu üniversitesi, Eğitim Bilimleri Enstitüsü.

Kappers, W. M., & Cutler, S. L. (2015). Poll everywhere! Even in the classroom: An investigation into the impact of using polleverwhere in a large-lecture classroom. *Computers in Education Journal, 6*(20). Retrieved from https://commons.erau.edu/publication/333

Kaynar, T. (2019). *Web 2.0 araçlarının yabancı dil öğretiminde kullanımı.* [Unpublished master's thesis]. Marmara Üniversitesi.

Kekeç Morkoç, D. & Erdönmez, C. (2014). Web 2.0 Uygulamalarının Eğitim Süreçlerine Etkisi: Çanakkale Sosyal Bilimler Meslek Yüksekokul Örneği . *AJIT-e: Bilişim Teknolojileri Online Dergisi* , *5*, 25-48 . https://doi.org/10.5824/1309-1581.2014.2.002.x

McIsaac, M. S., & Gunawardena, C. N. I. (1996). Distance education. In D. H. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology* (pp. 403-437). New York: Simon & Shuster Macmillan.

Miles, M. B. & Huberman, A.M. (1994). *Qualitative data analysis: an expanded sourcebook*. (2. rd). SAGE Publications

Neville, David, O. (2015): The story in the mind: the effect of 3D gameplay on the structuring of written L2 narratives, *ReCALL, 27*, 21-37. https://doi.org/10.1017/S0958344014000160

Noel, D., Stover, S. & McNutt, M. (2015). Student perceptions of engagement using mobilebased polling as an audience response system: Implications for leadership studies. *Journal of Leadership Education, 14*, 53-69.

Ocak, G. & Akkaş Baysal, E. (2021). Eylem araştırmasını anlamak. G. Ocak (Ed.) içinde*, Eğitimde eylem araştırması ve örnek araştırmalar* (s.1-46). Pegem Akademi.

Özerbaş, M. A. & Akın Mart, Ö. (2017). İngilizce öğretmen adaylarının Web 2.0 kullanımına ilişkin görüş ve kullanım düzeyleri. *Ahi Evran üniversitesi Kırşehir Eğitim Fakültesi Dergisi, 18*, 1152-1167.

Öztürk, G., & Gürbüz, N. (2014). Speaking anxiety among Turkish EFL learners: The case at a state university. *Journal of Language and Linguistic Studies, 10*(1), 1-17.

Patton, M. Q. (1987). *How to use qualitative methods in evaluation, program evaluation kit*. Sage Publications.

Peeters, W. (2018): Applying the networking power of Web 2.0 to the foreign language classroom: a taxonomy of the online peer interaction process. *Computer Assisted Language Learning*. https://doi.org/10.1080/09588221.2018.1465982

Prensky, M. (2001). Digital natives, digital immigrants. *On the horizon, 9*, 1-6.

Rose, P., & Sookraj, R. (2015). Needs Analysis: Undergraduates' evaluation of a university-wide English language course. *Carıbbean Educatıonal Research Journal,* 62.

Senemoğlu, N. (2000). *Gelişim, öğrenme ve öğretim.* Gazi Kitabevi.

Shon, H. & Smith, L. (2011). A review of Poll Everywhere audience response system. *Journal of Technology in Human Services, 29*, 236-245.

Strobl, C. (2014). Web 2.0 technologies for collaborative advanced writing. *CALICO Journal, 31*, 1-18. https://doi.org/10.11139/cj.31.1.1-18

Tatlı, Z. & Aksoy, D. A. (2017). Yabancı dil konuşma eğitiminde dijital öykü kullanımı. *Marmara Üniversitesi Atatürk Eğitim Fakültesi Eğitim Bilimleri Dergisi, 45,* 137-152. https://doi.org/10.15285/maruaebd.271060.

Ur, P (1996). *A course in language teaching, Practice and Theory.* Cambridge Teacher Training and Development. Series Editors. Marion Williams and Tony Wright.

Yıldırım, A. & Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri* (9. Baskı). Seçkin Yayıncılık

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Instructional Strategies in Science Education: A Dual Approach Combining Systematic Review and Secondary Qualitative Data Analysis

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Abstract

This study employed a dual research approach, incorporating both systematic review and secondary qualitative data analysis, to investigate instructional strategies and their rationales utilized by pre-service and in-service science teachers (PaIST) in physics topics. We chose widely recognized and readily accessible sources with extensive study coverage, including Web of Science, SCOPUS, Taylor & Francis Online, and ProQuest. Only four studies that conformed to our inclusion and exclusion criteria were identified for examination. The analysis unfolded in two phases: first, the identification of instructional strategies employed by PaIST, and second, the exploration of the underlying rationales guiding their choices. Our findings revealed a diverse array of instructional strategies, encompassing direct instruction, thought experiments, demonstrations, hands-on activities, think-pair-share, peer teaching, laboratory exercises, discussion/questioning techniques, drama, and real-life narratives. The rationales underpinning these strategies were multifaceted, aiming to enhance student motivation, stimulate cognitive development, facilitate collaborative group work, and foster meaningful learning experiences. Despite evidence supporting the effectiveness of various external strategies such as STEM education, out-of-school learning, and project-based teaching on students, pre-service and in-service science teachers appear hesitant to adopt these methods. Further research is needed to explore the barriers and factors influencing their instructional choices.

Keywords:Instructional strategy; pedagogical content knowledge; pre- and in-service science teachers; secondary qualitative data analysis; systematic review

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Introduction

The contemporary global landscape demands individuals who can proactively identify and capitalize on opportunities for personal and future well-being. This necessitates a multifaceted skill set, including inquiry, problem identification, creative and critical thinking, and the ability to establish causal relationships. Education plays a pivotal role in developing these skills, prompting researchers to investigate effective teaching approaches and instructional strategies for their acquisition (e.g., Tytler, 2003). As a result, novel teaching methodologies like STEM education, flipped classrooms, gamification, design thinking, and project-based learning have emerged, all contributing to the cultivation of highly skilled individuals.

Selecting Instructional Strategies for Effective Content Knowledge Teaching

Instructional strategies encompass choices and actions that educators undertake to attain particular learning objectives, involving the formulation of plans, methodologies, and activities (Jonassen et al., 1991). It is often discussed in the context of pedagogical content knowledge (PCK), a comprehensive model introduced by Lee Shulman, which reflects teacher competence in various domains (Kind, 2009; Loughran et al., 2006; Shulman, 1986; Van Driel et al., 1998). Within Shulman's PCK model, instructional strategies are a critical component. To delve deeper into this concept, it is apt to present the statement of Lee Shulman, who introduced the concept. According to Shulman (1986):

> ... for the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations in a word, the ways of representing and formulating the subject that make it comprehensible to others.

The subject of PCK, which is so important in raising individuals who will shape the future, has attracted much attention worldwide, especially after Shulman's explanations. This heightened interest has led to the proposal of numerous models associated with PCK (Abell, 2008; Gess-Newsome, 2015; Grossman, 1990; Magnusson et al., 1999; Morine-Dershimer & Kent, 1999; Park & Oliver, 2008; Rollnick et al., 2008). These models are typically developed by building upon previous ones. Within each model, teachers' PCK is unveiled through various components. It is noteworthy that upon close examination of these models, instructional strategies emerge as an essential domain. This domain is indispensable for PCK models. Instructional strategies, by revealing how and in what manner a teacher will impart knowledge to their students, encapsulate the essence of the teaching profession. Consequently, interpreting instructional strategies as the skeleton of PCK models might be an apt analogy. Teachers enter a classroom armed with the knowledge acquired during their undergraduate education, the experiences they have accumulated, and their motivation to teach. In this process, understanding why and how a teacher selects particular teaching strategies for specific subjects enables us to comprehend their perspectives and, perhaps most crucially, bridge the gap between theory and practice. In this study, the focus is on the instructional strategies employed by pre-service and in-service science teachers and the rationales guiding their choices. This sheds further light on the nature of PCK. Numerous studies in the literature investigate pre-service and in-service teachers' knowledge of instructional strategies based on any PCK model through methods such as observation (Barendsen & Henze, 2019; Nilsson & Karlsson, 2019; Scheuch et al., 2018), interviews (Van Driel et al., 1998), or a combination of both (Hanuscin et al., 2011; Nilsson & Vikström, 2015). Furthermore, there are studies in which pre-service and in-service teachers undergo training in teaching strategies (inquiry, modes, modeling, argumentation, etc.) to enhance their PCK (Faikhamta, 2013; Goodnough & Hung, 2009; Günther et al., 2019; Ladachart, 2020; Shein & Tsai, 2015; Wongsopawiro et al., 2017). These studies offer valuable insights into the levels of instructional strategy knowledge held by pre-service and in-service science teachers (PaIST), the translation of this knowledge into classroom practices, and strategies for improvement based on factors such as country, culture, discipline, and experience. Moreover, these studies illuminate how frequently a teacher employs a particular instructional strategy while teaching a subject and the underlying reasons for their choices.

Teacher's goals and purposes when selecting instructional strategies

Investigating which strategy teachers choose in their classrooms is one of the first questions of educational research. In one of the pioneering studies investigating this problem, it was found that teachers' decision-making on effective teaching strategies was mostly related to teacher attitudes

(Bender & Ukeje, 1989). However, it was also emphasized that the instructional strategies used to facilitate learning depends on the teaching conditions; thus, different instructional strategies should be chosen for different learning conditions (Jonassen, et al., 1991). In a more recent study, primary teachers chose inquiry and context-based instructional strategies because students needed to learn content knowledge about the subject matter (Walan, et al., 2017).

Teachers' science teaching goals and purposes, in other words, their beliefs significantly affect the teaching strategies they choose in their lessons (Mansour, 2009; Lee et al., 2004; Walan et al., 2017). Lee et al. (2004), in a longitudinal study with primary school teachers, listed the reasons for choosing inquiry strategies in three broad categories of goals: cognitive, affective, and pragmatic. They stated that cognitive goals include scientific inquiry, understanding science, and applying science to real-world situations. The affective goals are to develop a "love of science" in students and to get students "excited about science". Finally, they described the practical aims as "preparing students for assessments" and "integrating science into curriculum areas". Some researchers have expressed strategies as internal and external (Chou, 2013; Wang & Chen, 2013). Internal strategies, such as dialogical techniques, are pivotal in engaging students in the learning process, promoting active thinking, and drawing conclusions from data (Oliver et al., 2019). These strategies are crucial for establishing a positive classroom environment that supports student-centered teaching approaches and inquiry-based learning (Bielik & Yarden, 2016). External strategies in education can vary in terms of their focus of control for school restructuring. Strategies that are specific and prescriptive, relying on external authority, place the control for restructuring outside the school. On the other hand, strategies that are vague and rely on the school's authority place the control within the school. This indicates a continuum of control, ranging from external to internal, based on the clarity and authority of the strategies (Porter & Osthoff, 1994).

In research conducted by Williams and Clement (2015), it was determined that physics teachers used dialogical techniques, one of the micro techniques, within the scope of internal strategies. These techniques were employed because students share their scientific ideas in the classroom environment. Furthermore, recent studies have highlighted additional methods preferred by teachers in physics education. For example, research by Chiang et al. (2017) indicated a growing trend towards the use of inquiry-based learning strategies, where students explore physics concepts through hands-on experiments and guided investigations. This approach has been shown to enhance students' problem-solving skills and deepen their conceptual understanding. Additionally, recent research by Benabentos et al. (2021) highlights STEM education as a prominent instructional approach in physics teaching. The study emphasizes the effectiveness of student-centered practices that encourage active engagement and collaboration among learners. Faculty members reported utilizing various STEM-based strategies, which have gained traction as preferred methods for fostering deeper understanding and interest in physics concepts. This shift reflects the growing recognition of the importance of integrating innovative teaching methods into the physics curriculum, ultimately aiming to improve student learning outcomes and prepare them for future challenges in STEM fields. In middle school physics education, various instructional methods and techniques are utilized, with preferences often varying based on the topic being taught. For instance, collaborative learning has proven effective in teaching topics related to force and motion (Kıncal et al., 2007), while digital games are commonly employed to facilitate learning in energy-related topics (Martin et al., 2019). In the field of astronomy, instructional strategies frequently emphasize discussion-based activities (Miranda, 2010) and modeling techniques (Sağdıç, 2024).

There are assessment tools developed to investigate which strategy teachers use for what purpose in their lessons (e.g Ford, 2018). Although these tools provide the opportunity to reach large sample sizes, there may be a situation where teachers do not reflect on what is happening because they include self-evaluations. In essence, there is limited knowledge regarding the rationales teachers consider and how these rationales influence their selection of particular instructional strategies. Gathering such insights can enhance our comprehension of how teachers decide on teaching methods, ultimately paving the way for instructive recommendations on the successful integration of diverse teaching techniques.

Purpose of the Present Study

There may be disparities between the strategies that teachers are familiar with and those they implement in their classrooms. Such disparities can result in a gap between theory and practice when it comes to strategy selection. From this perspective, exploring the instructional strategies and the underlying

rationales employed by PaIST in their natural classroom settings can illuminate the nuances of the gap between theory and practice. By examining the specific instructional strategies used by PaIST in their lessons, without any external interference, this research aims to uncover the reasons behind these choices. Such insights can provide valuable understanding of both the authentic classroom environment and the teachers' pedagogical content knowledge (PCK). These insights can contribute to a deeper understanding of the authentic classroom environment.

Consequently, the research was designed to determine the instructional strategies employed by PaIST in teaching physics subjects and the rationales underpinning their decisions regarding these strategies. The present study aims to address the following research questions:

1. What does the literature reveal about the instructional strategies preferred by middle school by PaIST when teaching physics topics at the middle school level?

2. What are the rationales and underlying factors guiding the selection of the instructional strategies by PaIST when teaching physics topics at the middle school level?

Method

This research employed secondary research methods, specifically utilizing systematic review to identify and synthesize relevant literature, and secondary qualitative data analysis to examine the themes emerging from the selected studies. It is important to note that terminological ambiguity surrounding secondary research methods persists in the literature. Terms such as secondary data analysis, qualitative secondary analysis, qualitative secondary research, meta-analysis, and meta-synthesis are often used interchangeably, without clear delineation regarding their respective roles within the domain of secondary research methods. Manu and Akotia (2021) highlight this lack of clarity, emphasizing that while these terms are prevalent, distinctions between them remain unclear. Secondary research methods are clarified in this study by specifying the systematic review as the primary research tool, complemented by secondary qualitative analysis.

Systematic reviews play a crucial role in evidence-based research and decision-making by facilitating a comprehensive and unbiased synthesis of existing research on a specific topic. Through systematic searching, selection, and critical appraisal of relevant studies, systematic reviews allow researchers to assess the overall quality and strength of the evidence, helping to mitigate bias and ensuring a more reliable and robust summary of available findings (Higgins & Green, 2011). Additionally, systematic reviews enhance research transparency and reproducibility. This study employed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which provide a framework for reporting systematic reviews, ensuring clear and consistent presentation of methodology and findings (Moher et al., 2009). This transparency empowers other researchers to evaluate review quality, verify validity, and potentially replicate the study.

Furthermore, secondary qualitative data analysis is a valuable method that involves re-examining pre-existing qualitative data to address new research questions or to validate findings from prior research (Heaton, 2008; Largan & Morris, 2019, p. 29). By systematically analyzing such data, secondary qualitative data analysis promotes data reuse, enhances research rigor, and contributes to cumulative knowledge in qualitative research (Szabo & Strang, 1997). The process of secondary qualitative data analysis involves several steps. First, researchers identify and access relevant qualitative data sources, such as archived interviews, field notes, or transcripts. These data sources are then reviewed and selected based on their relevance to the research questions or objectives, as well as factors such as data quality, richness, and diversity. Secondary qualitative data analysis thus maximizes the value of existing qualitative data, enhancing rigor and credibility through opportunities for data triangulation and validation. The use of systematic review and secondary qualitative data analysis contributes to the replication and validation of findings, promoting cumulative knowledge in the field of pedagogical content knowledge (PCK) studies (Heaton, 2008; Largan & Morris, 2019, p. 29).

Data Collection

Web of Science, SCOPUS, Taylor & Francis Online, and ProQuest were selected for their well-regarded accessibility, rigorous indexing, and extensive peer-reviewed coverage, ensuring a comprehensive and reliable foundation for synthesizing educational research. Firstly, a search was made in Google Scholar

with the codes "(science teacher*) (primary | beginning | elementary | beginner*) (pre-service | candidate* | prospective) (instructional strategy*)" and "(science teacher*) (primary | beginning | elementary | beginner*) (instructional strategy*)". In this search, which was expressed as a pilot search, terms used in the literature related to research questions were identified, and a proper search code was developed for the main study. As a result, the following words were reached: science activity, strategy, pedagogical decision, practicum, teaching method, instructional decision, and knowledge of science activity. This pilot search aimed to reveal the behind-the-scenes decision-making processes of the instructional strategies that PaIST use in their lessons.

Inclusion and Exclusion Criteria

The inclusion and exclusion criteria are given in the Table 1.

Table 1.
Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
The research must be last published in 2021	Research published after 2021
The research group of the study must be PaIST.	Publications other than theses and research articles
The research must be carried out with observation and interview techniques based on the qualitative research method.	Research conducted only by interview
The statements of the PaIST about the reason for the teaching method chosen must be included in the interviews.	Paid publications without full-text access
The publication language must be English.	Research published in sources other than Web of Science, SCOPUS, Taylor & Francis Online, and ProQuest
PaIST must choose the teaching method of the physics subject.	Research conducted on chemistry and biology within the scope of science education
PaIST participating in the study must present any physics subject in a real or realistically adapted classroom setting.	

Teachers' knowledge of teaching strategy is not a new concept and that many countries have tried to improve teachers' classroom practice from past to present. For these reasons the starting publication year for eligible studies was left open-ended. As the research began in 2021, studies eligible for inclusion were required to have been published no later than 2021. In addition, since the scope of science is very wide, the search to studies that only included teaching physics subjects. PaIST's choose their own teaching methods without any external manipulation can reveal what they did in the real classroom environment, and why and how they decided on which teaching method. This would reflect the teachers' pure PCK. Finally, it was desired to reach studies investigating the rationale for the teaching strategies used by PaIST during their teaching practice.

The process of the selection of studies

Search codes were created according to the characteristics of each source, considering the inclusion and exclusion criteria, and searches were performed in the advanced search tab of each source. The search codes for the sources we have determined are in Table 2.

Table 2.
Search Codes for the Sources

Search Codes for Taylor & Francis Online	anywhere: “science teacher” anywhere: "physics" anywhere: "middle" OR "intermediate" OR "upper primary" OR "lower secondary" abstract: "qualitative" OR "case study" OR "mixed" OR "phenomenology" OR "grounded" OR "narrative" OR "ethnographic" OR "action research" anywhere: "practice" OR "reflection" OR "reaction" OR "science activity" OR "strategy" OR "pedagogical decision" OR "practicum" OR "teaching method" OR "technique" OR "instructional decision" OR "knowledge of science activity" OR "teaching practice"
Search Codes for Web of Science	ALL=science teacher AND ALL=physics AND ALL= (middle OR intermediate OR upper primary OR lower secondary) AND ALL=(qualitative OR case study OR mixed OR phenomenology OR grounded OR narrative OR ethnographic OR action research)
Search Codes for SCOPUS	TITLE-ABS-KEY ("science teacher") AND ALL (physics) AND (ALL(practice) OR ALL(reflection) OR ALL (reaction) OR ALL("science activity")OR ALL(strategy) OR ALL("pedagogical decision") OR ALL(practicum) OR ALL("teaching method") OR ALL(technique) OR ALL("instructional decision") OR ALL("knowledge of science activity") OR ALL("teaching practice")) AND (ALL(middle) OR ALL(intermediate) OR ALL("upper primary") OR ALL("lower secondary")) AND (ALL(qualitative) OR ALL("case study") OR ALL(mixed) OR ALL(phenomenology) OR ALL(grounded) OR ALL(narrative) OR ALL(ethnographic) OR ALL("action research"))
Search Codes for ProQuest	anywhere: “science teacher” anywhere: "physics" anywhere: "middle" OR "intermediate" OR "upper primary" OR "lower secondary" abstract: "qualitative" OR "case study" OR "mixed" OR "phenomenology" OR "grounded" OR "narrative" OR "ethnographic" OR "action research" anywhere: "practice" OR "reflection" OR "reaction" OR "science activity" OR "strategy" OR "pedagogical decision" OR "practicum" OR "teaching method" OR "technique" OR "instructional decision" OR "knowledge of science activity" OR "teaching practice"

To avoid bias in the research process, all sources were searched separately with the created codes. It should also be noted that the proxy settings of researchers’ universities were used to access paid resources in these sources. In addition, studies that matched the inclusion criteria were saved. While saving the studies, the *Standards for Reporting on Empirical Social Science Research in AERA Publications* report (American Educational Research Association, 2006) was taken into consideration to ensure the validity and reliability of the selection process. According to this report, transparency and a sufficient level of evidence were sought in the studies to be included in our research, thereby enhancing content validity by ensuring that only relevant and methodologically sound studies were selected. This criterion ensured that the chosen studies had a direct connection to the research questions, aligning with the systematic review’s purpose of providing reliable and applicable insights.

In addition, we developed search codes to comprehensively capture studies related to our research objectives. These codes included synonymous terms (e.g., “middle” OR “intermediate” OR “upper primary” OR “lower secondary”) to ensure inclusivity and reduce the risk of overlooking relevant studies that may use varied terminology. By sharing these codes with readers, we aim to maintain transparency and enable replication of our search process, further contributing to the study’s validity.

To reinforce reliability, two selection criteria both prevented bias and were decisive in evaluating the quality of the study. Separate coding was done by multiple coders to reduce the bias risk and reveal inter-rater reliability, following established guidelines (Lune & Berg, 2017). After all sources were

scanned, the researchers compared the data to assess inter-coder reliability, resulting in a high agreement rate of 95 percent. This substantial agreement reflects the rigorous coding process employed, ensuring consistent interpretations of the data across coders and contributing to the study's overall reliability.

Additionally, to increase the comprehensiveness and validity of the dataset, the researchers employed both backward and forward snowballing methods. First, the references of studies that met the inclusion criteria were examined to identify additional relevant studies (backward snowballing). Then, Google Scholar was used to determine citations for these included studies to locate any further research relevant to our study objectives (forward snowballing). However, no study matching the inclusion criteria was identified through these methods. Together, these strategies minimized the likelihood of missing key studies and strengthened the validity of the final dataset.

These processes align with the PRISMA checklist (Moher et al., 2009) requirements for systematic reviews, ensuring transparency, thoroughness, and rigor in data selection, coding, and analysis, thereby safeguarding the validity and reliability of the research findings.

Data Analysis

Firstly, we individually examined each article to ensure compliance with our inclusion and exclusion criteria. During this review, the primary objective was to identify instructional strategies used by PaISTs teaching physics subjects. In the process, information such as the authors of the studies, the country and year of the study, the type of study, whether the participants PaIST, and the specific physics topics taught by the participants was documented in an Excel spreadsheet. Subsequently, the assessments were then cross-checked. At last, the findings from the systematic review were presented in a concise and easily understandable fashion (Cook, et al., 1997; Moher et al., 2009).

Our secondary qualitative data analysis process consisted of several steps (Heaton, 2008; Largan & Morris, 2019, p. 29). Initially, we identified qualitative data sources within the selected studies. We scrutinized and selected these data sources based on their relevance to our research questions or objectives. We evaluated all included studies, taking into account factors such as data quality, richness and diversity, and collated the interview data provided by the original researchers. (Auerbach & Silverstein, 2003).

The first aim in the coding phase was to understand the rationales for the teaching strategies that PaIST uses during the lesson. Subsequently, it was examined whether these rationales were similar to the views expressed in the studies included in the review. In other words, the similarity and repetition frequency of the reasons for the teaching strategy used by the PaIST with the data in all studies included in this research were considered (Saldaña, 2013).

As secondary data analysts, authors are separated from the research context and have no idea about the details of the dynamics between interviewer and respondent (Smith, 2008). Therefore, direct quotations from the participants were used as the data for this study. This aimed to reach more objective results regarding the research question (Ruggiano & Perry, 2019). Before commencing the analysis, the selected qualitative data sources were compared. Subsequently, content analysis was conducted on these qualitative data sources.

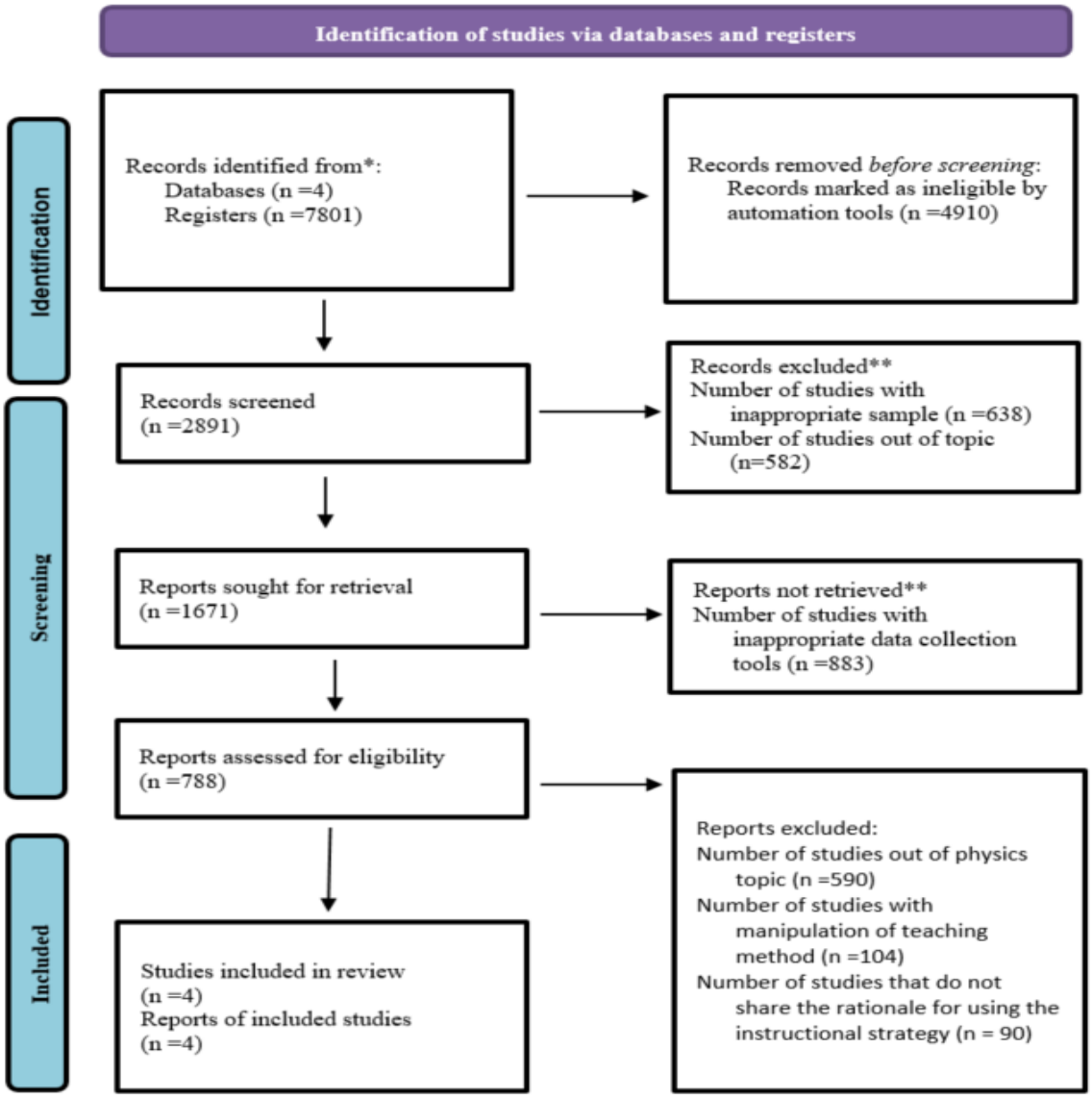

Figure 1. The Flowchart Showing the Whole Process

Results

The results related to the research questions are presented under two headings.

Preferred Instructional Strategies for Teaching Physics by PaIST

The generated search codes yielded in the four sources (n = 7801 from e-search and two from hand search; see PRISMA Figure 1.) Due to issues related to the subject matter (e.g., Walan, 2020), sample group (e.g., Engström & Carlhed, 2014; Melo, 2020), and data collection methods (e.g., Kersting, 2021) of these studies, 7,013 studies excluded after several evaluation stages. Furthermore, the remaining 788 studies excluded because the majority of them did not cover any specific physics topics. Additionally, in some of the remaining studies, there was evidence of manipulation of teachers' and teacher candidates' instructional strategy preferences (e.g., Ültay, 2017), or there were no qualitative data sources available concerning teachers' rationales for using instructional strategies (e.g., Tafrova-Grigorova, 2012). In the end, surprisingly, four studies were identified that met research criteria, involving middle school physics topics, taught by either PaIST, and explaining the rationale behind their chosen instructional strategies in these teaching practices.

Characteristics of selected original studies can be viewed in Table 3. This systematic review includes data from a total of six participants, consisting of two pre-service and four in-service science teachers.

Table 3.
Information about the Participants of the Studies, Physics Topics and Instructional Strategies

Reference	Name of Study	Country	Type of Research	Sample	Participant Name	Physics Subject/Grade	Used Instructional Strategy
Sæleset & Friedrichsen, 2021	Pre-service Science Teachers' Pedagogical Content Knowledge Integration of Students' Understanding in Science and Instructional Strategies	Norway	Article	Pre-service/ none	Lena	Energy, Technology & Design/ 6th	Direct instruction technique Thought experiment Hands-on activity
Gates, 2008	Middle School Science Teachers' Perspectives and Practices of Teaching Through Inquiry	USA	Dissertation	In service/ 10 years	Lisa	Simple machine/ 6th	Hands-on activity Think-pair-share Predict-observe-explain
				In-service/ 18 years	Lee Ann	Simple machine/6th	Hands-on activity Think-pair-share Discussion/Questioning
				In-service/ 10 years	Lena 2	Simple machine/6th	Hands-on activity Discussion/Questioning Think-pair-share
Yalaki, 2004	Science Teachers' Worldviews: A Way to Understand Beliefs and Practice	USA	Dissertation	In-service/ 3 years	Sara	Newton's laws, force and motion/ 6th, 7th, 8th	Hands-on activity Lecturing Peer teaching
Hahn, 2003	Interpretive Case Studies on the Influence of a Pre-service Contextual Science Research Course on Novice Scıence and Mathematics Teachers	USA	Dissertation	Pre-service/ none	Cathy	Force and motion, simple physics concepts, gravity/ not mentioned	Demonstration Lab activities Discussion/Questioning Drama Real-life stories Textbook instruction

The findings highlight several instructional strategies preferred by PaIST based on the physics topics being taught. These strategies include hands-on activities, think-pair-share, practical reasoning-explanation, and discussion. Specifically, hands-on activities were predominantly used for teaching basic mechanics topics, force and motion. Think-pair-share strategy was employed by both pre-service and in-service teachers across different physics topics. Discussion-based strategies were also frequently

observed. Real-life stories and demonstration were incorporated into lessons. The studies in this review were conducted in the United States and Norway, reflecting instructional approaches within these two distinct educational systems. Hands-on activities and peer teaching approaches were observed in the U.S., while the Norwegian study highlighted the use of reflective practices and the integration of science with students' everyday experiences. The studies reviewed span key middle school physics topics such as force, motion, and energy, with grade levels ranging from 6 to 8. Hands-on activities were widely used in teaching concepts like force and motion. Think-pair-share, discussion techniques, and real-life stories were also preferred strategies.

While SQDA (Systematic Qualitative Data Analysis) was utilized to categorize and interpret these findings, the systematic review process underscored a lack of sufficient research focusing on PaIST's instructional rationales and the effectiveness of these strategies across different physics topics. The limited pool of relevant studies highlights a need for further research to comprehensively understand the decision-making processes of teachers and to explore the impact of various strategies on student learning outcomes.

Rationales and Decision-Making Factors Behind Instructional Strategy Preference by PaIST in Physics Topics

As a result of the secondary data analysis, we shared the rationales for the instructional strategies in the form of assertion. These assertions include the rationales for why and how PaIST uses instructional strategies. These assertions are themes we create by combining codes according to their similarities and differences. The relationship of instructional strategies with code and themes is as in Figure 2.

Assertion 1: Using Hands-On/Laboratory Activities to Improve Learning, Motivate Students, And Connect Subjects to Real-World Situations

PaIST preferred classroom-based (hands-on) and laboratory-based (experimental) student-centered physics learning activities to promote students' learning, motivate them toward the lesson, and associate the subject matter with their daily lives.

In this secondary qualitative analysis, three participants in Gates (2008), one participant in Hahn (2003), one participant in Yalaki (2004), and one participant in Sæleset and Friedrichsen (2021) preferred active learning approaches so that their students could better learn and understand the subject. Lena2, Lisa, and Lee Ann preferred to use hands-on activities to enable students to learn by discovery. Lena2 thinks that students should experience the discovery process in their lessons. She stated that students took control and experienced learning in this process with the following words: "I think, for me, would be the phenomena first. For me, not to explain everything first, upfront, at least for me is a big change. Having, giving and putting more control into the students and letting them figure things out, without actually telling them how to do something or the way to do it is the biggest thing for me..." (Gates, 2008, p. 114). Lena2 thought students were not mature enough to explore concepts in the discovery process. She emphasized that the teacher's direction should be limited for her students to explore, but that being able to do this may not always be suitable for every student profile, and sometimes teachers should make extra efforts to realize this. On the other hand, Lee Ann emphasized the importance of students experiencing the discovery process. She expressed her ideas in the following words: "Ask a general question and have them refer back to it as different concepts are mastered. Giving students the opportunity to discover the concept versus spoon-feeding them can be beneficial." (Gates, 208, p.108). Lee Ann also stated that experience is significant for students to understand the relationship between concepts. Another teacher, Lisa, asked her students to do pulleys. In this lesson, she expected students to discover without giving any information. Lisa expressed her happiness when she saw her students make a moving pulley as: "I didn't give them any information on pulleys at the beginning of the lesson and I had the students explore making a pulley. I was surprised that they were able to make the moveable pulley!..."(Gates, 2008, p.113).

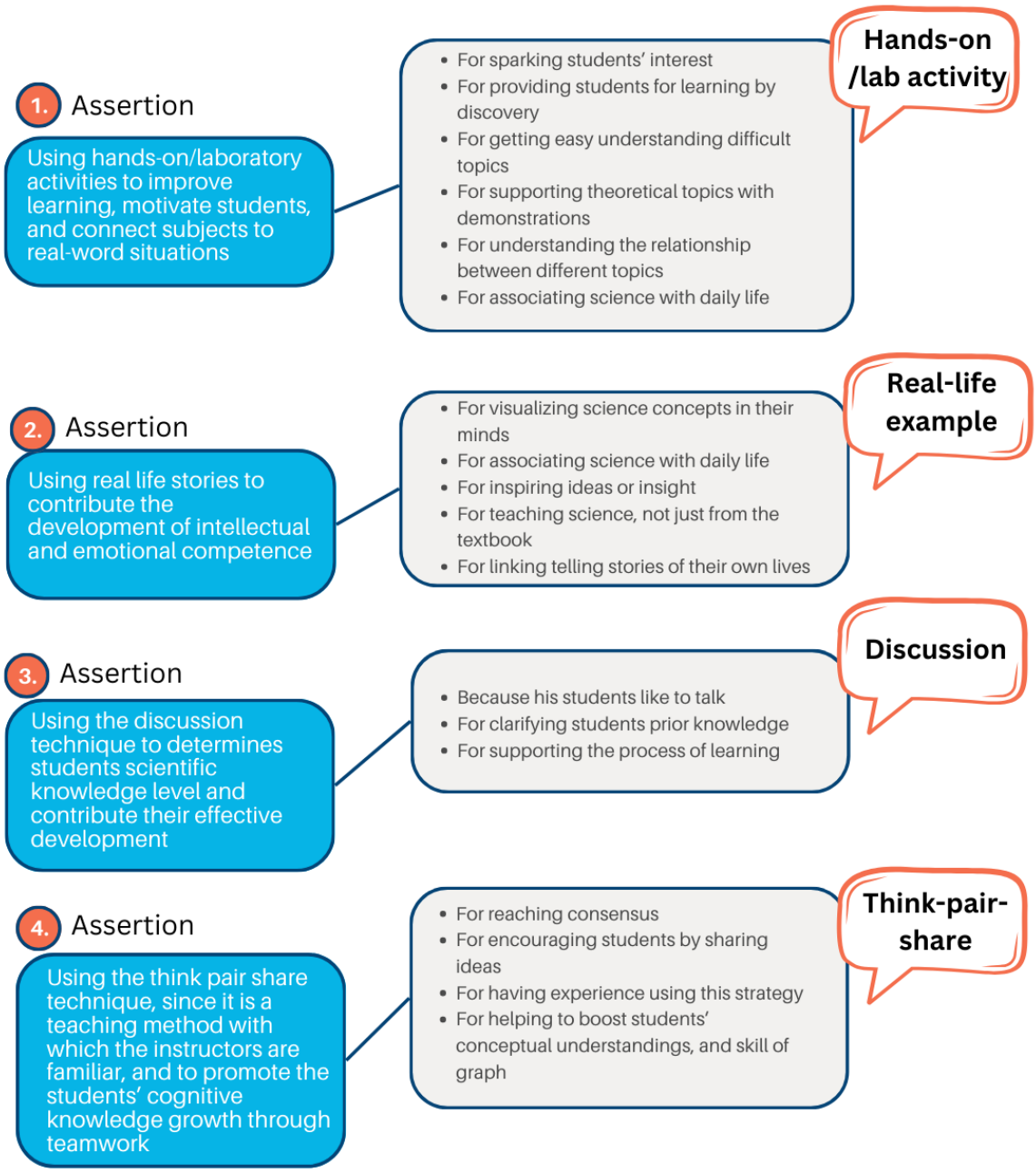

Figure 2. Relation of Assertion, Codes and Instructional Strategies

Lisa, Lee Ann, and Cathy chose hands-on activities to help their students understand difficult concepts. Lisa and Lee Ann, who took part in the same study, used the "tug of war" activity to explain balance forces. Lisa thought it would be easier for her students who experienced this game in real life to make sense of the balance force. Lee Ann also gave similar expressions to Lisa as the reason for using the same activity. Lee Ann said the following about hands-on activities: "...This activates student interest and allows them to use the common experience of a simple game to illustrate a difficult concept." (Gates, 2008, p.108). She chose games in which the students are active for teaching of the concepts that are difficult to understand. She also emphasized the importance of experiencing so that students can realize the relationship between concepts. Lena believes her students can connect theory and practice through their experiences: "I started out with theory and closed with the practical" (Sealeset & Friedrichsen, 2021, p.10). That's why, before instructing her students on the topic of energy, she had them design an electric circuit to test their theoretical understanding of the topic.

Two teachers in Gates (2008), one teacher in Yalaki (2004), and one pre-service teacher in Hahn (2003) preferred activities that students were active in to attract the attention and interest of their students. Lisa emphasized that her students enjoyed doing pulleys in the simple machine lesson. For another lesson, she commented, "I noticed lots of missed opportunities. The children were bored. We certainly should have started with the phenomena first. This would have sparked their interest" (Gates, 2008, p.113). She observed that they were bored when they did not do any hands-on and lab activities, and therefore she thought that they missed many learning opportunities. Similarly, Lee Ann used activities in which students were active to attract their attention. Lee Ann also added that one reason for including hands-on activities is to make difficult concepts understandable. Sara asked her students to do rocket projects in one of her classes. She was happier than on other days while expressing her thoughts about this lesson. She also stated that her students had fun doing the hands-on activity: "It is so much fun when they do big messy projects" (Yalaki, 2004, p.98). She thinks the educational environment becomes more fun when her students engage in hands-on activities. Cathy stated that she observed that the interest of her students increased. They had fun in her lesson in which she did experiments with her students in the laboratory environment in her lesson in which she explained Newton's laws: "...Allowing students to work in groups for research and laboratory activities is a good idea to improve student interest…" (Hahn, 2003, p.84) and "...They really enjoyed that lab" (Hahn, 2003, p.177).

One pre-service teacher in Hahn (2003) emphasized that one of the reasons why students use active activities in teaching physics is the visualization of concepts and associating them with daily life. In her lectures, Cathy aimed to associate experiments with daily life so that students could understand difficult concepts. Instead of using the experiments given in Cathy textbooks, she prefers the experiments she designed herself. For example, she dropped items with different masses on gravity in one of her lectures. Cathy chooses to show students how concepts relate to everyday life through experiments.

Assertion 2: Using Real-Life Stories to Contribute to the Development of Intellectual and Emotional Competence

Real-life stories are used in teaching physics subjects. Telling stories in their own lives allows students to enjoy and combine scientific knowledge with their own experiences. They require students to present their own life stories and discuss the physics concepts in those stories.

Assertion 2a: Using Real-Life Stories to Generate Insights about Concepts. One participant in Hahn (2003) preferred real-life stories to enable her students to generate insights about the concepts. Cathy stressed that her students' talks should include examples from daily life during her lecture on force and motion. She thinks that students who give examples from their own lives during the lesson have inspired ideas in their minds and developed insight into the subject. It is the reality that students experience in their lives. When they share this reality in their classes, the transfer of concepts to daily life is realized, and they are made to see their experiences from a different perspective. Cathy thinks that when students share their own experiences with their classmates, they can visualize the concepts in their minds: "...Students actually could visualize a "force" even though that is a difficult concept to visualize." (Hahn, 2003, 176).

Assertion 2b: Using Real-Life Stories as Students Like to Share Their Experiences. One participant in Hahn (2003) preferred real-life stories because their students like to present. Cathy stated that her students love daily life stories. Students are eager to share stories of their own lives in class and enjoy them. Cathy had the following to say about the real-life stories technique: "...With this strategy, the students are more willing to ask questions when confused and enjoy telling stories related to what we're learning." (Hahn, 2003, p.184).

Assertion 3: Using the Discussion Technique to Determine Students' Scientific Knowledge Level and Contribute to Their Affective Development

The discussion/question answer technique is used in teaching physics subjects. In this technique, students are provided with both asking questions to each other, and teachers ask them questions.

Assertion 3a: Using Discussion/Question-Answer (QA) Technique to Assess Students' Knowledge Levels at the Beginning and During the Learning Process. One participant, Gates (2008) preferred discussion/QA to determine her students' knowledge levels in the learning process. Lena2 used the discussion of terms to reveal students' prior knowledge of the subject. Lena2's lectures focused on

observable facts and their interrelationships. She used questions to provide these connections. She stated the following expression about the discussion/QA technique: "...made sure each of our lessons had an intro, phenomena, and post phenomena - making sure each phenomenon had a relationship to the point of the activity as well as each post-phenomena. We tied each back to the driving question…"(Gates, 2008, p.109).

Assertion 3b: Using Discussion Technique Because It is an Activity That Students Like. One pre-service teacher in Hahn (2003) and one in-service teacher in Gates (2008) frequently used discussion/QA because it is an activity that students like in the learning process. Lena and Cathy stated that their students love discussion environments, and they try to create this environment as much as possible. Lena2 noted that students appreciated discussing their own experiences using the expression: "...and the kids liked it. They enjoyed making and discussing their previous work" (Gates, 2008, p.126). Cathy also stated that his students love to talk: "My students love to talk, so they are more than willing to let me know why something relates to them. Learning is always more interesting when you can relate what you're learning to you personally."(Hahn, 2003, p.179). Cathy emphasized that the learning experience is more interesting for students who share their own experiences.

Assertion 4: Using the think-pair-share technique, since it is a teaching method with which the instructors are familiar, and to promote the students' cognitive knowledge growth through teamwork

The think-pair-share technique is used in teaching physics subjects. In this technique, students work in groups. They are asked to think together and reach a common decision on a question, and then all groups are asked to present their ideas.

Assertion 4a: Using the Think-Pair-Share Technique to Develop Students' Conceptual Understandings by Working Collaboratively. Two teachers in Gates (2008) used the think-pair-share technique in teaching physics as a reason for their students to reach a consensus, to support them to share their ideas and to help to boost students' conceptual understandings and skills of graphs. Lisa and Lee Ann emphasized that this technique is useful in making it easier for students to express their thoughts and to feel comfortable. Lee Ann stated that "...It takes the pressure off of individual students to give an answer and it allows students to discuss ideas before presenting them to the class…"(Gates, 2008, p.117). She thought students' sharing their ideas with a small group lessens their anxiety. Lisa also emphasized the importance of students discussing and reaching a consensus on a topic with their group mates: "When you put them in groups, that forces the group to come up with something to put on that paper and then they don't feel so intimidated" (Gates, 2008, p.123). Lisa and Lee Ann chose this technique and focused on students' communication and collaborative working skills.

Assertion 4b: Using the Think-Pair-Share Technique Since Teachers are Familiar with It. The teacher Lisa in Gates (2008) preferred the think, pair share technique since she used it frequently before. She stated her thoughts with the following words: "...I have really done a lot more with that…" (Gates, 2008, p.126). Lisa has chosen to use this familiar technique in her lessons.

Discussion

This article is one of the first attempts to examine the rationale of the instructional strategies used by PaIST in teaching middle school physics subjects with retrospective analysis. According to these analyses, our study underscores the scarcity of research focused on PCK within the context of PAIST's instructional strategies and their rationales when teaching physics subjects. Despite not imposing constraints on the publication year, we identified a limited pool of only four studies that met our criteria for examining the teaching strategies employed by science teachers after delivering any physics topic and the rationales behind these strategies. These studies have provided valuable insights into the rationale behind instructional strategies employed by PAIST when delivering lessons on various physics topics. They also underscore the profound dearth of research in this critical area.

In light of the limited available research, it becomes evident that PAIST frequently resorts to hands-on and laboratory activities. These strategies are employed not only to ignite students' interest but also to facilitate experiential learning, simplify the comprehension of intricate subjects, and reinforce theoretical concepts with practical demonstrations, thereby bridging interdisciplinary connections and

linking science to real-life scenarios. These rationales point to the development of affective and cognitive skills. Practical activities are emphasized to be critical for the development of individuals' attitudes and motivation toward science (Corter et al., 2011; Lago et al., 2017), which can have a positive effect on students in middle school age. Practical activities are one of the recommended strategies. Because they contribute to a better understanding of abstract concepts by concretizing them, understanding their relationship with other subjects, and also making the student more active in learning (Holstermann et al., 2010; Rutherford & Ahlgren, 1990, p. 186). A meta-synthesis study demonstrated the positive impact of practical activities on students' cognitive and affective development (Brown & Lan, 2013). Consequently, it becomes evident that PaIST aims to foster cognitive and affective development in their students through the effective integration of practical activities.

Furthermore, our findings indicate that PaIST frequently employs real-life stories to enable students to conceptualize scientific ideas, bridge the gap between scientific knowledge and daily life, stimulate creativity, and foster a sense of personal connection. They advocate that relying solely on textbooks for instruction is insufficient. These rationales signify the promotion of intellectual and emotional competence. Recognizing that science fundamentally constitutes the scientific explanation of individual experiences, it appears beneficial for middle school students that PaIST reinforce the teaching of physics topics with real-life narratives. In accordance with Clark and Moss's (2011) mosaic approach, sharing experiences perceived as 'individual tiles' by students significantly contributes to merging scientific and daily occurrences, fostering creativity and insight. This approach encourages students not merely to acquire information from textbooks, the internet, or the teacher but to actively apply the knowledge they gather from diverse sources to their lives. Similar to the teachers in McNeal's (2005) study, literature supports the idea that real-life narratives enhance students' comprehension and visualization by connecting them with practical activities (Hughes, 2010).

Furthermore, our investigation reveals that PaIST utilizes the discussion technique, driven by students' inclination towards interactive discussions and its utility in elucidating prior knowledge and enhancing the learning process. These rationales suggest that this technique effectively fosters students' cognitive and affective competencies. The discussion technique hinges on asking pertinent and well-timed questions, thereby achieving logical conclusions through iterative question-answer cycles. This method is often regarded as student-centred and meaningful (Osborne, 2014). Our findings align with other studies, indicating that PaIST prefers the discussion technique due to its ease of implementation, ability to elevate students' cognitive levels by promoting creative and critical thinking, and enhancement of student motivation (Jamil et al., 2021; Özder, 2011). Furthermore, several studies corroborate teachers' insights, demonstrating that the discussion technique has a positive influence on cognitive development (Galishnikova et al., 2019; Sepeng & Webb, 2012).

The final result is the rationale for using the think-pair-share technique, as it is familiar to pre-service science teachers and supports students' cognitive knowledge development through teamwork. This situation draws attention to teachers' self-efficacy beliefs (Evers et al., 2002; Jamil et al., 2021). Because familiar strategies boost their confidence and competence in teaching practices, highlighting the role of self-efficacy beliefs. Furthermore, due to their limited experience, pre-service teachers' concerns, such as ensuring classroom management, correctly maintaining and completing the implementation process, and using appropriate activities, may lead them to use the teaching strategies they have experienced. Therefore, it is natural for teacher candidates who have not yet gained much experience to use the strategies they feel safe and experienced (Bradbury, 2010; Kind, 2009).

Based on the findings of this research, a question arises: while there is evidence supporting the effectiveness of various external strategies such as STEM education, out-of-school learning, and project-based teaching on students, along with recommendations for their implementation, why do science teachers and teacher candidates seem hesitant to adopt these methods?

Conclusion

PaIST used macro and micro strategies such as hands-on, laboratory, real-life story, discussion, and think-pair-share techniques to provide students' cognitive development, support learning with visuals, and create motivation. Considering current findings, PaIST chooses experiments which they can relate to daily life in teaching physics subjects, hands-on activities, and strategies in which their students can

create environments in which they can express themselves. However, these studies did not consider additional factors that stimulate the strategy decision-making process.

Limitations and Recommendations

This study utilized specific databases to identify research articles that met the inclusion and exclusion criteria. However, access to paid publications might have been limited, representing a constraint of this research. One limitation of this study is that it exclusively included studies published in English. This criterion may have resulted in the exclusion of relevant research published in other languages, potentially leading to a narrower understanding of the topic. Future studies could enhance comprehensiveness by including data from articles in multiple languages, provided access to paid publications is secured. Despite the high volume of studies retrieved through keyword searches, only four studies met the inclusion and exclusion criteria established for this research. This limited number of relevant studies restricts the generalizability of the findings and hinders a broader perspective on the topic. To enhance the search strategy in future research, including specific physics topics taught in middle school (e.g., force and motion, energy) along with the term "physics" in database queries may yield a more comprehensive dataset.

The findings of this study indicate the need for further research examining the decision-making processes of PaIST regarding their selection of instructional strategies for teaching physics. Such research could uncover both the constraining and facilitating factors in the choice of student-centered strategies. Additionally, it is worthwhile to explore why PaIST may hesitate to adopt external strategies, such as STEM education, out-of-school learning, and project-based teaching, despite evidence supporting their effectiveness and recommendations for their integration.

As a secondary analysis, this study relies on previously collected data. While we endeavored to access all articles meeting our criteria and relevant to our research focus, the findings are limited to the direct quotations presented in the original publications. Access to the complete datasets from these original studies could potentially yield different insights.

Acknowledgment

Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

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Institutional Review Board Statement: This research is based on secondary data analysis and does not involve research conducted on live subjects. The data has been previously collected from publicly available data sources. Therefore, no ethical approval from an ethics committee is required for the compliance with ethical standards of this research.

Data Availability Statement: All data generated or analyzed during this study are included in this published article. Therefore, no additional data are available from the authors.

Conflict of Interest: Authors should declare that there is no conflict of interest among authors.

References

(Studies included in the systematic review are marked with an asterisk (*))

Abell, S.K. (2008). Twenty years later: Does pedagogical content knowledge remain a useful idea? *International Journal of Science Education, 30*(10), 1405-1416. doi:10.1080/09500690802187041

American Educational Research Association. (2006). Standards for reporting on empirical social science research in AERA publications. *Educational Researcher, 35*(6), 33–40. https://www.academia.edu/32050123/Standards_for_Reporting_on_Empirical_Social_Science_Research_in_AERA_Publications?from=cover_page

Auerbach, C., & Silverstein, L. B. (2003). *Qualitative data: An introduction to coding and analysis.* NYU Press.

Barendsen, E., & Henze, I. (2019). Relating teacher PCK and teacher practice using classroom observation. *Research in Science Education, 49*(5), 1141-1175. doi:10.1007/s11165-017-9637-z

Benabentos, R., Hazari, Z., Stanford, J. S., Potvin, G., Marsteller, P., Thompson, K. V., ... & Kramer, L. (2021). Measuring the implementation of student-centered teaching strategies in lower-and upper-division STEM courses. *Journal of Geoscience Education, 69*(4), 342-356. doi:10.1080/10899995.2020.1768005

Bender, W. N., & Ukeje, I. C. (1989). Instructional strategies in mainstream classrooms: Prediction of the strategies teachers select. *Remedial and Special Education, 10*(2), 23-30. doi:10.1177/07419325890100020

Bielik, T. and Yarden, A. (2016). Promoting the asking of research questions in a high-school biotechnology inquiry-oriented program. *International Journal of STEM Education, 3*(15), 2-13. doi:10.1186/s40594-016-0048-x

Bradbury, L. U. (2010). Educative mentoring: Promoting reform-based science teaching through mentoring relationships. *Science Education, 94*(6), 1049-1071. doi:10.1002/sce.20393

Brown, C. P., & Lan, Y. C. (2013). The influence of developmentally appropriate practice on children's cognitive development: A qualitative meta-synthesis. *Teachers College Record, 115*(12), 1-36. doi:10.1177/016146811311501207

Chiang, F. K., Diao, S., Ma, H., & Wang, Y. (2017). Effects of hand-on inquiry based learning using LEGO® materials on the learning of eighth-grade physics students. *International Journal of Engineering Education, 33*(3), 1098-1103.

Chou, P. N. (2013). Effect of instructor-provided concept maps and self-directed learning ability on students online hypermedia learning performance. *Journal of College Teaching & Learning (TLC), 10*(4), 223-234.

Clark, A., and Moss, P. (2011). *Listening to young children: The mosaic approach* (Second edition). National Children's Bureau.

Cook, D., Mulrow, C., & Haynes, R. (1997). Systematic reviews: synthesis of best evidence for clinical decisions. *Annals of Internal Medicine, 126*(5), 376. doi:10.7326/0003-4819-126-5-199703010-00006

Corter, J. E., Esche, S. K., Chassapis, C., Ma, J., & Nickerson, J. V. (2011). Process and learning outcomes from remotely-operated, simulated, and hands-on student laboratories. *Computers & Education, 57*(3), 2054-2067. doi:10.1016/j.compedu.2011.04.009

Engström, S., & Carlhed, C. (2014). Different habitus: different strategies in teaching physics? Relationships between teachers' social, economic and cultural capital and strategies in teaching physics in upper secondary school. *Cultural Studies of Science Education, 9*, 699-728. doi:10.1007/s11422-013-9538-z

Evers, W. J. G., Brouwers, A., & Tomic, W. (2002). Burnout and self-efficacy: A Study on teachers' beliefs when implementing an innovative educational system in the Netherlands. *British Journal of Educational Psychology, 72*, 227-243. doi:10.1348/000709902158865

Faikhamta, C. (2013). The development of in-service science teachers' understandings of and orientations to teaching the nature of science within a PCK-based NOS course. *Research in Science Education, 43*(2), 847-869. doi:10.1007/s11165-012-9283-4

Ford, C. (2018). Effective practice instructional strategies: Design of an instrument to assess teachers' perception of implementation. *Studies in Educational Evaluation, 56*, 154-163. doi:10.1016/j.stueduc.2017.12.004

Galishnikova, E. M., Baklashova, T. A., & Khafizova, L. V. (2019). *Didactic potential of discussion technique in teaching foreign language for pedagogics students*. In & R. Valeeva (Ed.), Teacher Education - IFTE 2017, vol 29. European Proceedings of Social and Behavioural Sciences (pp. 206-214). Future Academy. doi:10.15405/epsbs.2017.08.02.25

*Gates, H. A., (2008). *Middle school science teachers' perspectives and practices of teaching through inquiry*. (Publication No. 3332245) [Doctoral dissertation, University of South Carolina]. ProQuest Dissertations and Theses Global.

Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK. In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education* (pp. 28-42). Routledge Press.

Goodnough, K., & Hung, W. (2009). Enhancing pedagogical content knowledge in elementary science. *Teaching Education, 20*(3), 229-242. doi:10.1080/10476210802578921

Grossman, P. L. (1990). *The making of a teacher: teacher knowledge and teacher education*. Teachers College Press.

Günther, S. L., Fleige, J., zu Belzen, A. U., & Krüger, D. (2019). Using the case method to foster preservice biology teachers' content knowledge and pedagogical content knowledge related to models and modelling. *Journal of Science Teacher Education, 30*(4), 321-343. doi:10.1080/1046560X.2018.1560208

*Hahn, L. L. (2003). *Interpretive case studies on the influence of a pre-service contextual science research course on novice science and mathematics teachers.* (Publication No. 3156077) [Doctoral dissertation, The Florida State University]. ProQuest Dissertations and Theses Global.

Hanuscin, D. L., Lee, M. H., & Akerson, V. L. (2011). Elementary teachers' pedagogical content knowledge for teaching the nature of science. *Science Education, 95*(1), 145-167. doi:10.1002/sce.20404

Heaton, J. (2008). Secondary analysis of qualitative data: An overview. *Historical Social Research, 33*(3), 33-45. doi:10.12759/hsr.33.2008.3.33-45

Higgins, J. P., & Green, S. (2011). *Cochrane handbook for systematic reviews of interventions*. The Cochrane Collaboration. London, UK.

Holstermann, N., Grube, D., & Bögeholz, S. (2010). Hands-on activities and their influence on students' interest. *Research in Science Education, 40*(5), 743-757. doi:10.1007/s11165-009-9142-0

Hughes, S. W. (2010). A practical example of a siphon at work. *Physics Education, 45*(2), 162-166. doi:10.1088/0031-9120/45/2/006

Jamil, M., Muhammad, Y., & Qureshi, N. (2021). Critical thinking skills development: secondary school science teachers' perceptions and practices. *SJESR, 4*(2), 21-30. doi:10.36902/sjesr-vol4-iss2-2021(21-30)

Jonassen, D. H., Grabinger, R. S., & Harris, N. D. C. (1991). analyzing and selecting instructional strategies and tactics. *Performance Improvement Quarterly, 4*(2), 77-97. doi:10.1111/j.1937-8327.1990.tb00456.x

Kersting, M., Schrocker, G., & Papantoniou, S. (2021). 'I loved exploring a new dimension of reality'–a case study of middle-school girls encountering Einsteinian physics in the classroom. *International Journal of Science Education, 43*(12), 2044-2064. doi:10.1080/09500693.2021.1950943

Kıncal, R. Y., Ergül R., & Timur, S. (2007). Effect of cooperative learning method to student achievement in science teaching. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 32*, 156-163.

Kind, V. (2009). Pedagogical content knowledge in science education: perspectives and potential for progress. *Studies in Science Education, 45*(2), 169-204. doi:10.1080/03057260903142285

Ladachart, L. (2020). Thai first-year preservice science teachers' orientations toward teaching science. *The Asia-Pacific Education Researcher, 29*(5), 455-471. doi:10.1007/s40299-019-00498-6

Lago, A., Masiero, S., Bramuzzo, S., Callegaro, E., Poloni, E., Corrà, F., & Santovito, G. (2017, March). *Exploring microbiology and biotechnologies: a laboratory approach to the study of yeasts and bacteria in primary school*. [Paper presentation]. 11th International Technology, Education and Development Conference 2017, Valencia, Spain. doi:10.21125/inted.2017.0992

Largan, C. & Morris, T. (2019). *Qualitative secondary research: A step-by-step guide*. Sage.

Lee, O., Hart, J. E., Cuevas, P., & Enders, C. (2004). Professional development in inquiry-based science for elementary teachers of diverse student groups. *Journal of Research in Science Teaching, 41*(10), 1021-1043. doi:10.1002/tea.20037

Loughran, J. J., Berry, A., & Mulhall, P. (2006). *Understanding and developing science teachers' pedagogical content knowledge*. Brill.

Lune, H., & Berg, B. L. (2017). *Qualitative research methods for the social sciences*. Pearson.

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education* (pp. 95-133). Kluwer Academic.

Mansour, N. (2009). Science teachers' beliefs and practices: Issues, implications and research agenda. *International Journal of Environmental and Science Education, 4*(1), 25–48.

Martin, W., Silander, M., & Rutter, S. (2019). Digital games as sources for science analogies: Learning about energy through play. *Computers & Education, 130*, 1-12. doi:10.1016/j.compedu.2018.11.002

McNeal, K. (2005). The influence of a multicultural teacher education program on teachers' multicultural practices. *Intercultural Education, 16*(4), 405-419. doi:10.1080/14675980500304405

Miranda, R. J. (2010). Urban middle-school teachers' beliefs about astronomy learner characteristics. *Astronomy Education Review, 9*(1), 1-9. doi:10.3847/AER2010030

Melo, L., Cañada-Cañada, F., González-Gómez, D., & Jeong, J. S. (2020). Exploring pedagogical content knowledge (PCK) of physics teachers in a Colombian secondary school. *Education Sciences, 10*(362), 2-15. doi:10.3390/educsci10120362

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group*. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine, 151*(4), 264-269.

Morine-Dershimer, G., & Kent, T. (1999). The complex nature and sources of teachers´ pedagogical knowledge. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education* (pp. 21-50). Kluwer Academic

Nilsson, P., & Karlsson, G. (2019). Capturing student teachers' pedagogical content knowledge (PCK) using CoRes and digital technology. *International Journal of Science Education, 41*(4), 419-447. doi:10.1080/09500693.2018.1551642

Nilsson, P., & Vikström, A. (2015). Making PCK explicit—Capturing science teachers' pedagogical content knowledge (PCK) in the science classroom. International *Journal of Science Education, 37*(17), 2836-2857. doi:10.1080/09500693.2015.1106614

Oliver, M., McConney, A., & Woods-McConney, A. (2019). The efficacy of inquiry-based instruction in science: a comparative analysis of six countries using pisa 2015. *Research in Science Education, 51*(S2), 595-616. doi:10.1007/s11165-019-09901-0

Osborne, J. (2014). Teaching critical thinking? New directions in science education. School Science Review, 352, 53-62.

Özder, H. (2011). Self-efficacy beliefs of novice teachers and their performance in the classroom. *Australian Journal of Teacher Education, 36*(5), 1-15. doi:10.14221/ajte.2011v36n5.1

Park, S., & Oliver, J. S. (2008). Revisiting the conceptualization of pedagogical content knowledge (PCK): PCK as a conceptual tool to understand teachers as professionals. *Research in Science Education, 38*, 261-284. doi:10.1007/s11165-007-9049-6

Petticrew, M., & Roberts, H. (2008). *Systematic reviews in the social sciences: A practical guide*. John Wiley & Sons.

Porter, A. C., & Osthoff, E. (1994). *External strategies for stimulating and supporting school restructuring.* Madison, WI: Wisconsin Center for Educational Research.

Rollnick, M., Bennett, J., Rhemtula, N. D., & Ndlovu, T. (2008). The place of subject matter knowledge in pedagogical content knowledge: A case study of South African teachers teaching the amount of substance and chemical equilibrium. *International Journal of Science Education, 30*(10), 1365- 1387. doi:10.1080/09500690802187025

Ruggiano, N., & Perry, T. E. (2019). Conducting secondary analysis of qualitative data: Should we, can we, and how?. *Qualitative Social Work, 18*(1), 81-97. doi:10.1177/14733250177007

Rutherford, F. J., & Ahlgren, A. (1991). *Science for all Americans*. Oxford University Press.

Sağdıç, A. (2024). Shedding light on pre-service science teachers' instructional preferences and hurdles in teaching phases of the moon. *Kastamonu Education Journal, 32*(2), 201-214. doi:10.24106/kefdergi.1473470

Saldaña, J. (2013). *The coding manual for qualitative researchers*. Sage.

*Sæleset, J., & Friedrichsen, P. (2021). Pre-service Science Teachers' Pedagogical Content Knowledge Integration of Students' Understanding in Science and Instructional Strategies. *Journal of Mathematics, Science and Technology Education, 17*(5), 1-18. doi:10.29333/ejmste/10859

Scheuch, M., Panhuber, T., Winter, S., Kelemen-Finan, J., Bardy-Durchhalter, M., & Kapelari, S. (2018). Butterflies & wild bees: biology teachers' PCK development through citizen science. *Journal of Biological Education, 52*(1), 79-88. doi:10.1080/00219266.2017.1405530

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Shein, P. P., & Tsai, C. Y. (2015). Impact of a scientist–teacher collaborative model on students, teachers, and scientists. *International Journal of Science Education, 37*(13), 2147-2169. doi:10.1080/09500693.2015.1068465

Smith, (2008). Pitpalls and promises: the use of secondary data analysis in educational research. *British Journal of Educational Studies, 56*(3). 323-339. doi:10.1111/j.1467-8527.2008.00405.x

Sepeng, P., & Webb, P. (2012). Exploring mathematical discussion in word problem-solving. *Pythagoras, 33*(1), 1-8.

Szabo, V. and Strang, V. (1997). Secondary analysis of qualitative data. *Advances in Nursing Science, 20*(2), 66-74. doi:10.1097/00012272-199712000-00008

Tafrova-Grigorova, A., Boiadjieva, E., Emilov, I., & Kirova, M. (2012). Science teachers' attitudes towards constructivist environment: a Bulgarian case. *Journal of Baltic Science Education, 11*(2), 184-193.

Tytler, R. (2003). A window for a purpose: Developing a framework for describing effective science teaching and learning. *Research in Science Education, 33*(3), 273–298. doi:10.1023/A:1025423704068

Ültay, E. (2017). Examination of context-based problem-solving abilities of pre-service physics teachers. *Journal of Baltic Science Education, 16*(1), 113-122.

Van Driel, J. H., Verloop, N., & De Vos, W. (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching, 35*(6), 673-695. doi:10.1002/(SICI)1098-2736(199808)35:6<673::AID-TEA5>3.0.CO;2-J

Walan, S. (2020). Embracing digital technology in science classrooms—secondary school teachers' enacted teaching and reflections on practice. *Journal of Science Education and Technology, 29*(3), 431-441. doi:10.1007/s10956-020-09828-6

Walan, S., Nilsson, P., & Ewen, B. M. (2017). Why inquiry? Primary teachers' objectives in choosing inquiry-and context-based instructional strategies to stimulate students' science learning. *Research in Science Education, 47*, 1055-1074. doi:10.1007/s11165-016-9540-z

Wang, L. C., & Chen, M. P. (2012, July). *The effects of cognitive-affective interaction strategy on novices' creative performance in game design project*. In 2012 IEEE 12th International Conference on Advanced Learning Technologies (pp. 549-553). IEEE

Wongsopawiro, D. S, Zwart C. R, & Van Driel, J. H. (2017). Identifying pathways of teachers' PCK development. *Teachers and Teaching: Theory and Practice, 23*(2), 191-210. doi:10.1080/13540602.2016.1204286

Williams, G., & Clement, J. (2015). Identifying multiple levels of discussion-based teaching strategies for constructing scientific models. *International Journal of Science Education, 37*(1), 82-107. doi:10.1080/09500693.2014.966257

Van Driel, J. H., De Jong, O., & Verloop, N. (2002). The development of preservice chemistry teachers' pedagogical content knowledge. *Science Teacher Education, 86*, 572-590. doi:10.1002/sce.10010

Vikström, A. (2014). What makes the difference? Teachers explore what must be taught and what must be learned in order to understand the particulate character of matter. *Journal of Science Teacher Education, 25*(6), 709-727. doi: 10.1007/ s10972-014-9397-9

*Yalaki, Y. (2004). *Science teachers' worldviews: a way to understand beliefs and practices.* (Publication No. 3156258) [Doctoral dissertation, The Florida State University]. ProQuest Dissertations and Theses Global.

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Observing Primary School Pre-service Teachers' Oral Argumentation in Science Writing Heuristic Implementation

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Abstract

This study provides information on primary school pre-service teachers' (PST) oral argumentation in science writing heuristic (SWH) implementation. Previous research on SWH mainly did not consider primary school PSTs and their oral engagement in the argumentation process. Therefore, this study attempted to understand how primary school PSTs experienced the SWH implementation considering the three aspects of oral argumentation which are cognitive, epistemic, and social. The study lasted six weeks and 34 PST participated in the study. Data were collected using the Assessment of Scientific Argumentation in Class (ASAC) observation protocol. Accordingly, PSTs were observed throughout the implementation and the ASAC protocol was filled each week. Content and constant comparative analysis yielded results about students' oral argumentation. The main findings showed that participants' oral argumentation improved with time. Next, ASAC aspects' observation scores diverged and the scores for cognitive and epistemic aspects were higher than those for social aspects. The findings are discussed and implications are presented considering PST's oral argumentation and the use of ASAC.

Keywords: Oral argumentation, primary school pre-service teachers, science writing heuristics

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Introduction

Argumentation is a practice in which people collectively propose, support, and challenge ideas. People construct and validate knowledge through the argumentation process (Sampson & Clark, 2011). Three types of arguments can be used in argumentation: analytical, rhetorical, and dialectical (Kolsto & Ratcliffe, 2008). In science classes, dialectical argumentation exists. Conversations and informal logic are used during dialectical argumentation and the premises of conversation dominate evidence (Duschl, 2008). As we think that participants focus on whole-class discussion by using evidence, we used dialectical argumentation in this study.

Students can engage in argumentation through writing and talking (Yaman & Hand, 2022). In this study, we specifically paid attention to students' talking, which informs us about their oral argumentation, for the following reasons. First, argumentation is not a cognitive skill or task, it is a collective practice. It is not an end product of the lesson or it is not used in some part of the lesson (Ryu & Sandoval, 2012). As students engage in this practice collectively throughout the lesson by talking, there is a need to understand their oral argumentation process if we want to uncover students' argumentation practice. Second, students can learn through dialog, and students' dialogues should be studied to understand the nature of learning (Chen et al., 2016). Our attempt to understand students' oral argumentation can be valuable in understanding their learning process through argumentation.

According to Grooms et al. (2018), when students engage in argumentation, they also experience three aspects of argumentation which are cognitive, epistemic, and social aspects, and students' performance during oral argumentation can be observed and assessed. In this study, we use Grooms et al.'s (2018) ideas about the assessment of students' oral argumentation and accept cognitive, epistemic, and social aspects as part of students' oral argumentation. Accordingly, the cognitive aspect is about how group members negotiate, whether group members propose reasoned arguments, and whether they are skeptical. Epistemic aspects focus on to what extent the group's argumentation is consistent with scientific culture and norms. For example, epistemic aspects deal with whether group members use evidence and theories or assess the evidence. Lastly, social aspects are associated with how group members interact and discuss with each other, and whether group members respect others' ideas (Grooms et al., 2018).

Argumentation practice provides many advantages for students. For example, it improves students' science achievements (Aydeniz et al., 2012; Çetin et al., 2014; Kingir et al., 2013; Macagno et al., 2015). Aydeniz et al. (2012) explain how argumentation supports scientific achievements as follows: students make reasoning, externalize their ideas, and see the deficiencies of their arguments, and they adjust their ideas by increasing content knowledge. Likewise, students evaluate all ideas that seemed less important before. In this way, they can understand the topic more comprehensively. Similarly, people assist each other during argumentation, low achievers learn from high achievers and high achievers reinforce their understanding (Aydeniz et al., 2012). Argumentation's benefits are not limited to improving science achievements. For example, previous research reported that argumentation improves students' democratic citizenship (Chan & Erduran, 2023; Erduran & Pabuccu, 2015; Joshi, 2016; Orlander Arvola & Lundegard, 2012; Sengul, 2019), attitude (Hong et al., 2013), science literacy (Çetin et al., 2014; Webb et al., 2008), formation of models (Kara & Kingir, 2022; Mendonça & Justi, 2014), scientific epistemology (Erduran & Pabuccu, 2015; Evagorou & Dillon, 2011, Martin & Hand, 2009), critical thinking skills (Macagno et al., 2015), representational competency (Kara & Kingir, 2022; Nichols et al., 2016), argumentation skills' transfer to other disciplines (Chan & Erduran, 2023), and science process skills (Arslan et al., 2023).

Although argumentation presents many benefits to students, teachers rarely prefer to use it (Larrain et al., 2014) and there are mainly two reasons for the non-existence of argumentation in classes. These reasons can be grouped as out-of-class factors and teacher-related factors. Out-of-class factors can be assessment and curricular obligations (Kind et al., 2011), exam-oriented education, over-emphasis on content knowledge, and crowded classes (Jin et al., 2016). Except for these uncontrolled factors, some characteristics of teachers might inhibit the use of argumentation in science classes. Accordingly, have limited or no information and its role (Lin et al., 2017; Martin-Gamez & Erduran, 2018). Likewise, teachers fail to use argumentation for teaching (Dawson & Carson, 2017; Lin et al., 2017; Martin-Gamez & Erduran, 2018). As a result, students can not become familiar with argumentation and

construct complex arguments including qualifiers and rebuttals when argumentation is not used in class. On the other hand, Evagorou and Dillon (2011) reported teachers can improve both their understanding of argumentation and argumentation teaching through instruction.

Science Writing Heuristics (SWH)

One of the argumentation approaches that supports teaching and learning is science writing heuristics (SWH). SWH is an example of an argument-based inquiry approach consistent with the immersive approach (Cavagnetto, 2010). The immersive approach uses the argument as an epistemic tool and provides learning. Students immerse in epistemic practice and learn science content (Hand et al., 2019).

SWH frames on question, claim, and evidence. SWH aims students learn content knowledge through constructing and criticizing arguments (Hand et al., 2019). According to Hand et al. (2019), SWH has three phases which are the development of the underpinning epistemic framework of science (e.g., development of scientific practice), an argument phase (e.g., learning content), and a summary writing phase (e.g., teaching content to an audience).

Previous research showed that some argument-based inquiry (ABI) approaches suggested higher student learning benefits than other approaches (Weiss et al., 2022). For example, Weiss et al. (2022) compared 16 immersive ABI approaches and reported that SWH is better than other ABI approaches in terms of student actions, teacher actions, and generative opportunities. Similarly, Hand et al. (2021) reported that SWH improves students' content knowledge by closing the achievement gap, critical thinking skills, scientific reasoning, process skills, and representational skills more than traditional teaching in their systematic review. Furthermore, Hand et al. (2019) claimed that SWH is a useful approach starting from the early childhood level. As a result, we decided to use SWH to improve participants' engagement in oral argumentation.

Primary School Pre-service Teacher Education

Previous research reported that human beings start engaging in argumentation practice from the early years of their life (Chen, 2019; Lawson, 2003; Perry & Dockett, 1998; Ryu & Sandoval, 2012). For example; Ryu and Sandoval (2012) asserted that argumentation improves students' cognitive development at the elementary level, and students can learn argumentation practice and fundamental epistemic practices in these grades. However, Chen et al. (2016) reported students do not have enough opportunities to experience argumentation at the early elementary level (Grades 1-3). One of the reasons that primary school students (K-4) can not experience argumentation might be the content of the primary school pre-service teacher education programs (i.e., PST programs). Accordingly, PST programs do not include argumentation in their science courses, and therefore PST can not understand argumentation. Similarly, PST can not teach argumentation in their future classes (Chen et al., 2020; Martin-Gamez & Erduran, 2018; Şahin-Kalyon & Özdem-Yılmaz, 2023; Yaman & Hand, 2022). For example; Martin-Gamez and Erduran (2018) reported primary school PST had limited argumentation understanding and argumentation strategies for teaching. Researchers also reported that PST ignored the rebuttals which are signs of high-quality arguments. Likewise, Yaman and Hand (2022) reported that teachers teach as how they are taught. If their PST programs do not offer argumentation, these teachers will not use argumentation in their future careers. Therefore, PST programs could include argument-based inquiry approaches so that PST can use argumentation in their future class (Yaman, 2018; Yaman & Hand, 2022). In line with this, Aguirre-Mendez et al. (2020) reported non-science majors' science laboratory courses are based on memorizing facts, but these courses should give up memorization and focus on improving critical thinking skills. Therefore, science laboratories for non-science majors should embrace the SWH approach to improve critical thinking skills. Considering the above-mentioned needs, the current study focuses on improving primary school PST's oral argumentation via the SWH approach. In this way, we assume that pre-service teachers experience and understand argumentation, and they will use argumentation through SWH in their future primary school classes. Similarly, their future students who experience SWH may learn more.

Theoretical Framework

Kind et al. (2011) reported that schools use empirical logical ideas and argumentation is not integrated at school laboratories. According to these empirical ideas, traditional science laboratories are used,

there is one scientific method, science is not complex, and experiment results in absolute correct knowledge (Kind et al., 2011). However, interaction among individuals provides learning according to social constructivism. Tools, symbols, and language used in this interaction construct the knowledge. Students use scientific knowledge and validate it in the laboratory through argumentation. They also learn how science is done in this process (Walker & Sampson, 2013). Similarly, students become members of the scientific community and understand concepts, language, representations, and practices of science culture during argumentation in the laboratory (Sampson & Clark, 2011). In line with this explanation, social constructivism was used as the theoretical framework in the current study consistent with previous research (e.g., Walker & Sampson, 2013).

Literature Review

Previous research examined students' oral argumentation at different grade levels including early elementary level (Chen et al., 2016), elementary level (Berland & Lee, 2012, Chen et al., 2016, Chen & Qiao, 2020; Chen & Techawitthayachinda, 2021; Kim & Hand, 2015), middle school level (Duschl, 2008), highschool level (Sampson & Clark, 2011; Grooms et al., 2018), and pre-service teacher education level (Emig et al., 2014; Mete, 2023; Walker & Sampson, 2013; Yaman & Hand, 2022; 2024). For example; Chen et al. (2016) examined the role of teacher's questions during SWH in the early elementary level (K-3) and reported that the teacher's role was dispenser at the beginning of the study and students' answers corresponded to a low cognitive level according to Bloom taxonomy. Researchers reported that students ' answers improved from low cognitive level to high when the teacher's role transformed into moderator, coach, and participant. Likewise, ownership of ideas and activities is passed from the teacher to the students over time which is evidence for the improvement of students' engagement in argumentation.

In another study conducted with elementary and middle school students, Chen and Techawitthayachinda (2021) examined the strategies that teachers use to manage uncertainty during argumentation. Researchers reported that teachers propose a problem or emphasize inconsistent data patterns to raise uncertainty when there is no argumentation in class. To maintain uncertainty; researchers reported that teacher selects similar and different ideas to be discussed, asks students to criticize each other, and criticizes students' ideas for further thinking. Researchers added that when it is time to reduce and resolve uncertainty; the teacher assists students' collective construction of the problem's solution and uses students' prior knowledge to construct a holistic knowledge system.

Next, Sampson and Clark (2011) examined high school students' oral argumentation and reported that students producing high-quality arguments (i.e., high performers) mentioned many more core ideas and discussed them further. Likewise, high performers used oppositional discourse more than low performers and they could elaborate their discussion. Similarly, while high performers used rigorous criteria (e.g., consistency between claim and evidence) to assess arguments, low performers used informal criteria (e.g., consistency between claim and prior knowledge). Next, high performers used data for both the construction and criticism of their arguments, but low performers used data only for the construction of their arguments.

Researchers also examined PST's oral argumentation. For example; Yaman and Hand (2022) investigated pre-service chemistry teachers' oral argumentation in SWH instruction lasting 28 weeks. Researchers reported PST's argument and representation quality improved over time. They found a positive and significant relationship between oral argumentation and oral representation and added that written and oral argumentation complement each other as both forms of argumentation are used to convince others.

Although there were many studies conducted with various grade levels (e.g., pre-service teacher education) examining participants' oral argumentation, we found only two studies examining all three aspects of oral argumentation (Grooms et al., 2018; Walker and Sampson, 2013). Walker and Sampson (2013) studied PST and used the assessment of scientific argumentation in class (ASAC) observation protocol to understand PST's oral argumentation. Researchers found that participants' oral argumentation quality changed from one topic to another. While PST focused on argument generation at the beginning, they focused on argument evaluation later. Researchers also reported that participants could not integrate different data and construct high-quality arguments. In another study, Grooms et al.

(2018) focused on high school students' oral argumentation and reported that students engaged in argumentation better over time when they knew the content. Researchers reported epistemic and social aspects improved in familiar tasks, but the cognitive aspects did not. On the other hand, only the epistemic aspect improved in unfamiliar tasks. Researchers also found students did not evaluate claims and use scientific criteria when the epistemic aspect of argumentation was low. Similarly, students did not discuss new ideas when the social aspect of argumentation was low. It was also reported reasoned arguments were produced when the cognitive aspect was high.

Significance of the Study

Previous research reported that although there are many argumentation studies held with pre-service teachers, there are a limited number of studies conducted with primary school PST (Şahin-Kalyon & Özdem-Yılmaz, 2023). By examining primary school PST's oral argumentation, this study adds a contribution to primary school PST's science education literature.

Aguirre-Mendez et al. (2020) added that most of the argumentation studies are held with science majors, but there are limited studies held with non-science majors. However, most of the public is graduates of non-science major departments. Science courses for non-science majors should be designed to improve their science literacy (Aguirre-Mendez et al., 2020). In our case, primary school PSTs were also non-science majors and we designed a laboratory course based on SWH for them. This study may address the needs of non-science majors by offering science laboratory courses for primary school PST and non-science majors can improve their science literacy.

Another significance of the study is the aspects of oral argumentation. Regarding the aspects of oral argumentation, Sampson and Clark (2008) reported oral argumentation includes epistemic, cognitive, and social aspects of argumentation, but very few studies focused on all these three aspects together. In line with this, our literature review showed only two studies focused on these three aspects (Grooms et al., 2018; Walker and Sampson, 2013), and none of these studies were conducted with primary school PST. As a unique significance, this study focuses on primary school PST's oral argumentation considering three aspects (e.g. epistemic) to capture primary school PST's oral argumentation holistically which was ignored in previous research.

To sum up, this study aims to assess primary school PST's oral argumentation by considering three aspects of oral argumentation (e.g. cognitive) using the SWH approach. Therefore; the study has one research question: "How is primary school pre-service teachers' oral argumentation performance regarding cognitive, epistemic, and social aspects of argumentation during SWH implementation?" In this study, we specifically focused on primary school pre-service teachers' engagement in the argumentation process by using the ASAC observation protocol that includes cognitive, epistemic, and social aspects. In this way, we observed PSTs' oral argumentation in six weeks and tried to uncover both the nature of their oral argumentation in a SWH implementation and observe what changes in this process.

Method

Research Design

This qualitative study is an example of a case study that is the study of an issue investigated through a case or cases within a bounded system (Creswell, 2007). In case study research, the case is determined based on an issue (McMillan & Schumacher, 2001). The issue here is our limited understanding of primary school PST's oral argumentation including its aspects (e.g., epistemic). This SWH study was carried out to improve our understanding of primary school PST's oral argumentation. In other words, this SWH research attempted to solve the issue. Therefore, SWH implementation was the case in the current study. As each case has its boundaries (Creswell, 2007), this SWH implementation had its boundaries. Accordingly, the SWH implementation lasted six weeks. Activities unique to this SWH implementation were creating research questions, designing investigations, carrying out investigations, proposing arguments, small group discussions, and whole-class discussions (Kingir et al., 2013). During whole class discussion, the groups are expected to present their investigation reports, their claims, and whole-class engage in the oral argumentation process. As class engages in oral argumentation in whole-class discussion, we think that it is valuable to focus on whole-class discussion to collect data. Therefore, we specifically focused on whole-class discussions.

These activities were carried out starting from the first week and followed each week until the end of the study. Lastly, two groups of PST participated in the study, and each group was accepted as a sub-unit.

Participants

Two groups of PST participated in the study. There were 34 participants in the study. Group 1 included 15 students, and Group 2 had 19 students. All students were female in group 1, 3 of whom were male in group 2. All students were sophomore primary school pre-service teachers. The students were not good at science because they did not get many science courses in their high school. Likewise, their undergraduate department program did not offer so many science courses to develop their scientific knowledge. 'Fundamental science in primary school course' was the only science-related course students took before the study. So, students were not experienced in science and were labeled as non-science majors. The study was conducted in a private university located in Ankara, Türkiye. The primary school department's laboratory was used for research. Students voluntarily formed their groups and each group included 3-4 students. Group members did not change throughout the study.

Procedure

The study was conducted in Laboratory Applications in Science lesson prepared for primary school PSTs. Two sections (group 1 and group 2) participated in the research and the same instructor implemented the SWH and other activities. The course instructor was familiar with SWH and argumentation and implemented SWH in previous years, so the instructor was not trained for SWH.

SWH implementation was not directly implemented because primary school PSTs were unfamiliar with science and SWH. Therefore, the groups were prepared for scientific inquiry and argumentation in the first six weeks. Accordingly, laboratory materials were introduced in the first week. Various methods of data collection and analysis were focused on in the second and third weeks. PSTs conducted activities for basic process skills (e.g., measurement) in the fourth week. PSTs carried out experiments to understand integrated process skills (e.g., controlling variables) in the fifth week. In the sixth week, argumentation and SWH were introduced to participants, and the course instructor explained what was expected from them in this process. SWH implementation started in the seventh week and lasted six weeks. Each week's activity lasted four hours for each group. In total, each group experienced SWH 24 hours (6 weeks x 4 hours). All activities were created by the researchers.

In line with the SWH approach, each group found a research question about that week's big idea. Then, they prepared their research design and discussed it with the rest of the group to understand whether their research question was testable or not. Then, groups tested their investigation and reached their claims by using data as evidence for their claims. Next, groups presented their claim to the rest of the class in whole-class discussions and defended their arguments while others' criticized their claims. After all groups' arguments were discussed and PSTs negotiated on arguments, PSTs compared their ideas with secondhand data which are the course instructor, reliable internet sources, and science books. Negotiations with second-hand data let them reach a final argument that was the answer to their research question.

PSTs engaged in SWH implementation in six different activities. When we prepared the activities, we benefitted from our previous SWH experiences. Accordingly, we carried out SWH implementations with other participants except primary school PSTs in the past and we saw that these activities were ideal for the successful implementation of SWH. Therefore, the activities given in Table 1 were selected for the study. In the first week of SWH, the activity was about the electrical conductivity of liquids. In the second week, PSTs tried to solve the mystery of a magic box that was prepared based on the principles of liquid and gas pressure, gravity, and cohesive forces. The third week's activity was about heat transfer. In the fourth week, PSTs investigated the factors affecting the rate of solubility. Next week, PSTs tried to construct the highest and most durable towers using play doughs and toothpicks. In the last week, the groups visited a lake as a field trip and focused on the factors affecting plant populations in a specific area. The procedure is summarized in Table 1.

Table 1.
Summary of the Procedure

Weeks	Course Content
Week 1	Course Introduction and Laboratory Materials
Week 2	Different methods of data collection and analysis
Week 3	Different methods of data collection and analysis
Week 4	Basic Process Skills
Week 5	Integrated Process Skills
Week 6	Introduction of Argumentation and SWH
Week 7	Electrical Conductivity of Liquids (First SWH Activity)
Week 8	Magic Box (Second SWH Activity)
Week 9	Heat Transfer (Third SWH Activity)
Week 10	The Factors Affecting the Rate of Solubility (Fourth SWH Activity)
Week 11	Construction of Tower (Fifth SWH Activity)
Week 12	The Factors Affecting Plant Populations in a Specific Area (Sixth SWH Activity)

Data Collection

Data Collection Tool: ASAC Protocole

Sampson et al. (2012) reported examining whole argumentation in class and analyzing are is very difficult processes. For example, if we focus on the number of evidence, we ignore reasoning, student communication, criteria to evaluate arguments, and the use of materials. Sampson et al., (2012) claimed that there was a need for an instrument to assess all aspects of argumentation, and they prepared the Assessment of Scientific Argumentation in the Classroom (ASAC) observation protocol. Sampson et al. (2012) claimed researchers can understand the quality of argumentation in class, and the change in the quality of argumentation, and compare different approaches' effects on argumentation quality using ASAC. ASAC observation protocol is in English, and as observers, we filled the ASAC protocol throughout the study. How we used the ASAC protocol is explained in the data collection process.

In line with this, we used ASAC to understand primary school PST's oral argumentation in SWH implementation lasting six weeks.

ASAC is context and topic-free and was prepared to assess observable things in an argumentation class (Sampson et al., 2012). The instrument is 4 point Likert type and the items are scored 0 when they are never observed, and the rating score increases up to 3 depending on how often the item's expectation is met. ASAC has 3 constructs and includes 19 items. The maximum score for the whole scale is 57 (3 x 19). The first is the cognitive aspect including 7 items (e.g., Do participants focus on the solution of the problem?). The second is the epistemic aspect which also includes 7 items (e.g., Do participants use evidence?). The third is the social aspect that includes 5 items (e..g, Do participants respect each other?). The researchers found 97 % for the inter-rater agreement and correlated ASAC results with Toulmin Argumentation Pattern (TAP) results to support criterion validity, and found a correlation of 0.96. Furthermore, researchers got expert opinions from field experts twice to support the translational validity of the instrument (Sampson et al., 2012).

Data Collection Process

We focused on the whole class discussions to observe PSTs' oral argumentation. The authors sat at the back of the classroom and took notes on the ASAC protocol during whole class discussions for each group throughout the study. While we were taking notes, we did not interact with each other, and we scored ASAC items separately based on the field notes. After scoring each item, we wrote our justification for each scoring. After each lesson, we compared our scoring for each item. Then, we reached a consensus for disputed scorings. Inter-rater reliability was 87 % for the cognitive aspect, 91% for the epistemic aspect, and 90 % for the social aspect. In total, inter-rater reliability was found 88 % for ASAC instrument scores.

Data Analysis

This study attempts to understand primary school PSTs' oral argumentation and ASAC observation protocol was used throughout the study to reveal participants' oral argumentation. After ASAC protocols were filled, collected data was analyzed by two consecutive analyses which are content analysis and constant comparative analysis.

Content Analysis

Researchers took field notes during whole class discussions for each group and each week. Then, the content of these observations was used for scoring 19 ASAC items separately. For example, if researchers' field notes support expected behavior for that item, the content of the field notes was used as evidence for high scoring in that item. In this way, we converted the qualitative data (i.e., the content of the field notes) into quantitative data. Then, we summed up item scores to get the total ASAC score, total cognitive aspect score, total epistemic aspect score, and total social aspect score for each group and each week. In this way, we could identify the oral argumentation performance of each group for each week regarding total oral argumentation and individual aspects (e.g., cognitive aspect) and we got line graphs showing groups' oral argumentation performance throughout the study.

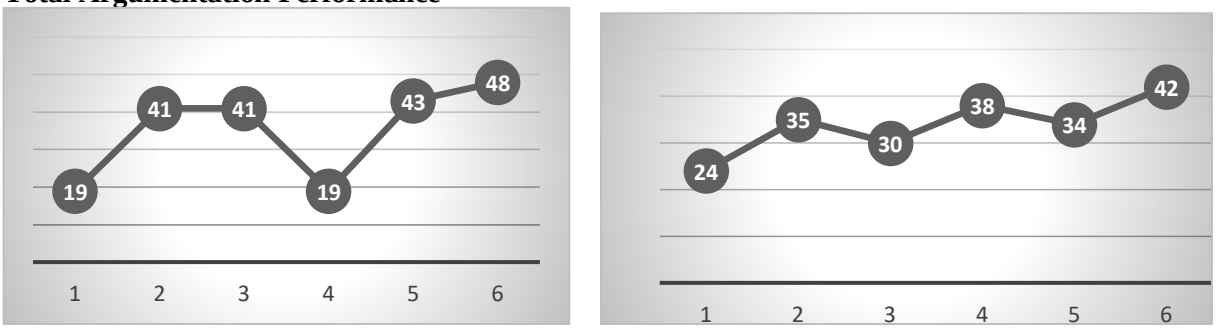
Constant Comparative Analysis

After we got graphs representing their oral argumentation performance and individual aspects for the two groups, we constantly compared these two groups' graphs in terms of total oral argumentation performance and different aspects of oral argumentation (e.g., cognitive aspect). Similar patterns in the two groups' graphs obtained from constant comparison analysis yielded assertions about PSTs' oral argumentation. These assertions are answers to the research question.

Findings

This study attempted to answer the research question "How is primary school pre-service teachers' oral argumentation performance regarding cognitive, epistemic, and social aspects of argumentation during SWH implementation?" To answer this question, the ASAC observation protocol was used and two groups of PSTs participated in the study. Examination of groups' ASAC scores assisted us in creating line graphs for the total argumentation performance, cognitive aspects, epistemic aspects, and social aspects.

Total Argumentation Performance



Group 1 Group 2

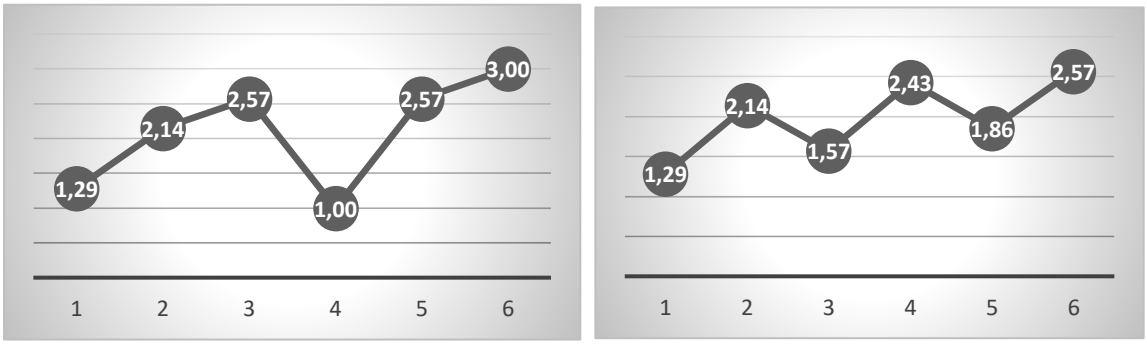
Figure 1. Overall Argumentation Performance

The two groups' total argumentation performances are presented in Figure 1. The maximum score the groups can get is 57 for the ASAC observation protocol. Group 1's observation score ranged between 19 and 48, and the mean score was 35.17. Accordingly, group 1 performed best in the 6th week (the factors affecting plant population) as they got 48 points over 57. On the other hand, group 1 performance was highly low in the 1st (electrical conductivity in liquids) and 4th (factors affecting the rate of solubility) weeks, and group 1 got 19 points in these weeks.

Group 2's total oral argumentation observation score ranged between 24 and 42, their mean was 33.83. Similar to group 1, group 2 performed best in the last week (the factors affecting plant population)

taking 42 points over 57. Group 2 performance was low in the first week (electrical conductivity in liquids) and their score was 24.

Cognitive Aspects



Group 1 Group 2

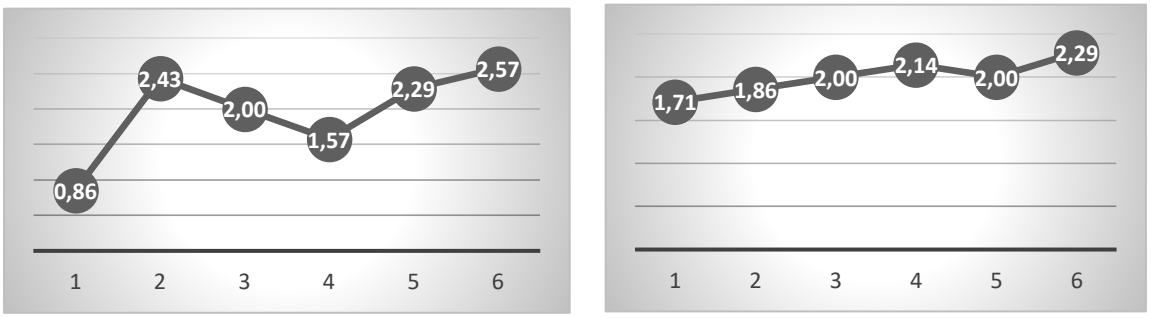
Figure 2. Groups' Cognitive Aspects' Results

After total oral argumentation scores, we specifically focused on PSTs' aspects of oral argumentation in SWH implementation. In the ASAC, the number of items for different aspects is different. For example, cognitive and epistemic aspects have 7 items, but social aspects have 5 items. Therefore, we focused on the mean scores to compare PSTs' performance in different aspects of oral argumentation. As the maximum score for each item was 3, the maximum mean score was 3 too for each aspect of oral argumentation.

The cognitive aspect is about how group members negotiate, whether group members propose reasoned arguments, and whether they are skeptical (Grooms et al., 2018). Weekly mean scores for oral argumentation's cognitive aspects are presented in Figure 2 for each group. Group 1's cognitive aspects' mean score was 2.10 over 3, and the scores ranged from 1.00 to 3.00. Group 1's cognitive aspect reached the highest level in the last week (the factors affecting plant population) and it was 3.00; on the other hand, the group's cognitive aspects' result was the least (M=1.00) in the fourth week (factors affecting the rate of solubility).

Similar to group 1, group 2's cognitive aspects' mean score was 1.98 over 3, and the range was between 1.29 and 2.57. In the last week, group 2's cognitive aspects score reached 2.57 which was the highest for this group. The lowest cognitive aspects score group 2 got was 1.29 and this score was obtained in the first week (electrical conductivity in liquids).

Epistemic Aspects



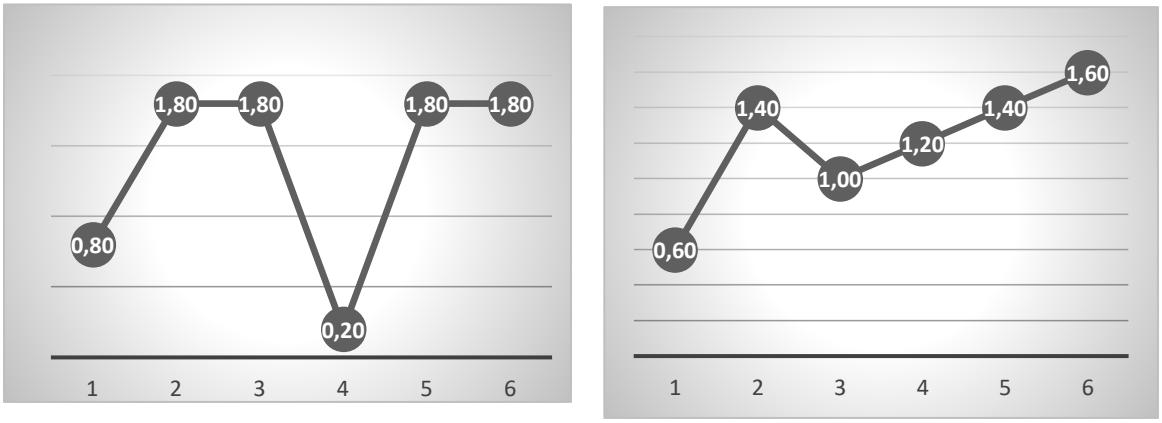
Group 1 Group 2

Figure 3. Groups' Epistemic Aspects' Results

Epistemic aspects focus on to what extent the group's argumentation is consistent with scientific culture and norms (Grooms et al., 2018). Figure 3 shows that group 1 improved their epistemic aspects' score from 0.86 to 2.57 over time. The mean score for group 1's epistemic aspects was 1.95 over 3. While the epistemic aspects' score was the lowest in the first week (M=0.86), it was highest in the last week (M=2.57).

Similar to Group 1, group 2's epistemic aspects score improved, but there were fewer fluctuations in Group 2 (see Figure 3). Group 2's epistemic aspects score increased from 1.71 to 2.29. The mean score was 2.00 over 3. The group performed best in the last week (M=2.29), but their epistemic aspects' performance was relatively low in the first week (M=1.71).

Social Aspects



Group 1 Group 2

Figure 4. Groups' Social Aspects' Results

Social aspects are associated with how group members interact and discuss with each other, and whether group members respect others' ideas (Grooms et al., 2018). The performance of the social aspects of the groups was lower compared with the other two aspects (e.g., cognitive) throughout the study, but the social aspects performance still increased for both groups (see Figure 4). Accordingly, group 1's social aspects' mean score was 1.37 and it ranged from 0.20 to 1.80. In the fourth week (factors affecting the rate of solubility), it can be claimed that PSTs nearly did not engage in argumentation (M=0.20). On the other hand, the group's social aspect performance was relatively higher in other weeks (M=1.80) except week 1.

Similar to group 1, group 2's social aspect's mean score was low (M=1.20 over 3). The scores ranged between 0.60 and 1.60. The group's social aspects' performance was the lowest in the first week

(electrical conductivity in liquids) (M=0.60), but it gradually increased and reached 1.60 in the last week (the factors affecting plant population).

Depending on these findings, we claimed two assertions about primary school PSTs' oral argumentation performance in this SWH implementation lasting 6 weeks.

Assertion 1: Participants' oral argumentation improved over time.
The main argument for the findings is there is an improvement in participants' oral argumentation from the first week to the last week in general (see figures). Accordingly, group 1's total oral argumentation score increased from 19 to 48, and group 2's total oral argumentation increased from 24 to 42 (figure 1). A similar trend was also observed in aspects of oral argumentation. For example; cognitive aspects' weekly mean score increased from 1.29 to 3.00 for group 1 and from 1.29 to 2.57 for group 2 (figure 2). Likewise, epistemic aspects' weekly mean score increased from 0.86 to 2.57 for group 1 and from 1.71 to 2.29 for group 2 (figure 3). Similarly, the weekly mean score for social aspects increased from 0.80 to 1.80 for group 1 and 0.60 to 1.60 for group 2. In conclusion, it can be claimed that both participants' total oral argumentation and its aspects' scores improved throughout the study.

Assertion 2: ASAC aspects' observation scores diverged and the scores for cognitive and epistemic aspects were higher than those for social aspects.
When we examined Figures 2, 3, and 4; we noticed that participants' performance was not the same in different aspects of oral argumentation although all of them increased. Accordingly, the cognitive and epistemic aspects' scores were higher than the social aspects' scores (see Figure 2-3-4). For example, the groups' last week performance was at a high level (more than 2.00 over 3.00) for cognitive and epistemic aspects, but both groups' social aspects performance was medium-high (1.80 for group 1 and 1.60 for group 2) in the same week.

Similarly, both groups developed their cognitive and epistemic aspects' scores more than their social aspects' scores in general. Accordingly, group 1 improved their cognitive aspects' score by 1.71 points, and group 2 improved by 1.28 points (figure 2). Likewise, group 1 improved their epistemic aspects' score by 1.71 points (figure 3). On the other hand, groups improved their social aspects' scores by only 1.00 points (figure 4) although the social aspects' starting score was lower compared with their cognitive and epistemic aspects' initial scores.

Discussion, Conclusion, and Suggestions

Discussion of the study is shaped based on two assertions presented in the findings section. Hence, we first discuss the development of primary school PSTs' oral argumentation performance in this SWH study. Then, we discuss the divergence of oral argumentation aspects and attempt to explain why PSTs' performance of cognitive and epistemic aspects was higher than their social aspects' performance.

Improvement of Oral Argumentation

Primary school PSTs improved their oral argumentation over time depending on ASAC observation results. Similarly, Chen et al. (2016) reported that 5th-grade students improved their oral argumentation through SWH. Accordingly, students focused on the construction of arguments by ignoring others' ideas and they did not criticize others impeding oral argumentation in the initial weeks. However, students started listening to others' ideas and they challenged, rejected, and supported them in later weeks, so their oral argumentation improved (Chen et al., 2016). Similarly, in our research, participants avoided attacking others' ideas about the electrical conductivity of the liquids (week 1) although their results were different from other groups. They just talked about their claims and did not share their ideas about others' claims. On the other hand, when it comes to last week that the factors affecting the plant population, all groups criticized each other, they actively engaged in whole-class discussions, and students reported they had headaches at the end of the lesson as they thought too much during the lesson. A similar trend was also observed in Walker and Sampson's (2013) study. Walker and Sampson (2013) reported that PSTs focused on argument generation in the initial weeks, but they focused on both argument generation and argument evaluation in the following weeks.

Walker and Sampson (2013) explained students' initial low argumentation performance considering class culture. Accordingly, PSTs accepted the instructor as an epistemic authority and asked the instructor who was right when they contradicted others. In other words, PSTs focused on reaching correct knowledge and ignored the argumentation process in these initial weeks (Walker & Sampson, 2013). Similarly, Lin and Mintzes (2010) reported it is very difficult to improve students' argumentation skills in authoritarian cultures. The same situation can be also true for the current study because PSTs tried to verify their knowledge in the initial weeks by asking questions to the course instructor instead of engaging in oral argumentation. Walker and Sampson (2013) added that PSTs started to compare faults in the data collection process after two weeks, and they started changing their ideas and their reasoning started to increase. Similarly, oral argumentation scores started increasing after the second week in this study.

We think that the science writing heuristics (SWH) approach as a scaffolding facilitated PSTs' oral argumentation process. For example, PSTs used writing and talking simultaneously as an aspect of SWH. Chen et al. (2016) explain the benefits of the simultaneous use of writing and talking as such: when participants integrate writing and talking, they construct the knowledge using texts. Participants also support their ideas using representations in their writing. Similarly, the integration of talk and representations forms deep thinking. Faulty ideas and missing parts of the models in the written texts are also criticized and original ideas change faster when writing and talking are simultaneously used in SWH (Chen et al., 2016).

Likewise, prompt questions found in the SWH student template could facilitate PSTs' oral argumentation. For example, they could write their evidence, claim, data, and others' ideas in the SWH student template. By using their SWH student reports, they might easily engage in oral argumentation. However, researchers should be careful with the scaffolding issue. The scaffolding issue happens if one of the scaffolding aspects (problematizing or structuring content) is over-emphasized, the scaffold does not work, and participants can not benefit from scaffolding for better argumentation (Emig et al., 2014). This issue can be also true for this study. For example, participants would like to explain their arguments in their way, but the prompt questions we provide might inhibit the exhibition of some of their valuable ideas which can not be captured by prompt questions.

Similarly, Enderle et al. (2022) reported prompt questions to cause formal structures while they assist students' learning. Such formal structures may decrease student discourse and move the lesson from student-centered to teacher-centered because support tools may decrease student autonomy, and if these tools are not used correctly, pseudo-argumentation can be done in class (Enderle et al., 2022). Inappropriate use of scaffolding was also seen in group 1 in the fourth week and this erroneous scaffolding resulted in the low performance of PST's oral argumentation in that week. The fourth week's topic was 'The Factors Affecting the Rate of Solubility' and participants were not knowledgeable in this topic in group 1. The course instructor provided an example of a research question about the topic and assisted PSTs with how they could conduct their experiment. Accordingly, the instructor said that factors like mixing the solution, changing heat, or the size of particles might affect the rate of solubility and said that the group's research question could be 'What is the effect of the size of particles in the rate of solubility?'. Furthermore, the instructor assisted participants in how they could design their experiment considering this research question. In other words, the course instructor improved structuring and decreased problematizing the content. As a result, group 1 did not engage in oral argumentation much in week 4.

Furthermore, this study showed that PSTs' oral argumentation does not improve linearly, and there are some fluctuations as seen in Figure 1. For example; the performance of the second group decreased from week 4 to week 5 or the performance of the first group was the same in the second and third weeks. We think that the context and argumentation relationship explains why oral argumentation does not develop in some weeks. According to Cavagnetto and Kurtz (2016), students are not deficient in making argumentative reasoning, but they do not know when they activate their reasoning and the context determines when students activate their reasoning. If contextual cue is provided, students' performance improves. In this study, some activities can be more demanding than others for students, and PSTs might not activate their reasoning in those weeks, so their oral argumentation could be limited. Similarly, Walker and Sampson (2013) reported that PSTs could not improve their oral

argumentation in the last week of the study because PSTs did not understand the task and materials. Researchers added that if PSTs use materials they know very well, their argumentation performance can increase.

Cognitive, Epistemic, and Social Aspects of Argumentation

In this study, we observed the development of students' oral argumentation in a six-week-long SWH study. When we specifically analyzed three aspects of oral argumentation, we observed that the cognitive and epistemic aspects' scores were higher than the social aspects at the initial observations. Throughout the study, all three aspects' scores improved, but the final scores of social aspects were still lower than the other two oral argumentation aspects.

Similar to this study, Grooms et al. (2018) carried out an argument-based inquiry study using ADI (Argument-driven Inquiry) with high school students. Researchers reported that participants' oral argumentation's cognitive aspect did not improve in their study. They also added that participants engaged in scientific argumentation as they did in real-life argumentation and participants did not change their thought system (Grooms et al., 2018). On the other hand, participants of this study improved their oral argumentation's cognitive aspects. This can be related to two factors. First, our participants were PSTs and older than Grooms et al.'s (2018) participants. Because of their age, our participants might adapt using reasoned claims and examining alternative ideas, so their oral argumentation's cognitive aspects increased. Second, the treatment differences might cause a difference between the two studies considering the cognitive aspect. While we used SWH, the previous research used ADI. The SWH approach might be better than ADI for developing cognitive aspects of oral argumentation. In line with this, when comparing different ABI approaches in terms of student actions, teacher actions, and generative opportunities, Weiss et al. (2022) reported the superiority of SWH over ADI. Likewise, Hand et al. (2021) reported that SWH improves critical thinking skills (CTS) and scientific reasoning more than alternative treatments. The participants of this study might have improved their CTS and scientific reasoning due to SWH, and they might exhibit their developing reasoning and skills as evidence for improvement of cognitive aspect.

Next, oral argumentation's epistemic aspects improved in this study consistent with Grooms et al. (2018). Grooms et al. (2018) reported epistemic aspects improve regardless of participants' familiarity with the topic when they get argument-based inquiry (ABI) treatment. This means that when participants engage in ABI, they learn the rules of scientific argumentation (e.g., what counts as valid evidence in scientific argumentation) (Grooms et al., 2018). Grooms et al. (2018) also added participants can transfer their epistemic aspect level from a familiar context to an unfamiliar one. Similarly, participants of this study seem to transfer their developing epistemic aspects level to new contexts (physics, chemistry, biology) during the study. Development of the epistemic aspect through SWH is also consistent with Ryu and Sandoval's (2012) ideas. Accordingly, Ryu and Sandoval (2012) reported that participants construct the scientific criteria when they learn science through practice and there are no criteria imposed on participants. In this way, participants learn the scientific norms and criteria. In line with this, we think that the SWH approach provides participants opportunities for science practices which are designing experiments, data collection, small group discussions, whole class discussions, and negotiations with experts. When participants engaged in these practices, their oral argumentation's epistemic practice might have improved. Similarly, Hand et al. (2004) found that students learn argument structures better and connect research questions, claims, and evidence successfully when they get SWH implementation.

Although participants' cognitive and epistemic aspects of oral argumentation were relatively high throughout the study, the social aspects were lower at the beginning and end than the other two aspects. Therefore, we think that social aspects are the problematic part of this study. Groom et al.'s (2018) findings were more complicated than current research. The researchers reported participants improved social aspects in the familiar context, but they did not engage in whole class discussion and they accepted the claims without criticism when they were unfamiliar with the topic (Grooms et al., 2018). As participants of this study were primary school PSTs, they had limited content knowledge (Şahin-Kalyon & Özdem-Yılmaz, 2023) which might make them unfamiliar with most science topics and this might explain why their oral argumentation's social aspects scores were less. Another reason for lower social aspect scores can be related to the duration of the treatment. This study lasted six

weeks and social aspects improved from low level to the medium-high for both groups in this period. If the study had lasted more, social aspects scores might have improved further and reached the other two aspects' levels. If this explanation is correct, we may infer that improvement of social aspects requires more time than cognitive and epistemic aspects.

Implications

The study has significance for primary school pre-service teacher education programs, course instructors from primary education departments, and researchers. To begin with, the content of this laboratory course is new for primary school PST programs. Accordingly, we designed a course that prepares primary school PSTs for scientific inquiry in the first six weeks and oral argumentation using SWH in the last six weeks. Primary school PST programs can use our design in their science laboratory courses to increase PST's argumentation understanding and teaching. We think that laboratory courses for primary school PST should not start with SWH. Instead, they should start with warm-up weeks for SWH that make students familiar with the scientific inquiry because these students have no specialization in science.

The study has two implications for course instructors teaching in primary school PST programs. First, we advise course instructors to use SWH in primary school PST laboratory courses because SWH implementation supports' PST's oral argumentation and its aspects. Second, course instructors should be careful with scaffolding because over-structuring the scaffold decreases PST's oral argumentation performance. When course instructors assist PSTs, they should consider whether the uncertainty of the issue still invokes PSTs to engage in argumentation.

The study also has implications for researchers. First, previous research used ASAC mainly in ADI research, and ASAC was not used in SWH studies. This study showed that ASAC can also be used in SWH research to assess oral argumentation. Therefore, we advise future SWH studies to use ASAC to observe and assess participants' oral argumentation. Furthermore, the use of ASAC in SWH and ADI research can be a bridge for these two different ABI approaches. Second, some researchers might expect linear development of oral argumentation in SWH implementation, but this expectation was not met in this study. We think that context and task difficulty may impede the development of oral argumentation. For example; PSTs' oral argumentation performance decreased in some weeks in our study. Therefore, researchers should be careful when preparing the tasks. If tasks are very difficult, PSTs may not engage in oral argumentation although they become familiar with argumentation. Third, cognitive aspects of oral argumentation developed in this study and we attributed this development to participants' age and SWH implementation, but we do not know the exact factor. Researchers may conduct experimental research to understand the reason for cognitive aspects' development. Lastly, we think that due to PSTs' limited content knowledge and the short duration of the treatment, participants' oral argumentation's social aspects were limited. Future research can support primary school PSTs' fundamental science content knowledge before SWH implementation and SWH studies can last longer than this study. In this way, primary school PSTs might have better content knowledge and take advantage of longer SWH implementation. As a result, they can improve their oral argumentation more than this study's participants.

Limitations

The study has some limitations. First of all, the study focused on whole class discussions; therefore, this study does not inform about individual participants' oral argumentation performance. Future research may address individuals' oral argumentation process. Second, we did not use video recording in this study, so we might have missed some points or events during observations. However, two researchers observed the groups to catch all events and we discussed every detail after teaching to better understand the groups' performance. Third, the study can last longer and PST can benefit from SWH more, but still, we think that participants benefitted from SWH and they improved their oral argumentation.

Acknowledgment

Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

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References

Aguirre-Mendez, C., Chen, Y. C., Terada, T., & Techawitthayachinda, R. (2020). Predicting components of argumentative writing and achievement gains in a general chemistry course for nonmajor college students. *Journal of chemical education*, *97*(8), 2045-2056.

Arslan, H. O., Genc, M., & Durak, B. (2023). Exploring the effect of argument-driven inquiry on pre-service science teachers' achievement, science process, and argumentation skills and their views on the ADI model. *Teaching and Teacher Education*, *121*, 103905.

Aydeniz, M., Pabuccu, A., Cetin, P. S., & Kaya, E. (2012). Argumentation and students' conceptual understanding of properties and behaviors of gases. *International Journal of Science and Mathematics Education*, *10*(6), 1303-1324.

Berland, L. K., & Lee, V. R. (2012). In pursuit of consensus: Disagreement and legitimization during small-group argumentation. *International Journal of Science Education*, *34*(12), 1857-1882.

Cavagnetto, A. R. (2010). Argument to foster scientific literacy: A review of argument interventions in K–12 science contexts. *Review of Educational Research*, *80*(3), 336-371.

Cavagnetto, A. R., & Kurtz, K. J. (2016). Promoting students' attention to argumentative reasoning patterns. *Science Education, 100*(4), 625-644.

Chan, J., & Erduran, S. (2023). The impact of collaboration between science and religious education teachers on their understanding and views of argumentation. *Research in Science Education*, *53*(1), 121-137.

Chen, Y. C. (2019). Using the science talk–writing heuristic to build a new era of scientific literacy. *The Reading Teacher*, *73*(1), 51-64.

Chen, Y. C., Aguirre-Mendez, C., & Terada, T. (2020). Argumentative writing as a tool to develop conceptual and epistemic knowledge in a college chemistry course designed for non-science majors. *International Journal of Science Education*, *42*(17), 2842-2875.

Chen, Y. C., Hand, B., & Park, S. (2016). Examining elementary students' development of oral and written argumentation practices through argument-based inquiry. *Science & Education, 25*(3-4), 277-320.

Chen, Y. C., & Qiao, X. (2020). Using students' epistemic uncertainty as a pedagogical resource to develop knowledge in argumentation. *International Journal of Science Education*, *42*(13), 2145-2180.

Chen, Y. C., & Techawitthayachinda, R. (2021). Developing deep learning in science classrooms: Tactics to manage epistemic uncertainty during whole-class discussion. *Journal of Research in Science Teaching*, *58*(8), 1083-1116.

Chen, H. T., Wang, H. H., Lu, Y. Y., Lin, H. S., & Hong, Z. R. (2016). Using a modified argument-driven inquiry to promote elementary school students' engagement in learning science and argumentation. *International Journal of Science Education*, 38(2), 170-191.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed.). Sage.

Çetin, P. S., Dogan, N., & Kutluca, A. Y. (2014). The quality of pre-service science teachers' argumentation: Influence of content knowledge. *Journal of Science Teacher Education*, *25*(3), 309-331.

Dawson, V., & Carson, K. (2017). Using climate change scenarios to assess high school students' argumentation skills. *Research in Science & Technological Education*, *35*(1), 1-16.

Duschl, R. A. (2008). Quality argumentation and epistemic criteria. In S. Erduran, & M.P. Jimenez-Aleixandre (Eds.), *Argumentation in science education: Perspectives from classroom based research* (pp. 159-175). Dordrecht, the Netherlands: Springer.

Emig, B. R., McDonald, S., Zembal-Saul, C., & Strauss, S. G. (2014). Inviting argument by analogy: Analogical-mapping-based comparison activities as a scaffold for small-group argumentation. *Science Education*, *98*(2), 243-268.

Enderle, P., Grooms, J., Sampson, V., Sengul, O., & Koulagna, Y. (2022). How the co-design, use, and refinement of an instructional model emphasizing argumentation relates to changes in teachers' beliefs and practices. *International Journal of Science Education*, *44*(14), 1-27.

Erduran, S., & Pabuccu, A. (2015). Promoting argumentation in the context of chemistry stories. In *Relevant Chemistry Education* (pp. 143-161). SensePublishers, Rotterdam.

Evagorou, M., & Dillon, J. (2011). Argumentation in the teaching of science. In *The professional knowledge base of science teaching* (pp. 189-203). Springer Netherlands.

Grooms, J., Sampson, V., & Enderle, P. (2018). How concept familiarity and experience with scientific argumentation are related to the way groups participate in an episode of argumentation. *Journal of Research in Science Teaching*, *55*(9), 1264-1286.

Hand, B., Cavagnetto, A., & Norton-Meier, L. (2019). Immersive approaches to science argumentation and literacy: What does it mean to "Live" the languages of science?. *Theorizing the future of science education research*, 99-113.

Hand, B., Chen, Y. C., & Suh, J. K. (2021). Does a knowledge generation approach to learning benefit students? A systematic review of research on the science writing heuristic approach. *Educational Psychology Review*, *33*(2), 535-577.

Hand, B., Wallace, C. W., & Yang E. (2004). Using a science writing heuristic to enhance learning outcomes from laboratory activities in seventh-grade science: quantitative and qualitative aspects. *International Journal of Science Education*, 26(2), 131-149.

Hong, Z. R., Lin, H. S., Wang, H. H., Chen, H. T., & Yang, K. K. (2013). Promoting and scaffolding elementary school students' attitudes toward science and argumentation through a science and society intervention. *International Journal of Science Education*, *35*(10), 1625-1648.

Jin, H., Hokayem, H., Wang, S., & Wei, X. (2016). A US-China interview study: Biology students' argumentation and explanation about energy consumption issues. *International Journal of Science and Mathematics Education*, *14*(6), 1037-1057.

Joshi, P. (2016). Argumentation in democratic education: The crucial role of values. *Theory Into Practice*, *55*(4), 279-286.

Kara, S., & Kingir, S. (2022). Implementation of the model-based science writing heuristic approach in elementary school science. *International Journal of Science and Mathematics Education*, *20*(4), 683-703.

Kim, S., & Hand, B. (2015). An analysis of argumentation discourse patterns in elementary teachers' science classroom discussions. *Journal of Science Teacher Education*, *26*(3), 221-236.

Kind, P. M., Kind, V., Hofstein, A., & Wilson, J. (2011). Peer argumentation in the school science laboratory—exploring effects of task features. *International Journal of Science Education*, *33*(18), 2527-2558.

Kingir, S., Geban, O., & Gunel, M. (2013). Using the science writing heuristic approach to enhance student understanding in chemical change and mixture. *Research in Science Education*, *43*(4), 1645-1663.

Kolsto, S. D., & Ratcliffe, M. (2007). Social aspects of argumentation. In S. Erduran, & M.P. Jimenez-Aleixandre (Eds.), *Argumentation in science education: Perspectives from classroom based research* (pp. 117-136). Dordrecht, the Netherlands: Springer.

Larrain, A., Freire, P., & Howe, C. (2014) Science Teaching and Argumentation: One-sided versus dialectical argumentation in Chilean middleschool science lessons. *International Journal of Science Education*, *36*(6), 1017-1036.

Lawson, A. (2003). The nature and development of hypothetico-predictive argumentation with implications for science teaching. *International Journal of Science Education*, *25*(11), 1387-1408.

Lin, Y. R., Hung, C. Y., & Hung, J. F. (2017) Exploring teachers' meta-strategic knowledge of science argumentation teaching with the repertory grid technique, *International Journal of Science Education*, *39*(2), 105-134.

Lin, S. S., & Mintzes, J. J. (2010). Learning argumentation skills through instruction in socioscientific issues: The effect of ability level. *International Journal of Science and Mathematics Education*, *8*(6), 993-1017.

Macagno, F., Mayweg-Paus, E., & Kuhn, D. (2015). Argumentation theory in education studies: Coding and improving students' argumentative strategies. *Topoi*, *34*(2), 523-537.

Martin, A. M., & Hand, B. (2009). Factors affecting the implementation of argument in the elementary science classroom. A longitudinal case study. *Research in Science Education*, *39*(1), 17-38.

Martin-Gamez, C., & Erduran, S. (2018). Understanding argumentation about socio-scientific issues on energy: a quantitative study with primary pre-service teachers in Spain. *Research in Science & Technological Education*, *36*(4), 463-483.

McMillan, J. H., & Schumacher, S. (2001). *Research in Education*. Longman.

Mendonça, P. C. C., & Justi, R. (2014). An instrument for analyzing arguments produced in modeling-based chemistry lessons. *Journal of Research in Science Teaching*, *51*(2), 192-218.

Mete, P. (2023). Argumentation Skills of Pre-Service Elementary Teachers on Atmospheric Pressure. *Journal of Science Learning*, *6*(1), 100-116.

Nichols, K., Gillies, R., & Hedberg, J. (2016). Argumentation-based collaborative inquiry in science through representational work: Impact on primary students' representational fluency. *Research in Science Education, 46*(3), 343-364.

Orlander Arvola, A., & Lundegård, I. (2012). 'It's her body'. When students' argumentation shows displacement of content in a science classroom. *Research in Science Education, 42*, 1121-1145.

Perry, B., & Dockett, S. (1998). Play, argumentation, and social constructivism. *Early Child Development and Care*, *140(*1), 5-15.

Ryu, S., & Sandoval, W. A. (2012). Improvements to elementary children's epistemic understanding from sustained argumentation. *Science Education*, *96*(3), 488-526.

Sampson, V., & Clark, D. B. (2008). Assessment of the ways students generate arguments in science education: Current perspectives and recommendations for future directions. *Science Education*, *92*(3), 447-472.

Sampson, V., & Clark, D. B. (2011). A comparison of the collaborative scientific argumentation practices of two high and two low-performing groups. *Research in Science Education*, 41(1), 63-97.

Sampson, V., Enderle, P. J., & Walker, J. P. (2012). The development and validation of the assessment of scientific argumentation in the classroom (ASAC) observation protocol: A tool for evaluating how students participate in scientific argumentation. In M. S. Khine (Ed). *Perspectives on scientific argumentation: Theory, practice, and research* (pp. 235-272). Springer.

Sengul, O. (2019). Linking scientific literacy, scientific argumentation, and democratic citizenship. *Universal Journal of Educational Research*, *7*(4), 1090-1098.

Şahin-Kalyon, D., & Özdem-Yılmaz, Y. (2023). The development of pre-service primary teachers' understanding and skills of argumentation through argument-driven ınquiry. *Science & Education*, 1-28.

Walker, J. P., & Sampson, V. (2013). Learning to argue and arguing to learn: argument-driven inquiry as a way to help undergraduate chemistry students learn how to construct arguments and engage in argumentation during a laboratory course. *Journal of Research in Science Teaching*, 50(5), 561-596.

Webb, P., Williams, Y., & Meiring, L. (2008). Concept cartoons and writing frames: Developing argumentation in South African science classrooms? *African Journal of Research in Mathematics, Science and Technology Education*, *12*(1), 5-17.

Weiss, K. A., McDermott, M. A., & Hand, B. (2022). Characterizing immersive argument-based inquiry learning environments in school-based education: A systematic literature review. *Studies in Science Education*, *58*(1), 15-47.

Yaman, F. (2018). Effects of the science writing heuristic approach on the quality of prospective science teachers' argumentative writing and their understanding of scientific argumentation. *International Journal of Science and Mathematics Education*, *16*, 421-442.

Yaman, F., & Hand, B. (2022). Examining pre-service science teachers' development and utilization of written and oral argument and representation resources in an argument-based inquiry environment. *Chemistry Education Research and Practice*, *23*(4), 948-968.

Yaman, F., & Hand, B. (2024). Examining the link between oral and written reasoning within a generative learning environment: the impact of the Science Writing Heuristic approach. *International Journal of Science Education*, *46*(8), 750-772.

e-Kafkas Journal of Educational Research e-KJER Research Article

Public Opinion about European Researchers' Night on Climate Change and Polar Science in Türkiye

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Abstract

The European Researchers' Night is an annual event held across Europe on the last Friday of September, with the primary goal of promoting public recognition of scientists, disseminating information about the real-world impact of their research, inspiring young people to pursue careers in science, and raising awareness about research and innovation activities. In 2022, European Researcher's Night focused on climate change and polar science in Istanbul and Gaziantep provinces. The central aim was to enhance public awareness of polar regions and global climate change, as well as to facilitate the acknowledgment of researchers and their work by the general public. This study examined the opinions of participants who attended these events, including 221 primary school students, 687 secondary school students, 525 high school students, and 319 adults. Utilizing a mixed-method approach, participant opinions were collected through both questionnaires and interviews conducted concurrently during the events. The results indicated that the events were highly effective in increasing participants' understanding of climate change and polar science. Many attendees reported a heightened interest in scientific topics and a greater appreciation for the work of researchers. In conclusion, these events serve as effective channels for communicating scientific research with the public and underscore the importance of research extending beyond the confines of research communities.

Keywords: European researchers' night, polar science, climate change, science festival, public opinion.

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Introduction

The European Researchers' Night, held annually across Europe on the last Friday of September, is an event designed to bring research closer to the public, increase the visibility of researchers, and inspire young people toward scientific careers (Roche et al., 2017; Jensen et al., 2021; CORDIS, 2022). This initiative, funded by the European Union since 2005, promotes public engagement with science through interactive activities like demonstrations, workshops, and exhibitions, especially targeting youth and families with limited exposure to STEAM (Science, Technology, Engineering, Arts, and Mathematics) fields. By fostering connections between researchers and communities, it advances scientific literacy and inquiry in accessible and engaging ways.

This study aims to investigate the impacts of the European Researchers' Night events in Türkiye, specifically focusing on public engagement and awareness, particularly regarding climate change. By examining public feedback on events held under the EDUCATE project, this research explores how these activities influence participants' perceptions, behaviors, and awareness of critical scientific topics. Through this analysis, we aim to contribute to the understanding of science festivals' influence on society in Türkiye.

Literature Review

Science festivals, which vary in duration from a single day to a month within the same area, are important in encouraging a positive attitude toward science among diverse groups, including students, families, educators, and academics (Enserink, 2004; Bencze & Bowen, 2009). Studies indicate that such events effectively foster scientific curiosity and promote research careers among participants (Gülgün et al., 2019). For instance, Martini et al. (2022) found that similar events in over 20 Italian cities successfully engaged young audiences by creating positive, impactful experiences with science. Likewise, Arnoe et al. (2016) emphasize that these events promote direct communication between researchers and the public, helping to demystify scientific careers and inspiring youth to consider science as a viable path. Mazitelli et al. (2018) also observed that while not all participants aspired to be scientists, many expressed enthusiasm for science, emphasizing the role of these events in making science accessible and appealing (Jensen & Buckley, 2012; Roche et al., 2018).

While there is limited literature specifically on the impacts of European Researchers' Night in Türkiye, international studies have shown significant positive outcomes from similar public engagement events. Such events increase public understanding of science, foster positive attitudes towards scientific research, and encourage young people to pursue careers in science (Brossard & Lewenstein, 2010; Roche et al., 2018). The European Commission's Horizon 2020 Work Programme highlights the importance of these events in promoting public recognition of researchers and their contributions to society. Further research and detailed reporting on the outcomes of European Researchers' Night in Türkiye will contribute to the broader understanding of the impact of public engagement in science.

In Türkiye, the European Researchers' Night has taken place at various times, including in 2014, 2016, and 2018 (TÜBİTAK,2021). Events like "Life is Science, Science is Life: LET'S DO THE SCIENCE!" and "SCI-ALL (Science Unites ALL)" combined fun and educational activities, positively shaping participants' perceptions of science and researchers (CORDIS, 2024a, 2024b). These events received high satisfaction ratings, highlighting the positive impact of public engagement initiatives and their potential to promote scientific interest among young people and the broader community in Türkiye. International and national evidence suggests that these events empower participants by fostering positive attitudes towards science and supporting a scientifically informed society (Altay & Lakhlifi, 2020).

Importance of the Study

In this study, we aim to understand the broader impacts of the European Researchers' Night events on the Turkish public, particularly by examining how these activities influence participants' views. Gathering public opinions on such events is essential, as it provides insights into the effectiveness of science engagement initiatives and highlights areas for improvement. Public feedback allows organizers to design future events that align more closely with audience expectations and interests, ensuring that the events remain relevant and engaging while effectively promoting scientific awareness (Bunderson, 1996).

As part of the EDUCATE project, the European Researchers' Night events in 2022 provide a unique context to explore these dynamics. Held in Istanbul and Gaziantep, these events focused on climate change and polar research themes, targeting an audience that included families, students, and young people with limited prior exposure to scientific research. These events aimed to increase awareness and foster a sense of responsibility toward global issues by directly engaging participants with critical topics like environmental conservation. Understanding the effects of these targeted activities, particularly on younger audiences, can offer valuable insights for enhancing future European Researchers' Night events.

Including climate change activities is crucial, given the pressing nature of global environmental challenges. Events emphasising climate literacy are particularly valuable as they inform and empower the public to take a proactive approach to environmental issues (Miller & Edwards, 2017). Türkiye's recent initiatives in polar research, including the establishment of the Polar Research Center at Istanbul Technical University and the Polar Research Institute under TÜBİTAK MAM, highlight the country's commitment to this cause. Through the EDUCATE project, researchers from Türkiye aim to increase public awareness about climate change by featuring climate-themed activities in the European Researchers' Night. By analyzing participant feedback, this study will assess the effectiveness of these efforts and contribute to the broader understanding of the role of public engagement in fostering environmental responsibility.

This research addresses the following questions:

1. What are the most significant reasons for the participants attending the EDUCATE events?
2. To what extent do participants believe that the EDUCATE events have influenced their daily behaviors and increased their awareness and understanding of the poles and climate change?
3. How do participants evaluate the success of the events?
4. What are the participants' overall views of the EDUCATE events, including the content, organization, and relevance of the activities presented?
5. What are the participants' views on how EDUCATE events affect their interest in scientific topics and their understanding of the work of researchers?
6. What suggestions do participants have for improving the EDUCATE activities based on their experiences?

Materials and Method

Research design

This research adopted a mixed-methods approach, a comprehensive methodology involving collecting both qualitative and quantitative data to address the research inquiries. This approach leverages the advantages inherent in integrating these distinct types of data, thereby maximizing the benefits derived from such integration (Creswell, 2017). Within the framework of this study, a convergent parallel design was employed, facilitating the simultaneous collection of quantitative and qualitative data during the activities. According to Creswell and Plano Clark (2018), this design is characterized by the concurrent collection and analysis of both data types, followed by integrating the results into a comprehensive interpretation. The EDUCATE Night events, held over two days in Istanbul and Gaziantep, provided the setting for this data collection, where diverse groups of students and adult guests engaged with various activity stands. Obtaining participant feedback immediately before their departure from the event areas required the concurrent collection of quantitative and qualitative data. Creswell and Plano Clark (2018) further elucidate that the convergent parallel design is particularly advantageous in scenarios where the researcher is constrained by time and must collect both data types in a single field visit and where a thorough understanding of the research problem mandates the integration of both quantitative and qualitative insights.

Study setting

The EDUCATE project, conducted as part of the "European Researchers' Night" under the Marie Skłodowska-Curie Actions of the European Commission, featured a series of events focused on global climate change. These events were designed to present research findings in a manner accessible to the general public, to enhance societal awareness of polar regions and global climate change. By illustrating the impact and benefits of this research on everyday life, the project sought to engage the public and

introduce them to the relevant scientific studies and the researchers behind them. A key objective of the project was to inspire the younger generation by providing enjoyable and informative experiences that highlighted the roles of researchers, thereby fostering potential role models. To achieve these aims, various activities-including science workshops, booth events, exhibitions, seminars, and concerts-were organized in Istanbul and Gaziantep from September 30 to October 1, 2022. In addition to these events, awareness-raising campaigns were conducted before and after the event, utilizing digital platforms as well as social and visual media to spark curiosity about polar regions, global climate change, and related scientific research. The events featured a range of interactive and educational activities, such as hands-on experiments, science shows, demonstrations, guided tours, competitions, quizzes, games, lectures, special school programs, and concerts. Approximately 150 staff members were involved in the organization and execution of these diverse EDUCATE events.

Study group

Quantitative and qualitative data were systematically collected from event participants to evaluate the activities' effectiveness. For the quantitative phase of the research, a purposive sampling method was employed, with the maximum variation sampling technique specifically chosen to ensure a diverse representation of perspectives among stakeholders who experienced the event (Büyüköztürk et al., 2014). The rationale for choosing the maximum variation sampling method was to capture a wide range of perspectives from different stakeholders who experienced the event. The demographic characteristics of the participants in the quantitative phase are detailed in Table 1.

Table 1.
Demographic Information about the Participants in the Quantitative Research

Level	Variable		n	%
Primary	Gender	Female	101	45.7
		Male	117	52.9
		Missing	3	1.4
	Grade	1st Grade	49	22.2
		2nd Grade	40	18.3
		3rd Grade	37	17
		4th Grade	92	42.2
		Missing	3	1.4
	Province	İstanbul	141	63.8
		Gaziantep	80	36.2
Secondary	Gender	Female	369	53.7
		Male	302	44
		Missing	16	2.3
	Grade	5th Grade	87	12.7
		6th Grade	160	23.3
		7th Grade	290	42.2
		8th Grade	128	18.6
		Missing	22	3.2
	Province	İstanbul	399	58.1
		Gaziantep	288	41.9
High School	Gender	Female	342	65
		Male	183	34.8
	Grade	9th Grade	217	41.3
		10th Grade	112	21.3
		11th Grade	133	25.3
		12th Grade	43	8.2
		Missing	21	4
	Province	İstanbul	322	61.2
		Gaziantep	203	38.6

Table 1 continuing

Adult	Gender	Female	185	58
		Male	134	42
	Age	30 and younger	116	36.4
		31-40	124	38.9
		41-50	58	18.2
		50 and older	21	6.6
	Province	İstanbul	228	71.5
		Gaziantep	91	28.5

As seen in Table 1, the quantitative phase of the study involved a participant pool comprising 221 primary school students, 687 secondary school students, 525 high school students, and 319 adults. The primary school students, ranging from grades 1 to 4, were aged between 6 and 11 years, whereas secondary school students, encompassing grades 5 to 8, fell within the age bracket of 11 to 15. High school students, spanning grades 9 to 12, were situated in the age range of 15 to 18 years.

Conversely, the qualitative phase of the research involved conducting face-to-face interviews with 60 participants. The study group was determined using the maximum variation sampling technique, a purposive sampling method, to ensure a broad range of perspectives from stakeholders who experienced the event (Creswell, 2017). The rationale behind this selection was to capture the diversity of views among participants, thereby enriching the qualitative analysis. Detailed information about the participants involved in the qualitative phase is presented in Table 2.

Table 2.
Demographic Information about the Participants in the Qualitative Research

Participant Code	**Gender**	**Province**	**Age**	**Grade/Education**	**Occupation**
P1	Female	Gaziantep	11	Secondary 6th Grade	Student
P2	Male	Gaziantep	8	Primary 3rd Grade	Student
P3	Male	Gaziantep	10	Primary 4th Grade	Student
P4	Male	Gaziantep	14	High School 9th Grade	Student
P5	Female	Gaziantep	10	Secondary 5th Grade	Student
P6	Female	Gaziantep	12	Secondary 5th Grade	Student
P7	Female	Gaziantep	13	Secondary 6th Grade	Student
P8	Female	Gaziantep	14	Secondary 7th Grade	Student
P9	Female	Gaziantep	13	Secondary 6th Grade	Student
P10	Female	Gaziantep	13	Secondary 6th Grade	Student
P11	Female	Gaziantep	14	Secondary 7th Grade	Student
P12	Female	Gaziantep	12	Secondary 6th Grade	Student
P13	Female	Gaziantep	13	Secondary 7th Grade	Student
P14	Female	Gaziantep	13	Secondary 7th Grade	Student
P15	Female	Gaziantep	12	Secondary 7th Grade	Student
P16	Male	Gaziantep	14	Secondary 8th Grade	Student
P17	Male	Gaziantep	13	Secondary 7th Grade	Student
P18	Male	Gaziantep	14	Secondary 8th Grade	Student
P19	Male	Gaziantep	11	Secondary 5th Grade	Student
P20	Male	Gaziantep	7	Primary 1st Grade	Student
P21	Male	Gaziantep	12	Secondary 6th Grade	Student
P22	Male	Gaziantep	7	Primary 1st Grade	Student
P23	Male	Gaziantep	11	Secondary 5th Grade	Student
P24	Female	Gaziantep	45	Graduate Degree	Biologist
P25	Female	Gaziantep	40	Graduate Degree	Environmental engineer
P26	Male	Gaziantep	39	High School	Technician
P27	Male	Gaziantep	44	Undergraduate Degree	Medical Personel

Table 2 continuing

P28	Female	Gaziantep	38	Primary	Housewife
P29	Male	Gaziantep	43	High School	Technician
P30	Female	Gaziantep	10	Secondary 5th Grade	Student
P31	Male	Gaziantep	11	Secondary 6th Grade	Student
P32	Male	Gaziantep	12	Secondary 7th Grade	Student
P33	Male	Gaziantep	11	Secondary 6th Grade	Student
P34	Male	Gaziantep	10	Secondary 5th Grade	Student
P35	Female	İstanbul	16	High School 11th Grade	Student
P36	Male	İstanbul	29	Undergraduate Degree	Researcher
P37	Female	İstanbul	15	High School 10th Grade	Student
P38	Female	İstanbul	14	High School 9th Grade	Student
P39	Female	İstanbul	16	High School 11th Grade	Student
P40	Male	İstanbul	17	High School 11th Grade	Student
P41	Male	İstanbul	16	High School 11th Grade	Student
P42	Female	İstanbul	17	High School 11th Grade	Student
P43	Female	İstanbul	16	High School 11th Grade	Student
P44	Male	İstanbul	16	High School 11th Grade	Student
P45	Male	İstanbul	21	Undergraduate Degree	University Student
P46	Female	İstanbul	17	High School 12th Grade	Student
P47	Male	Gaziantep	8	Primary 2nd Grade	Student
P48	Male	Gaziantep	8	Primary 2nd Grade	Student
P49	Female	Gaziantep	16	High School 11th Grade	Student
P50	Female	Gaziantep	16	High School 11th Grade	Student
P51	Female	Gaziantep	16	High School 11th Grade	Student
P52	Female	Gaziantep	51	-	Housewife
P53	Male	Gaziantep	43	Undergraduate Degree	Teacher
P54	Female	Gaziantep	32	-	Housewife
P55	Female	Gaziantep	32	-	Housewife
P56	Female	Gaziantep	40	Undergraduate Degree	Paramedic
P57	Female	Gaziantep	43	Undergraduate Degree	Teacher
P58	Male	Gaziantep	14	High School 9th Grade	Student
P59	Male	Gaziantep	14	High School 9th Grade	Student
P60	Female	Gaziantep	14	High School 9th Grade	Student

As can be seen in Table 2, 25 of the participants were male and 35 were female. Twelve of them participated in the events in Istanbul and 48 in Gaziantep. Their ages exhibited a broad spectrum, spanning from 7 to 51 years. Among the qualitative participants, six were classified as primary school students, 23 as secondary school students, and 17 as high school students. Additionally, 14 participants were classified as adults, each representing various occupations such as student, housewife, researcher, teacher, paramedic, environmental engineer, and technician.

Data collection

Both qualitative and quantitative data were procured through a collaborative effort involving volunteer assistants and researchers. Quantitative data were obtained via in-person and online methods, with the researcher and volunteer assistants facilitating data collection during the event. In the in-person approach, participants filled out printed surveys during their on-site engagement.

Concurrently, an online data collection procedure was implemented, with participant information and survey items being transitioned to a digital platform using Google Forms, thereby establishing an online form. QR codes were disseminated in various locations within the event venue to encourage participation. These QR codes provided access to surveys created through Google Forms, permitting participants to complete them using their mobile devices or tablets, with assistance from volunteer assistants as required.

Qualitative data were gathered via face-to-face interviews utilizing semi-structured interview forms. The interviews aimed to gain a deeper insight into participants' perspectives regarding EDUCATE events, the realm of science, and researchers in general. Given the significant number of student participants within the event setting, several interviews were conducted in the format of focus group discussions. A total of 37 interviews took place, spanning both Istanbul and Gaziantep. Nine of the interviews conducted in the research were focus group interviews and 28 of them were individual interviews.
In reporting these interviews, participant details, such as gender (denoted as F for female and M for male), attendance location (IST for Istanbul and GZT for Gaziantep), age, and, if applicable, grade levels for students, were provided. In the case of adult participants, information pertaining to their educational attainment and professions was disclosed.

Official approvals for data collection were obtained from the Ministry of National Education and the Ankara University Directorate of Ethical Council (approval dated 30.06.2022 and decision number 33). Furthermore, an informed consent form from parents or guardians was secured to administer surveys and conduct interviews.

Data collection instruments

The data was collected from participants who attended the European Researchers' Night event through data collection instruments comprising questionnaires and interview forms. These data collection instruments were meticulously refined after undergoing a process of expert evaluation. Separate questionnaires and interview forms were developed to cater to the distinct participant groups.

Questionnaires

Quantitative data were collected through questionnaires developed by the researchers. Questionnaires were created by scanning the relevant literature for research purposes. Additionally, the development of the questionnaires was inspired by the measurement instruments used in previous Night events (ERNEst21; G9Night; EXPLORATHON 2021). Questionnaires were developed according to age and grade variables as Primary, Secondary, High School and adult questionnaire forms. The Primary School questionnaire encompassed 11 items, while the Secondary School questionnaire comprised 17 items. The High School and adult questionnaires each featured 17 and 15 items, respectively. In the questionnaires, participants were asked about topics such as their motivation to attend the festival, how they would rate the quality of the event, their opinions about research, researchers, and being a researcher, the impact of science on daily life, whether their interest in science increased, whether the event influenced their future occupational decisions, whether they would attend similar organizations in the future, how much fun they had during the events, how relevant the events were to their age and interests, how relevant the context, communication, and materials were, and how they would rate the organizational aspects such as timing, supporting personnel, and transportation.

The response format of the Primary and Secondary School questionnaires was configured as a 3-point Likert scale, wherein participants rated statements as '1- do not agree,' '2- somewhat agree,' and '3- agree.' In contrast, the High School and adult questionnaires employed a 5-point Likert scale, allowing participants to express their agreement using options '1- strongly disagree,' '2- slightly agree,' '3- partially agree,' '4- strongly agree,' and '5- completely agree.'

It is necessary to examine simultaneously whether the questionnaires measure consistently or whether there is consistency between the questionnaire items. Internal consistency reliability is used extensively in social sciences to test the consistency of the questionnaire items internally. In order to establish the internal consistency and reliability of the questionnaires used in this study, the Cronbach's Alpha coefficient was computed. In line with prevailing literature, it is generally expected that a Cronbach's Alpha coefficient should be at or above 0.70 to deem a scale reliable (Pallant, 2001). According to an alternative perspective, coefficients below 0.40 imply a lack of reliability, those between 0.40 and 0.60 indicate low reliability, and those between 0.60 and 0.90 signify high reliability (as per Özdamar, 1997, cited in Tavşancıl, 2010). In this context, the Cronbach's Alpha reliability coefficients for the questionnaires were determined to be 0.61 for the Primary School questionnaire, 0.80 for the Secondary School questionnaire, 0.88 for the High School questionnaire, and 0.88 for the adult questionnaire.

The Interview Form

Qualitative data were collected with a semi-structured interview form developed by the researchers. The interview form was created by scanning the relevant literature for the purposes of the research. The developed draft interview forms were sent to the opinion of four field experts. The recommendations from experts in fields such as curriculum, educational administration, primary education, and science education were evaluated collaboratively with the researchers and the consultant, after which the interview form was finalized, containing nine questions in its semi-structured format.

In the qualitative phase of the study, rigorous efforts were undertaken to ensure the validity and trustworthiness of the research, following the criteria of credibility, transferability, dependability, and confirmability (as outlined by Guba and Lincoln, 1985, cited in Creswell, 2016). Expert opinions were solicited for the semi-structured interview questionnaire developed by the researchers to bolster credibility. In the pursuit of transferability, the researchers utilized the maximum variation sampling method among purposeful sampling methods and furnished comprehensive descriptions to facilitate broader applicability. As a matter of fact, as Merriam (2013) suggested in qualitative studies a study group should be formed by creating an intentional variety and difference. Furthermore, participant characteristics were meticulously detailed to aid in transferability. Lastly, to ensure confirmability, the findings were anchored in participants' own statements, adhering to the approach advocated by Guba and Lincoln (1982).

The research team was divided into two groups to analyse the data obtained from the interview forms, with each group conducting separate analyses. Subsequently, the researchers convened to compare their results. Ensuring reliability in qualitative research is crucial, and Miles and Huberman's (1994) formula was employed for this purpose. It is generally recommended that the inter-rater agreement percentage be 70% or higher (Miles & Huberman, 1994). In this study, the reliability was calculated at 86%. Following this, the researchers engaged in discussions to resolve any discrepancies in coding, ultimately reaching a consensus and finalizing the coding framework.

Data analyses

The quantitative data collected in this study were analysed using the Statistical Package Program for Social Sciences (SPSS). Prior to the analysis, a comprehensive examination of the dataset was conducted to identify and address missing data in the variables. It was ascertained that no variable contained more than 5% missing data, adhering to the guidelines set forth by Tabachnick and Fidell (2014). Univariate outliers were identified through the application of standardized z-scores. Descriptive statistics, which encompass techniques such as percentage, frequency, and arithmetic mean, were employed in the data analysis process.

For the qualitative phase of the research, NVivo 10 software was utilized. The research team was divided into two groups to analyze the data obtained from the interview forms, with each group conducting independent analyses. Content analysis was employed as the method, aimed at thoroughly exploring the data to identify underlying concepts and categories (Yıldırım & Şimşek, 2008). Following an inductive approach, participants' statements were initially coded, and categories were subsequently derived from these codes. The process of category formation involves grouping multiple codes or subcategories to establish a common pattern or idea (Creswell, 2016). Throughout the identification of subcategories, efforts were made to adhere closely to the participants' original expressions. After completing their individual analyses, the researchers compared their results, reached a consensus, and finalized the coding and categorization process. The findings were then presented in tables, with frequencies indicated and interpreted by the researchers.

Findings

The findings of this study have been structured and presented in alignment with the sequence of the research questions. To ensure coherence and clarity, each research question is explicitly referenced in the section headings, labeled as RQ1, RQ2, etc.

Findings of quantitative research

The statements in the questionnaires were examined under the headings of "reasons to attend EDUCATE events", "contributions of the events to learning" and "evaluation of the activity". The findings obtained from these categories were analyzed under these headings.

RQ1: Reasons to attend EDUCATE events

The arithmetic averages of the answers given by the participants to the statements regarding the reasons for attending the EDUCATE events are given in Table 3.

Table 3.
Means of the Reasons to Attend the EDUCATE Events

Reasons to attend the events	Primary School*	Secondary School*	High School**	Adult**
	Mean	Mean	Mean	Mean
I attended these events because:				
I was interested in science.	2.75	2.84	4.09	4.33
I thought it would be fun.	2.90	2.84	4.17	4.29
I am interested in the poles.	2.48	2.46	3.46	4.04
My parents wanted it.	-	1.57	2.07	
My teacher asked me to.	-	1.74	2.65	
I wanted it.		2.87	4.44	4.51

*1- disagree, 2- somewhat agree, 3- agree
**1-strongly disagree, 2-disagree, 3-somewhat agree, 4-agree, 5-completely agree

As delineated in Table 3, the analysis reveals distinctive motivations underlying event participation. Specifically, Primary School students (Mean = 2.90) and High School students (Mean = 4.17) predominantly attended the events with the primary expectation of enjoying the activities. In contrast, Secondary School students indicated the highest level of participation, driven not only by the anticipation of enjoyment but also by their intrinsic interest in science. A similar pattern emerged among adult participants, emphasising their interest in science as a key motivator.

Furthermore, both Secondary and High School students conveyed that their participation in the events was voluntary and not contingent on familial or pedagogical encouragement. Likewise, the adult participants similarly emphasized that their involvement was entirely self-initiated.

RQ2: Contribution of the events to learning

The responses of the participants to the statements about the contributions of the EDUCATE activities to them are given in Table 4.

Table 4.
Means of the Expressions Regarding the Contribution of the Activity

Statements related to the contribution of the events	Primary School*	Secondary School*	High School**	Adult**
	Mean	Mean	Mean	Mean
In this event, I gained new knowledge about the Poles and climate change.	2.70	2.74	4.07	4.29
In these events, I understood how climate change affects our daily lives.	2.51	2.69	3.89	4.25
After participating in these activities, I thought of becoming a scientist. / If I have the opportunity after participating in these activities, I would like to take part in a scientific study. (Adult)	2.31	2.08	2.94	4.21
I may use what I learned in these activities in my daily life.	-	2.64	3.86	4.27
After participating in these events, I became aware of my lack of knowledge about the Poles and climate change.	-	2.65	3.73	4.31
After participating in these events, I will be more careful about the Poles and climate change in my daily life.	-	2.75	4.03	4.35

*1- disagree, 2- somewhat agree, 3- agree,
**1-strongly disagree, 2-disagree, 3-somewhat agree, 4-agree, 5-completely agree

As can be seen in Table 4, the highest mean in all groups occurred for the statement "After participating in these activities, I am more careful in my daily life about the Poles and climate change" (M_s = 2,75, M_h = 4,03, M_s = 4,35). In other words, the event enhanced participants' awareness and significantly improved their understanding of the poles and climate change. Participants were more willing to incorporate this newly acquired knowledge into their daily lives, reflecting a meaningful learning experience.

RQ3: Evaluation of the event

The participants' responses to the statements containing their evaluations of EDUCATE activities are given in Table 5.

Table 5.
Means of Evaluation of the Events

Statements related to the general evaluation of the events	Primary School*	Secondary School*	High School**	Adult**
	Mean	Mean	Mean	Mean
Participating in these events made me happy.	-	2.87	4.39	4.56
I had fun at these events.	-	2.87	4.23	4.59
I would share what I learned in these activities with my family and friends.	-	2.83	4.27	4.72
The activities were appropriate for my age and level of knowledge.	-	2.80	4.21	
I would attend similar events again.	2.91	2.82	4.33	4.51

*1- disagree, 2- somewhat agree, 3- agree
**1-strongly disagree, 2-disagree, 3-somewhat agree, 4-agree, 5-completely agree

All participant groups, namely Secondary School (Mean = 2.87), High School (Mean = 4.23), and adult (Mean = 4.59) cohorts, reported deriving enjoyment from their participation in EDUCATE activities. Notably, Secondary School students (Mean = 2.83) exhibited a slightly lower level of enjoyment compared to High School (Mean = 4.27) and adult groups (Mean = 4.72), with the latter two cohorts expressing a greater inclination to disseminate the knowledge acquired during the activities to their respective social circles. Moreover, both Secondary School (Mean = 2.80) and High School students (Mean = 4.21) demonstrated a high degree of agreement regarding the suitability of the activities in relation to their age and level of knowledge.

In a unanimous consensus, all participants expressed a positive disposition toward partaking in similar activities in the future.

Findings of qualitative research

Categories that emerged after the analysis of data obtained from the interviews are shown in Figure 1.

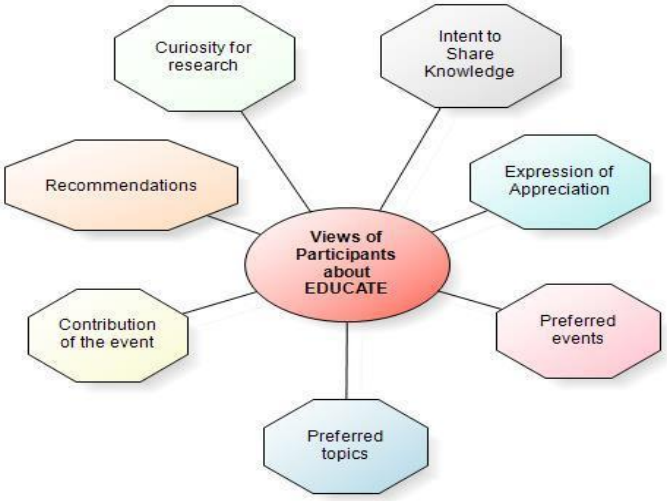

Figure 1. Categories from Interviews on EDUCATE

As illustrated in Figure 1, the analysis of the interview data was categorized into several distinct categories: preferred events, preferred topics, expression of appreciation, contributions of the event, curiosity for research, intent to share knowledge with others, and suggestions. In the following sections, each of these categories will be introduced and discussed in detail, with individual sub-topics presented as separate headings under the relevant research problem to provide a clear and organized structure to the qualitative findings.

RQ4: Preferred events

The views of the visitors who attended the EDUCATE events about the most favorite events are given in Table 6.

Table 6.
Events Preferred by the Participants

Categories	Sub-Categories	f	Statements of the interviewees
Fun events	Painting and spinning tops	20	P28: We liked spinning tops, seeing children's previous games and the games of our childhood (F, GZT, 38, Primary, Housewife).
	Recycling activities	19	P53: It is nice that they produce fuel from fruit waste at one of the stands. (M, GZT,43 Undergraduate, Teacher) P58: We planted plants in the soil, melon plants, for example, the fertilizer production that we did, actually attracted my attention. (M, GZT, 14, Student, 9th Grade).
	Technology events	13	P59: Gaziantep University had the most electric car in the festival area, and it caught my attention more. (M, GZT,14, Student, 9th Grade) P1: I was most interested in making a penguin with a 3D printer. (F, GZT, 11, Student, 6th Grade)
	Jumping activity	2	P40: The activity of TÜBİTAK to create earthquakes by jumping was good. (M, IST, 17, Student, 11th Grade)
Scientific events	Conferences	18	P41: A teacher's presentation about plastics caught my attention. After that, I was very interested in the presentation of a teacher who stayed at the Polish base. (M, IST, 16, Student, 11th Grade) P24: Scientists who give conferences know their subjects. They can easily answer any question we ask. Children have the chance to learn and practice directly, thanks to their face-to-face meetings with the people who want to do scientific research. Thank you for your hard work. (F, GZT, 45, Graduate, Biologist)
	Science truck	8	P51: We examined living things under the microscope in the science truck, I liked it very much. I liked everything inside the truck. (F, GZT, 16, Student, 11th Grade) P59: I learned more comprehensive knowledge about the displacement and formation of the continents in the world in the truck. (M, GZT, 14, Student, 9th Grade) P42: We watched space-related things in the truck the most, and I liked it. (F, IST,17, Student, 11th Grade)
	Astronomy workshop	5	P49 The event is very nice. We learned a lot. They showed the sun. We just looked there (in the telescope) (F, GZT, 16, Student,11th Grade)
	İTÜ student group activity	2	P45: I liked Postim's Good Week event. I think the card game is very instructive. There is a network tower event at the Istanbul Technical University Polar Studies Club. They create digital memories, I find them very successful. (M, IST, 21, University Student)

When Table 6 is examined, it is possible to say that painting and spinning top activities, recycling activities, and conferences attracted a lot of attention.

RQ4: Preferred topics

Participants expressed a distinct preference for topics related to polar regions, with a total of 30 participants' views indicating a heightened level of interest. The following are illustrative examples of participants' opinions on this topic.

> My particular interest was drawn to Antarctica, the wildlife inhabiting these polar regions, the polar boundary, and polar bears (P44, Male, Istanbul, 16 years old, Student, 11th Grade).
> I harbor a strong desire to engage in scientific pursuits, especially as a cartographer, with a specific interest in participation in polar expeditions (P45, Male, Istanbul, 21 years old, University Student).

In addition to their polar-related interests, participants also expressed a genuine enthusiasm for climate-related subjects. For instance, Participant 37 attended the EDUCATE event due to a deep-seated interest in climate change and environmental issues, sharing that they have initiated an environmental team with fellow students at their school, with a focus on launching an environmental project (Female, Istanbul, 15 years old, Student, 10th Grade). Similarly, Participant 45 expressed a desire to create thermal maps of polar regions to examine temperature fluctuations and the impacts of global warming (Male, Istanbul, 21 years old, University Student).

RQ4: Expression of appreciation

Upon analyzing the participants' responses to inquiries about their views of the activities, it is evident that all participants consistently held highly favorable views. The interviewees' answers to the question of how did you find the activities are given in Table 7.

Table 7.
Interviewees' Expressions of Appreciation

Categories	f	Statements of the interviewees
Satisfaction and Positive Evaluation	60	P12: I found the event very nice. There were many good activities. I am very happy to devote my time to these activities. (F, GZT, 12, Student, 6th Grade) P16: The activities were good and we learned new things. A trip made by our school. It was really nice to combine so many topics into one. (M, GZT, 14, Student, 8th Grade) P36: The event was well evaluated and well organized. It has a large number of participants. I think it is a good organization to appeal to young minds in order to popularize polar science studies. (M, IST, 29, Researcher, Undergraduate Degree) P38: I think the activities are good, appropriate for our age. (F,IST,14,Student,9th Grade)
Fun and Enjoyment	16	P58: It's actually pretty good. There's an event everywhere and it's free. We can do what we want. I had so much fun in two days. If it happens again, I would prefer to come again. (M, GZT, 14, Student, 9th Grade) P44: The event was very good, it was entertaining and informative. (M, IST, 16, Student, 11th Grade) P52: The event is very good for children, we had a lot of fun, we enjoyed it. (F, GZT, 51, Housewife)
Educational and Informative	11	P42: I found the event nice, it was informative. Good, I use it in daily life. (F, IST,17, Student, 11th Grade) P8: It was both impressive and instructive. (F, GZT, 14, Student, 7th Grade) P17: We are both having fun and being informed. It's so much fun. (M, GZT, 13, Student, 7th Grade)
Impact and Contribution of the Event	6	P17: It was very entertaining and very useful. (M, GZT, 13, Student, 7th Grade) P53: I think it is very effective and useful. I think it would be great for all people to participate in these events. (M, GZT, 43, Teacher, Undergraduate Degree)
Interest and Impressiveness	5	P56: Actually, it is a nice, useful and interesting activity. (F, GZT, 40, Paramedic, Undergraduate Degree)

When Table 7 is examined, these statements collectively underline participants' predominantly favorable reception of the events, with activities being perceived as engaging, enjoyable, and instructive.

RQ5: Contribution of the event

The views of the participants related to the statement "contributions of the EDUCATE activity" are given in Table 8.

Table 8.
Contribution of the event

Categories	f	Statements of the interviewees
Learning New Knowledge	34	P5: I learned new things about animals and climate change. (F, GZT,10, Secondary School Student, 5th Grade) P10: We pollute nature a lot and this affects the climate a lot. Since we need to prevent this, we can try to do something. In fact, after today, I will be much more careful. (F, GZT, 13, Student, 6th Grade) P60: I have a lot of knowledge about Zero waste. There was a throwback activity. It was nice. We learned many things. (F, GZT,14, Student, 9th Grade)
Reinforced Knowledge	15	P45: My opinion about the poles was strengthened. I was already interested. It was very nice. (M, IST, 21, University Student, Undergraduate Degree) P59: I already had knowledge about climate. I learned more useful things from the science truck here. I learned more comprehensive information about the formation of the continents in the world. (M, GZT,14, Student, 9th Grade). P35: I think I am already conscious about this issue. I pay a lot of attention to climate change etc. This area was an area that I was interested in, so it gave me more information. (F, IST, 16, Student, 11th Grade)
Raising Awareness	14	P26: It is better to know the value of water and green. How can we protect it? what should we do? (M, GZT, 39, Technician, High School) P21: I became more conscious about the poles. I understood better that we need to protect them. (M, GZT, 12, Student, 6th Grade) P58: Here, I learned to avoid waste. This is because it is a situation that indirectly affects the climate. (M, GZT, 14, Student, 9th Grade)
Increasing Motivation	12	P37: After this event, I plan to participate in scientific activities. These can be workshops or forums. (F, IST, 15, Student, 10th Grade)
Useful for the new generation	10	P45: Polar awareness training caught my attention. I find it very valuable that people in the younger age group understand this and pass it on to future generations. (M, IST, 21, University Student) P36: I think it is a good organization to appeal to young minds to popularize polar science studies. (M, IST, 29, Researcher, Undergraduate Degree) P57: Actually, I'm not a very scientific person, but when my children see space, stars, and falling stars through a telescope, we are happy when they get excited. (F, GZT, 43, Teacher, Undergraduate Degree)
Generating new ideas for the future	10	P1: The poles melt as a result of methane gas. We are making a project to prevent this. There may be a new project after the event here. (F, GZT, 11, Student, 6th Grade) P37: I came to the EDUCATE event because I am interested in climate change and environmental issues. I formed an environmental team with my friends at my school. We want to start a project about this environmental team. I attended the event to think about the projects that our team can do and to develop ideas. (F, IST, 15, Student, 10th Grade) P40: We wanted to research the topography of the poles and geomorphological observations, and we plan to continue this at TUBITAK Marmara Research Institute. (M, IST, 17, Student, 11th Grade)

As can be seen in Table 8, the interviewees stated that they learned new knowledge through the activities and became more sensitive to these issues. They also stated that the activities enabled them to generate new ideas.

RQ5: Curiosity for research

The views of the participants related to the statement "curiosity for research" are given in Table 9.

Table 9.
Curiosity for Research

Category	f	Statements of the interviewes
Poles	28	P41: Personally, when I want to go to the pole, I wonder about the living things there. The geographical formations of the ratio are very interesting to me. I used to do more research on them. (M, IST, 16, Student, 11th Grade) P44: I would like to participate in a research event on the history of Antarctica. (M, IST, 16, Student, 11th Grade) P41: I would like to participate in scientific studies on Antarctica. I would like to do fieldwork. (M, IST, 16, Student, 11th Grade)
Climate change	20	P36: I would like to do research on climate change and sustainability. (M, IST, 29, Researcher, Undergraduate Degree) P35: I would like to research animal species that have disappeared due to climate change. (F, IST, 16, Student, 11th Grade) P54: If I had the opportunity to research, I would research climate change. Waste is a sensitive subject for me, recycling of waste is very different, I would like to work on it the most. (F, GZT, 32, Housewife)
Scientific activities	16	P8: I would definitely like it. I would like to learn science better. (F, GZT, 14, Student, 7th Grade) P37: I am currently taking part in many scientific activities. I am thinking of participating in scientific activities after this event. (F, IST, 15, Student, 10th Grade)
Animals	13	P20: I would like to. I would like to do research on animals living in the poles. P35: I like biology very much as a course. That's why I would like to participate in nature-related activities. (M, GZT, 7, Student, First Grade) P38: Maybe I would like to do research on endangered animals. (F, IST, 14, Student, 9th Grade) P46: I would like to do research on animals living in the poles. I would like to do research on the creatures that live there. (F, IST, 17, Student, 12th Grade)
Space and astronomy	6	P43: I would like to research unknown planets. I would like to do research on astronomy. (F, IST, 16, Student, 11th Grade) P38: I would like to take part in studies related to space. (F, IST, 14, Student, 9th Grade) P49: Yes, I would. I want to go into space and do research. (F, GZT, 16, Student,11th Grade)
Technology	2	P1: I participated in TÜBİTAK Teknofest. I would like to participate in studies on robots. (F, GZT, 11, Student, 6th Grade)
Social	1	P42: I would rather do scientific activities on social issues. (F, IST,17, Student, 11th Grade)

When Table 9 is examined, the participants exhibit a predominant interest in the investigation of polar regions and climate change. Beyond these focal areas, participants also express a keen desire to explore various topics encompassed within educational activities, such as astronomy, space, robotics, biology, and the study of animal species.

RQ5: Intent to Share Knowledge

It is noteworthy that participants expressed an intent to disseminate newfound knowledge to others. Participants' statements serve as illustrative examples:

> My primary action upon returning to school will be to share the knowledge I acquired here." (P12, Female, Gaziantep, 12 years old, Student, 6th Grade).
> I intend to inform my neighbors, as they also have children, and I wish to encourage them to visit and witness this event." (P52, Female, Gaziantep, 51 years old, Housewife).
> I aspire to encourage my peers to visit this venue. It is my belief that visiting this place has the potential to transform people's perspectives." (P53, Male, Gaziantep, 43 years old, Teacher, Undergraduate Degree).

RQ6: Suggestions

Suggestions from the participants about the EDUCATE activity are given in Table 10.

When Table 10 is examined, it can be concluded that the participants wanted to have more variety of events, to attend such events more frequently, to learn about the Poles in school subjects, and to hear about the event more effectively.

Table 10.
Suggestions of the participants

Categories	Sub-Categories	f	Statements of the interviewees
Content	More variety of events	8	P3: More clubs coming, and better things happening. (M, GZT, 10, Student, Primary 4th Grade) P4: I think there should be more diverse activities. Enlarge the stands. (M, GZT, 14, Student, 9th Grade)
	Recommendations for the contents of the events	4	P21: Photos of animals could have been posted more. (M, GZT, 12, Student, 6th Grade)
Organization	Announcing the event more effectively	6	P24: I expected the announcements to be made differently in this environment. (F, GZT, 45, Biologist, Graduate Degree) P27: It would be great if it reaches more people. (M, GZT, 44, Medical Personnel, Undergraduate Degree)
	Recommendations for the event area	6	P35: Activities can be done in a larger area. (F, IST, 16, Student, 11th Grade) P37: I just came to the event, it is a very nice and friendly environment. Just a little crowded. Due to the crowd, we did not have the opportunity to talk to the people in the workshop much. Other than that it's a good event. (F, IST, 15, Student, 10th Grade)
Duration	Organization of similar events	6	P26: It would be better to have this event twice a year, if possible, rather than once in a while. (M, GZT, 39, Technician, High School Graduate) P53: It is good that such activities are carried out frequently. (M, GZT, 43, Teacher, Undergraduate Degree)
	Longer time for the events	2	P19: Its duration should have been extended further. (M, GZT, 11, Student, 5th Grade).
Other	Course subjects in the curriculum about the Poles	1	P15: Things about climate change are in social studies class. From there, we satisfy our curiosity. There are no lessons about the poles. We are more curious about the poles where there is nothing about poles in Social Studies and Science classes. (F, GZT, 12, Student, 7th Grade)

The qualitative findings from the EDUCATE project interviews were organized into distinct categories, each representing different aspects of participants' experiences. The most preferred events included interactive and fun activities, such as painting, spinning tops, and recycling workshops, which garnered significant attention. Participants also expressed a strong interest in polar regions and climate change topics, indicating a heightened awareness and concern for environmental issues. Many participants appreciated the educational value of the events, with some expressing a newfound curiosity for research, particularly in areas such as polar exploration, climate change, and scientific activities. The activities were also seen as impactful, fostering an intent among participants to share the knowledge they acquired with others. Suggestions for future events included calls for a greater variety of activities, better organization, and more effective communication to reach a broader audience. Overall, the qualitative data highlights the positive influence of the EDUCATE events on participants, particularly in enhancing their awareness and motivation to engage in scientific inquiry.

Discussion, Conclusion, and Suggestions

Since it began in 2005, museums, universities, and science centers have organized EDUCATE events across Europe, covering more than 300 locations. Notably, in 2022, these events exhibited a substantial presence in Istanbul, the most populous city in Türkiye, as well as Gaziantep, another prominent urban center. Those who participated in the EDUCATE event reported a heightened interest in scientific research, particularly in the main themes of polar regions and climate change. Additionally, they indicated a greater awareness and expressed a stronger enthusiasm for engaging in such research and

pursuing careers as scientists. These findings are consistent with those of Martini et al. (2022), who found that similar events, organized across more than 20 Italian cities during the European Researchers' Night coordinated by Frascati Scienza, effectively encouraged young people to consider scientific careers by generating a tangible impact on their engagement with science. This parallel underscores the broader impact of European Researchers' Night events in fostering scientific curiosity and motivating the next generation of scientists. Furthermore, as Arnoe et al. (2016) highlighted, these night events' primary objectives include raising public awareness of researchers' work, fostering dialogue between researchers and citizens, and inspiring young individuals to pursue careers in science. Similarly, Mazitelli et al. (2018) reported that participants, particularly young people, although not necessarily aspiring to become scientists, felt satisfied and motivated to engage with science, expressing enthusiasm for experiencing and interacting with scientific activities.

Evaluating science communication activities is a challenging task that demands managing complex information flows and relationships among subjects from whom a change is expected. This complexity is particularly evident in large-scale events like the European Researchers' Night (EDUCATE), where ambitious goals are often set (Pellegrini, 2021). The Ministry of National Education, in conjunction with the municipalities of Istanbul-Tuzla and Gaziantep, provided requisite permissions, as well as issued announcements and extended transportation facilities. Such collaborative efforts synergized multiple stakeholders to facilitate the attendance of a considerable number of students. Consequently, these inter-institutional alliances have ensured unfettered access and participation in the events for individuals with a keen interest. This strategic approach has effectively mitigated the apprehensions raised by Bultitude (2014) regarding the potentially exclusive nature of participation in such events. As a result, it is evident that participation in these scientific events, supported by the Ministry of National Education and local municipalities in Türkiye, is likely to be high. Therefore, future organisers of similar events should consider more effective guidance for students and more active involvement in the activities. It is recommended that university students assume leadership and mentorship roles, providing guidance to secondary school students throughout the activities. Given the large number of participants, our observations suggest that better organization of the event area could prevent overcrowding in certain sections, thereby allowing each participant to engage more fully in all activities.

The events held for school students were met with considerable enthusiasm, particularly with regard to the interactions with researchers. The research findings indicate that most participants expressed enjoyment of the event, perceived it to be of high quality, and indicated a desire to attend similar events in the future. This is consistent with the findings of previous years' night events. For example, Arnoe et al. (2016) examined the results of night events held between 2006 and 2015. They found that approximately 85% of participants evaluated the events positively and around 98% expressed a desire to participate in such events again. Similarly, the ERNEst 2021 event revealed that both adults and students expressed a strong interest in visiting laboratories (adults – 63%, students – 52%) and workshops (adults – 62%, students – 58%) as part of future European Researchers' Nights. Additionally, the G9NIGHT 2021 event demonstrated that 82.2% of participants believed that such events should be held more frequently. For this reason, it would be beneficial for future training to include practice at explaining what it is like to be a researcher and how the job works. This should draw on not just personal experience but also the sorts of examples provided by career guidance counsellors. This may facilitate students' comprehension of the multiplicity of pathways that lead to a career in research, beyond the conventional single route.

The spectrum of participants in the event is quite diverse. While the majority consists of students ranging from elementary school to university levels, participants also include parents of students as well as individuals from various professional backgrounds. This diversity is significant in terms of the widespread impact of the event. Although not officially noted, migrant students have also been part of the event. This further contributed to ensuring inclusivity within the event. Notwithstanding Arnstein's (1969) hierarchical framework of citizen participation, these events are characterized as exemplars of public engagement in the literature. This paradigm shift toward public engagement is underscored by institutional support.

Both participants from Istanbul and Gaziantep have expressed their appreciation for the events, their desire for more similar activities to be organized, and their increased interest and awareness in scientific

research, and research on polar and climate change through European Researchers' Night events. Additionally, participants often emphasized that announcements that are more effective would increase participation in the events. This result is consistent with the statement “The opportunities for social learning provided by public engagement events are becoming more important to the role of science in society” (Davies et al., 2009). The events organized within the EDUCATE project enhanced public awareness and knowledge of climate and polar science. By aligning with established research on climate change education, these events successfully bridged the gap between scientific knowledge and public understanding, thereby contributing to a more informed and engaged public in addressing climate-related challenges.

Limitations to the Research

It is recommended that future research outcomes be enhanced by conducting a comparative analysis of participants' perspectives on scientific research, polar issues, and climate change before and after their participation in the European Researchers' Night event. A longitudinal study of the same individuals before and after the event would have enabled a detailed examination of any changes in their responses. Nevertheless, the considerable number of participants in both urban centers rendered this approach impractical.

Furthermore, the questionnaires and interview protocols were deliberately constructed with a restricted number of items and questions. This limitation was necessary due to the anticipated large-scale participation, in order to guarantee the feasibility of data collection during the event. In addition, measurement tools with completed validity and reliability studies can be developed and used in such activities.

Recommendations for Future Work

The participation of primary school students in the EDUCATE event was limited, primarily due to the challenges of managing young children in a crowded environment. Based on these observations, it may be more effective in future events to have primary school students participate separately from other groups, perhaps during earlier hours. Additionally, collecting data from primary school students through interviews may be more appropriate given their age and comprehension levels.

While this study assumed a homogeneous participant group of Turkish citizens, inclusive educational practices suggest the importance of considering the diverse populations present in Türkiye, including Syrian refugees. Although no direct data on this group was collected in this study, the inclusion of such populations in future research is strongly recommended. This would enable a more comprehensive understanding of educational needs and foster inclusive practices that address the challenges faced by refugee youth.

In summary, these recommendations emphasize the importance of enhancing student engagement, improving event organization, and adopting inclusive practices that account for the diverse populations in Türkiye, ensuring that future initiatives are more effective, accessible, and reflective of the country's demographic realities.

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Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

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References

Altay, S. and Lakhlifi, C. (2020). Are science festivals a good place to discuss heated topics?. *JCOM 19*(01), A07. doi: 10.22323/2.19010207

Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners, 35*(4), 216–224.

Arnone, S., Bellini, F., Faccini, M., Maselli, D., Mazzitelli, G., Paximadas, I., & Spagnoli, F. (2016). Results from impact assessment on society and scientists of Frascati Scienza European researchers' nights in years 2006–2015. In *ICERI2016 Proceedings,* 3356-3365.

Bencze, J. L. & Bowen, G. M. (2009). A national science fair: Exhibiting support for the knowledge economy, *International Journal of Science Education, 31*(18), 2459-2483. doi:10.1080/09500690802398127

Brossard, D., & Lewenstein, B. (2010). A critical appraisal of models of public understanding of science: Using practice to inform theory. *International Journal of Science Education, 31*(3), 353-370. doi:10.1080/09500690701494010

Bultitude, K. (2014). Science festivals: Do they succeed in reaching beyond the 'already engaged'? *Journal of Science Communication, 13*(4), 1–3. https://doi.org/10.22323/2.13040301

Bunderson, E. D. & Anderson, T. (1996). Preservice elementary teachers' attitudes toward their experience with science fairs, *School Science And Mathematics, 96*(7), 371-377. doi;10.1111/j.1949-8594.1996.tb15855.x

Büyüköztürk, Ş. (2014). *Sosyal bilimler için veri analizi el kitabı[Data analysis handbook for social sciences]*. Ankara: Pegem Akademi.

CORDIS (2022). European researchers' night 2022-2023. Retrieved from https://cordis.europa.eu/programme/id/HORIZON_HORIZON-MSCA-2022-CITIZENS-01-01

CORDIS (2024a). Results for Life is Science, Science is Life: LET'S DO THE SCIENCE! ID 633256. Retrieved from https://cordis.europa.eu/project/id/633256/reporting

CORDIS (2024b). Results for Science Unites ALL ID 722956. Retrieved from https://cordis.europa.eu/project/id/722956/results

Creswell, J. W. (2016). Nitel araştırma yöntemleri. *Qualitative research methods]. M. Bütün & SB Demir, Trans.(Eds.). İstanbul: Siyasal Kitapevi*.

Creswell, J. W. (2017). *Karma Yöntem Araştırmalarına Giriş*. [*A Concise Introduction to Mixed Methods*] (Sözbilir, S. Çelik, İ. H. Acar and Y. Göktaş Trans. M.). Ankara: Pegem Akademi Publications.

Creswell, J. W. ve Plano Clark, V. L. (2018). *Karma Yöntem Araştırmaları Tasarımı ve Yürütülmesi* [*Designing and Conducting Mixed Methods Research*] (Y. Dede & S. B. Demir Ed. & Trans). Ankara: Anı Publishing.

Davies, S., McCallie, E., Simonsson, E., Lehr, J. L., & Duensing, S. (2009). Discussing dialogue: Perspectives on the value of science dialogue events that do not inform policy. *Public Understanding of Science, 18*(3), 338–353. doi:10.1177/0963662507079760

Enserink, M. (2004). Europe clones U.S. science festival. *Science, 305*(5689), 1387.

ERNEst21 (2021). ERNEst21 Impact assessment. Retrieved from https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e740a82c&appId=PPGMS

EXPLORATHON (2021). Impact assessment. Retrieved from https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5eb970651&appId=PPGMS

G9NIGHT (2021). Impact assessment. Retrieved from https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5edc4306c&appId=PPGMS

Guba, E. G., & Lincoln, Y. S. (1982). Epistemological and methodological bases of naturalistic inquiry. *ECTJ, 30*(4), 233-252nd. doi:10.1007/BF02765185

Gülgün, C., Yılmaz, A., Avan, Ç., Ertuğrul Akyol, B. & Doğanay, K. (2019). TÜBİTAK tarafından desteklenen bilim şenliklerine (4007) yönelik ilkokul/ortaokul öğrencilerinin ve atölye liderlerinin görüşlerinin belirlenmesi [Determination of the views of primary, secondary school students' and workshops leaders' for the science fairs supported by TUBITAK (4007)], *Journal*

of STEAM Education (Bilim, Teknoloji, Mühendislik, Matematik ve Sanat Eğitimi Dergisi), 2(1), 52-67.

Jensen, E., & Buckley, N. (2014). Why people attend science festivals: Interests, motivations and self-reported benefits of public engagement with research. *Public Understanding of Science, 23*(5), 557-573. doi:10.1177/0963662512458624

Jensen, A. M., Jensen, E. A., Duca, E., & Roche, J. (2021). Investigating diversity in European audiences for public engagement with research: Who attends European Researchers' Night in Ireland, the UK and Malta? *PLoS ONE, 16*(7), 1-12. doi:10.1371/journal.pone.0252854

Martini, M., Della Ceca, A., Burzachechi, G., Donghia, R., Ciocca, G., Pierangeli, S., Diociaiuti, E. & Guglielmotti, V. (2022). *Leaf project: science communication in covid era, EDULEARN22 proceedings,*1030-1039. doi:10.21125/edulearn.2022.0284

Mazzitelli G., Arnone S., Bramato M., Capra I., Ciocca G., Ceca A. D., et al. (2018, 5-7 March). *12 years of data, results and experiences in the European Researchers' Night project*, Proceedings of INTED, Valencia, Spain. doi:10.21125/inted.2018.0031

Merriam, S. B. (2013). *Nitel araştırma desen ve uygulama için bir rehber, (*S. Turan, Trans). Ankara: Nobel.

Miller, J. D., & Edwards, S. (2017). Climate literacy: The role of science festivals in promoting public understanding of climate change. *Science Communication, 39*(6), 733-761. doi:10.1177/1075547017738012

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis*. London: Sage Publication.

Özdamar, K. (1997). *Paket Programlar ile İstatistiksel Veri Analizi* I. [Statistical Data Analysis with Software Packages I.] Eskişehir: Anadolu University Faculty of Science Publications.

Pallant, J. (2001). *SPSS survival manual: A step-by-step guide to data analysis using SPSS for Windows* (Version 10 and 11). Maidenhead: Open University Press.

Pellegrini, G. (2021). Evaluating science communication: Concepts and tools for realistic assessment. In M. Bucchi & B. Trench (Eds.), *Routledge handbook of public communication of science and technology* (pp. 305–322). Routledge. doi:10.4324/9781003039242

Roche, J., Davis, N., O'Boyle, S., Courtney, C., & O'Farrelly, C. (2018). European Researchers' Night: Enhancing public recognition of researchers and their work. *Public Understanding of Science, 27*(5), 593-609. doi:10.1177/0963662517750055

Roche, J., Davis, N., O'Boyle, S., Courtney, C., & O'Farrelly, C. (2017). Public perceptions of European research: an evaluation of European Researchers' Night in Ireland. *International Journal of Science Education, Part B, 7*(4), 374-391. doi:10.1080/21548455. 2017.1371354

Tabachnick. B. G., & Fidell. L. S. (2014). *Using multivariate statistics* (6th ed.). Boston: Pearson.

Tavşancıl, E. (2010). *Tutumların ölçülmesi ve veri analizi* [*Measuring attitudes and data analysis with SPSS]*. Ankara: Nobel Yayın Dağıtım.

TÜBİTAK (2021). *European Researchers' Night presentation*. Ufuk Avrupa. Retrieved from https://ufukavrupa.org.tr/sites/default/files/2021-06/night_tubitak_sunum_1.pdf

Yıldırım, A., ve Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri* (8. Baskı). Ankara:Seçkin Yayıncılık.

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Art Education Experiences in Unified Classrooms: A Phenomenological Study

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Abstract

This research aims to create a perspective on the Visual Arts course through the eyes of unified classroom teachers and to reveal their experiences. It is a matter of curiosity how the unified classroom practice, which can be seen as a problem in terms of education, results in terms of art education. This is the first research in the literature in terms of analyzing the positive/negative situations experienced in the Visual Arts course applied in unified classrooms. Phenomenology design, one of the qualitative research designs, was preferred in the study. The study group of the research consisted of 10 classroom teachers (4 female and 6 male) working in primary schools in a provincial centre in Anatolia and teaching in combined classes. Data were collected through interview form, metaphor study and artificial intelligence drawing application. The data obtained from the metaphors were transformed into a meaningful text and concretised with a colourful drawing with artificial intelligence application. Debriefing was then carried out with the participants on the resulting image, aiming to ensure both the internal consistency of the study and the concretisation of abstract expressions. The results of the studies in the literature show that education in unified classrooms leads to a negative process and result. However, according to the results of this research; it was seen that art education in unified classrooms produced positive effects and results. It has been revealed that there is an interactive, collaborative process in unified classrooms and that there is no situation that would negatively affect education. In addition, it was also among the results that art education in unified classrooms is an important impact factor in terms of social, cognitive, kinetic and artistic sense in terms of being an individual for students and coping with life dynamics. This situation shows that art can be used as an important influence factor in the construction of individual and life. Repeating this research after the participants were given art education might make a difference in terms of both education and participants.

Keywords: Unified classrooms, art education, visual arts lesson.

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Introduction

The concept of unified classrooms, which is used in the primary education level in the education system, continues today. The development of economic, technological and social opportunities has not yet led to a radical change in this concept. For this reason, education in institutions with unified classrooms has been discussed in many discussions and researches. The opinions of teachers, the situation of students, the advantages or disadvantages of this practice have been frequently examined in the literature.

In this study, firstly, the processes of unified classrooms applications from past to present have been examined. Necessary inferences were made by taking into account the application areas formed by these two concepts, the observations and opinions of the practitioners and the application areas formed by these two concepts with the art education applied in the unified classrooms within the scope of the visual arts course. The aim of the study is to shed light on visual arts courses through the experiences of classrooom teachers as the practitioners in unified classrooms. Unified classrooms are typically considered problematic in terms of instructional experiences and as educational settings. This study focused specifically on art classes as unified classroom experiences, and it is probably the first study in the literature to investigate art classes in a unified setting.

Literature Review

Combined Classroom Concept

In the ever-changing and developing world order, the importance of knowledge is increasing. Schools, which are educational institutions that provide knowledge in a systematic and organized way, are a part of this dynamic. Education and training are carried out with various applications according to the existing situation in schools. One of these applications is the unified class application shaped according to certain variables (Saadet, 2020). The combined class is defined as the low number of students arising from the low population required by geographical and economic conditions and the education of student groups at different grade levels in one class by one teacher (Binbaşıoğlu, 1983; Demirel, 2019; Köksal, 2009). In this practice, one or at most three teachers can provide education for students at different levels and needs. The concept of combined classrooms is generally referred to as "multigrade classes" by researchers as required by two important factors: administrative and economic conditions (Miller, 1999, p. 48).

The concept of unified classrooms in Turkey has a long history. In 1951, a study was initiated for village schools. Prof. K. V. Wofford was invited to this study. Wofford proposed a new system, the "grouping system", instead of the "grade level system". Thus, he suggested that an equal level program for groups would be more effective. It is also known that these suggestions were included in the 1968 Primary School Program (Binbaşıoğlu, 1983, p.2). Today, there is no program specifically applied to combined classes. Combined classes and independent classes are subject to the same program. However, it is seen that the grouping system is applied according to student needs in the combined classrooms applied in rural village schools (Gözbaba, 2020). Having a special program for combined classes will make this practice more effective. Looking at the 2011-2012 data, it was found that 256,581 students were in combined classrooms and 35% of primary schools were combined classrooms. When the 2018-2019 education data are examined, there are 292,810 students studying in village schools, 22,971 teachers and 5731 schools. This shows the existence of 23% combined classrooms (Gözbaba, 2020; Gül et al., 2020; MEB, 2012). In the light of these data, it is important to emphasise the importance of the education provided with this practice, which has a considerable amount of combined classrooms over the years.

Unified classrooms practice is also seen in many countries of the world. We can list these countries as follows: Canada, Japan, the United States of America, Germany, France, Finland, Denmark, Denmark, the Netherlands, Sweden, Spain and many other countries. In some states of the USA, such as the state of Alabama, the rate of combined class application is quite high. In the state of Alaska, although the number of teachers to carry out the combined classrooms practice is low, teacher recruitment is approached meticulously (ATP, 2015; Erdem, 2011). Recent statistics show that the rate of combined classrooms in Finland is 16.4%, in Austria 15.3%, and in South Africa 30%. Research also shows that the quality of education in combined classrooms in these countries is quite difficult, especially for practitioners (Blease & Condy, 2015; Statistik Austria, 2013).

Reasons for Combined Classroom Practice

The practice of merged classrooms is based on some justifications. While one of them is geographical conditions, another one is the results of economic conditions. As a result of the changes in the population, there was a need for a unified classrooms practice in order to provide education in some way. The low number of students resulting from the low population brought along definitions according to rural areas. In addition, the problems of assigning teachers to these regions and the lack of sufficient number of classes made the combined class compulsory (Amaç & Yıldırım, 2020; Göçer & Palavan, 2017). Regarding this situation, UNESCO gathered the reasons for the unified classrooms practice under ten headings with the "Education for All" (EFA) report in 2005 (Little, 2004, p. 6):

1. In sparsely populated areas, all classes are taught together or with two teachers,

2. In sparsely populated areas, some educators teach combined classes within a school, while others teach separate classes,

3. Decrease in the number of educators and students in schools with self-contained classrooms over time,

4. The fact that there are school and classroom requirements in areas with increasing population, but these requirements are not met,

5. The lack of importance given to the school in the region due to the parents' desire to take their students to better schools,

6. A formal increase in the number of students enrolled in a branch, resulting in the merging of most students into other branches,

7. The presence of students of different ages and grade levels in mobile schools,

8. Teachers appointed to the regions do not go to these regions voluntarily and the need for teachers weakens in terms of quantity and quality,

9. The shortage of teachers in unified classrooms due to different reasons, despite the creation of a suitable educational environment and sufficient number of teachers,

10. Some schools find this practice more appropriate than regular education on the grounds of curricula and educational reasons.

When these items are taken into consideration, the reason for the use of combined classrooms is primarily the insufficient number of students due to the small population. In addition to this, reasons such as teacher shortage are among the items related to teachers. Only in the tenth item, it can be concluded that this practice is continued as a result of a preference. Due to the small number of students, it is considered more economical to teach all grade levels in one classroom with a single teacher instead of building several classrooms in a school. The idea that it would be safer for students at the primary school level to study with their families in terms of pedagogical aspects, and that it would be difficult for the child to leave the family from a young age with the transport system is considered important. From this point of view, it is considered as a social service provided by the state that students receive education in their regions (Göçer & Palavan, 2017; Gözbaba, 2020; Samancı, 2016; Taşar, 2014).

Advantages of Combined Classroom Practice

The concept of unified classrooms is a 'solution' rather than a 'problem' in the Turkish education system. Having a roof for education in rural areas with low and decreasing population is a system that provides a solution as it is a close option and easily accessible in conditions where geographical conditions are not suitable (Köksal, 2009; Ocakcı, 2017). When we look at the education applied in combined classes, it is seen that the goals to be achieved in self-contained classes emerge naturally in combined classes. With the development of students' self-discipline skills, self-learning, self-management, research, questioning and problem-solving skills develop. At the same time, it is seen that practices such as group work, co-operation and peer learning are more prominent. We can show the beneficial aspects of the unified classrooms practice as follows (Bilir, 2008; Erdem, 2019; Samancı, 2016; Şahin, 2015; Taşdemir, 2012):

1. Education can be provided in regions with low standards.

2. Teacher needs can be met and assignments can be made.

3. In rural areas with sparse populations, both the right to education and the principles of economy are respected without the need for large and costly schools.

4. Peer learning is realized by ensuring the interaction of student groups of different ages and levels.

5. Students develop their learning skills by working alone during homework hours when they are not under the responsibility of the teacher.

6. Sharing and cooperation behaviours are supported instead of competition among students.

7. Students who cannot reach the course outcomes with students at their own level for different reasons can learn from students at the previous level.

8. The small number of students allows the teacher to deal more easily with students with individual differences.

9. Depending on the class in which the lectures are given, the student has the opportunity to repeat the lessons of the previous year or to have preliminary knowledge about the lessons to be learnt in the following year.

Limitations of Combined Classroom Practice

Unified classrooms, which have a large proportion of primary schools among the institutions providing education within the state in Turkey, are considered important because they provide education to many students and are a different application. However, it has some limitations in terms of deficiencies in practice. These limitations can be listed as follows (Abay, 2007; Aksoy; 2008; Al, 2019; Ocakcı, 2017; Köklü, 2000; Köksal, 2009; Yılmaz, 2011):

1. Teachers who do not have experience in merged classrooms have difficulties in adapting to the location and merged classroom practice.

2. Facing transportation problems due to the fact that unified classrooms are generally far from city centers

3. Problems in accessing resources such as technology, infrastructure, school building needs, teaching materials

4. Migration from villages to cities and decrease in the number of students in this situation

5. The curriculum program applied in all schools is the same as the curriculum program applied in unified classrooms

6. The fact that teachers carry out the maintenance and administrative work of the school in addition to teaching

7. The problems of conducting lessons with different students according to age, individual differences, academic level, ability and knowledge variables at the point of reaching the desired goal.

The limitations listed in the literature are; adaptation problems of the teachers who are the implementers of the application, lack of a special program, technical infrastructure deficiencies, the difficulty of holistic conditions brought by different settlements.

Art Education

The existence of art is an indicator of an integrated phenomenon that begins with the existence of humanity and manifests itself in every aspect of life. Throughout the historical process, it has taken place in different cultures, different perspectives, and in this respect, in every position where human beings are located. While it is in question in every period, it has reached to the present day by being kneaded in the circle of human feelings and thoughts. In this case, the absence of a common definition specific to art is one of the most normal results. Famous philosophers and writers for the definition of art, have

defined art from their own perspectives. While Picasso sees art as a way of life, according to Hegel, art is the appearance of the soul in the essence. Bacon, on the other hand, sees art as the human being who settles in nature, and art is the life of man as a whole and the ability to convey his thoughts (Bakırhan, 2019; Türkdoğan, 1981; Yılmaz, 2021). Erinç (2010) defines art as "doing a job like a master and the product produced for the work done is the work of a master" (p. 102). Artut (2006) defines art as "Art is a universal means of communication and the most effective tool for the individual to express himself/herself and therefore to realize himself/herself" (p. 139). Balcı and Say (2013) define art as "Art is a human-specific activity and on this basis, everything that affects human beings also affects art" (p. 44).

Although the concept of art is a part of human and society, it is the common denominator of every change and development. Art, which is constantly developing, renewing and strengthening its bond with the period, introduces itself to new ages and generations. In addition to creating the dynamics of society and culture, it prepares the ground for the formation of great interactions. Art education is needed for the transfer of art knowledge. In this case, individuals are introduced to art education at a very young age and trainings are given from primary school level in order for the interpretation process to progress more quickly (Başbuğ & Başbuğ, 2016).

As societies have developed and changed depending on various variables, art education has also developed and changed depending on these variables. Art education, which closely follows the cultural, scientific, economic, geographical and political transformations of societies, has made progress within the framework of certain rules and planning. As the society has different expectations for the education system, the need for art education has been implemented according to different purposes and methods. In addition, the emergence of new fields of science such as psychology, philosophy, logic, natural science, sociology, anthropology and aesthetics has affected the sustainability of these aims and methods. With the emergence of movement formations and artists who pioneered the movement, the existence of new conceptions of art has been recognized. Thus, societies' different perspectives on art and artists have created new ways of thinking. The developments brought about by this situation have helped to start studies on the scientific basis of art education. Art education has gone through many stages in terms of history and has enabled societies and itself to progress by renewing (Şahin, 2018). Just as art is seen as a means of communication, art education is a phenomenon that enables this tool to be used in the most accurate way. Art education is one of the best ways to carry the traces of the past to today's world. Art education, which is planned and programd under the roof of education, shows order and responsibility to individuals. Art education enables individuals to have beautiful identities such as being rational, consistent, original, sensitive and harmonious, as well as being able to gain multidimensional thinking, research, questioning, creative thinking skills (Çellek, 2003; Gökdere, 2018).

Aim of Art Education

Education through art sheds light on the creativity of individuals, and emotions and thoughts are filtered and included in the construction process. Art education, which is the main element of intuitive education, aims at the development of individuals by considering the unity of characteristic features and skills (San, 1977). The aims of art education are defined by Read (1981) as; "To make emotional states understandable and shareable, to transfer experiences in the flow of consciousness, to be specific and standardized to the natural structure of perception and sensation" (p. 132). San (1977), on the other hand, stated the aims of art education according to today's perception as "emphasising the importance of art in human life, using art as a means of communication, supporting skills such as critical, creative and artistic thinking, creating aesthetic concern, shedding light on one's own cultural values as well as versatility" (p. 21). Based on these aims, art education should contribute to being productive and creative according to the age levels at which it will be effective. While supporting the behavioural and cognitive development of individuals, the goals are achieved by supporting the development of emotions (Yılmaz, 2021).

Art education starts with play in childhood for the first time in an individual's life. The behaviours, skills and emotions developed in this period prepare the ground for the child to discover himself/herself. In this process, the child begins to reveal what he/she experiences and what makes him/her feel through

art. In addition, while experiencing psychological relaxation, he/she starts to express himself/herself more comfortably and becomes emotionally stronger (San, 1983). Art education, especially in primary and secondary school periods, is the most important step of the child's personality and character development (Aslantaş, 2014). Art education is organized under various course names at primary and secondary school levels. These course names are 'Visual Arts', 'Art Activities' and 'Technology and Design' (Uygun, 2019, p. 15).

Visual Arts Education at Primary School Level

Visual Arts Education is the name given to all the theoretical and practice-based studies in higher education education levels, including pre-school period, which gathers many art branches under one title, including painting, architecture, sculpture, graphic, industrial and practical arts, as well as photography, cinema and fashion art (Kırışoğlu, 2009). The Visual Arts course in the current program was previously called 'Painting and Drawing'. The reason for changing the name of the course was that art education, which has intense goals in line with the effect of multiple perception stimuli brought by the conditions of our age, cannot achieve its goals under only one discipline area. In order to ensure awareness and adaptation in the age we live in, we must be prepared for constantly increasing stimuli. In this way, the Visual Arts course, which develops awareness and adaptation in individuals, should provide a broader perspective on the universally changing culture, art, science and life styles (Türkkan, 2008).

Visual arts course takes the important responsibility of raising art producers and consumers who are sensitive to art through the development of students' creativity and aesthetic consciousness. The main aim of this course is to raise creative, thinking, perceiving, expressing emotions and productive individuals who involve themselves in art, have aesthetic personality perception, take part in the construction of society. Visual Arts course does not aim to train students as artists. What is important is to help them develop intellectual, perceptual, intuitive and emotional aspects in the process. In this context, the discovery of artistic talents involves the process itself. Each stage in the process is possible by guiding the process in order to discover the student's innate talents. These guidance teachings are stated as showing the differences between looking and seeing, making the student feel visual discrimination, helping him/her transform his/her experiences into artistic form, supporting him/her to express his/her artistic expressions well according to the correct use of materials.

The Visual Arts Course program, which undertakes the tasks of art education at the primary and secondary school level, is included in the primary and secondary school curricula renewed in 2018. This program was accepted to be implemented gradually by including the 1st, 2nd, 3rd, 4th, 4th, 5th, 5th, 6th, 7th and 8th grades at primary and secondary school level (MEB, 2018). The program is planned with a constructivist approach, which is a student-centred understanding, taking into account universal values and stimuli suitable for today's age. It emphasized the need to prepare educational environments for this purpose by giving importance to out-of-class activities as well as in-class activities. For this purpose, the desired art environment will be achieved in terms of motivating students more easily, attracting their interest and directing them to artistic activities. With the program, the formation of aesthetic perception, development of hand-eye coordination, transfer of cognitive and affective experiences, application of interdisciplinary methods and techniques in a different way and putting them into practice with conscious guidance are important tasks undertaken by the program. However, in addition to the applications, the program includes theoretical examination and understanding of artworks from the past to the present, visual reading-writing and the development of art history awareness and art accumulation (Demir, 2014; MEB, 2018; Türkkan, 2008).

Primary and Secondary School Visual Arts (Grades 1-8) Curriculum

The program includes visual arts education for eight years and consists of successive stages: primary school (1st, 2nd, 3rd and 4th grades) in the first stage and secondary school (5th, 6th, 7th and 8th grades) in the second stage. In the first stage, the Visual Arts course is taught by classroom teachers, while in the second stage it is taught by teachers with a Visual Arts branch. It is seen that the curricula prepared for each discipline have common titles such as General Objectives of Curricula, Values, Competencies, Measurement and Evaluation Approach in Curricula, Individual Development and Curricula, and

Conclusion. Specific objectives, field-specific skills, points to be considered and explanations with achievements are prepared specifically for each course.

Specific Objectives of the Visual Arts Curriculum

Visual Arts education does not require an individual to be an artist or to have superior talents. Visual Arts education is a necessity for individuals from all age groups at all levels, as it provides advantages in terms of positive acquisitions and societies, such as self-expression, gaining aesthetic consciousness.

The aims of the Visual Arts Curriculum prepared in the light of these requirements:

1. Have visual literacy, perception and aesthetic awareness,

2. To have knowledge, skills and understanding of basic concepts and practices in the field of visual arts,

3. Actively participates in discussions about visual arts and evaluates these discussions,

4. Analyses the nature and origin of visual arts and questions its value,

5. Consciously monitors current culture-art objects/designs,

6. Understands the value of the cultural heritage of his/her own culture and other cultures and protects them,

7. Expresses his/her thoughts by using knowledge, materials, skills, techniques and technology effectively and safely in visual art works,

8. Associate visual arts with other disciplines,

9. Demonstrating ethical behaviour in the field of art,

10. Recognized professions related to the field of art,

11. To educate individuals who are willing to learn and apply Visual Arts.

Visual Arts Lessons in Combined Classes

When the literature was examined, only one study on the Visual Arts course given in unified classrooms was found. In this respect, our study is considered important in order to complete the deficiency in this field. The only study in the field is Kayalıoğlu's (2020) study titled "Investigation of Visual Arts Course Duration in Primary Schools with and without Unified Classes between 1948-2019" (p. 544). In this study, comparisons were made between the periods given to the Visual Arts course in independent and unified classrooms between certain years and suggestions were made for the necessity of extending the course periods. In the study, it is not possible to talk about a specially prepared program for combined and independent classes except for certain years. According to the results, it was decided that the Visual Arts course should be taught by the teacher of the class in all classes since 2012. At the same time, in the study, the problems of the classroom teachers arising from the lack of materials, workshops and materials in independent classrooms were determined. In addition to this, the problems of classroom teachers working in combined classrooms have been pointed out with a comment on how much difficulties classroom teachers who have difficulties in independent classrooms may have in combined classrooms.

When the current studies in this field are examined, the attitudes of teachers towards the Visual Arts course taught by classroom teachers in primary school and the problems they encounter are discussed. Özcan (2017) examined the evaluation of the Visual Arts curriculum by classroom teachers. In his study, classroom teachers stated that although they considered the curriculum sufficient, they did not have enough information about the curriculum, there were no areas for the course, there was no room for group work due to the crowded classes, and they had problems with insufficient class time. In the study conducted by Gökdemir and Filiz (2018) in order to identify the problems experienced by 3rd and 4th grade teachers in Visual Arts lessons and to suggest solutions to these problems, it was concluded that teachers' attitudes towards the Visual Arts course were positive, but they encountered some problems. These problems were expressed as lack of materials for most of the teachers, not being supported by the school administration, not having special workshops for the course, the achievements not being at an

understandable and applicable level, being a course that seems unnecessary for parents, and not bringing the materials. Şenkaya (2021), in his study, met with 108 educators on the problems encountered by classroom teachers in the Visual Arts course and the evaluation of teachers' opinions. Classroom teachers emphasized that teaching art to students within the scope of the Visual Arts course is very important for raising individuals who enjoy life. It was concluded that the classroom teachers were competent in the visual arts program, that they were able to transfer the methods and techniques to the students, and that they did not have difficulties in the implementation, feedback and evaluation stages. However, it was also concluded that some teachers did not feel themselves competent in the field of cultural heritage. In addition, it was stated that the general problem was due to the insufficient duration of the lessons.

The researches address the problems experienced by classroom teachers in the Visual Arts course as a result of the inadequacy of the program, workshops, materials and class hours. These problems are within the scope of the problems experienced by classroom teachers teaching in self-contained classrooms. In unified classrooms, it should not be difficult to estimate the quality of the Visual Arts course, which is taught for one hour in the curriculum. It is a known fact that more of these problems are experienced.

Aim of Study

The aim of this study is to create a perspective on the Visual Arts course from the perspective of the classroom teacher who is the implementer of the lessons in unified classrooms and to reveal the experiences. It is a matter of curiosity what kind of results the unified classrooms practice, which can sometimes be seen as a problem or an advantage in terms of education, produces in terms of art education.

For this reason, this study is considered important as it is the first study in the literature in terms of analyzing the positive and negative situations related to the Visual Arts course implemented in unified classrooms. In the study, the opinions of primary school teachers, their metaphorical descriptions and the conversations (debriefing) on the image obtained from the artificial intelligence application (Image 1.) were used as sources to obtain data.

Method

Research Model/Design

Phenomenology design, one of the qualitative research designs, was preferred in the study. In phenomenological research, it is aimed to reveal the perceptions and experiences of the participants from their perspective (Ersoy, 2016). In this study, the phenomenology design was preferred since the participants' perceptions and experiences about visual art education in unified classrooms were tried to be revealed.

Group of Study

The study group of this research consists of 10 classroom teachers (4 female and 6 male) working in primary schools in a provincial centers in Anatolia and teaching in combined classrooms. In determining the study group, convenient sampling method, one of the purposeful sampling methods, was taken as a basis. In this sampling, which prioritizes being easily accessible and convenient at the same time, the easiest and most accessible subjects are evaluated in the context of data until the sample of the required size is obtained (Berg & Lune, 2019; Gürbüz & Şahin, 2018).

Data Collection Tool

In this study, semi-structured interview form, metaphor study and artificial intelligence drawing application were used as data collection methods. The data obtained from the metaphors were transformed into a meaningful text and concretized with a colored drawing (Figure 1.) with an artificial intelligence application. The instruction given to artificial intelligence was limited to one time only. Afterwards, conversations (Debriefing) were held with the participants on the resulting visual to ensure

the internal consistency of the study and to concretize abstract expressions. The instruction given to the artificial intelligence was presented together with the visual.

Data Analysis

Within the scope of the research, categorical analysis technique, one of the types of descriptive content analysis, was used to analyze the data. The themes, categories and subcategories were tabulated and analyzed to make in-depth inferences.

The processes of data collection and analysis were reported in detail, filed and recorded in computer programs. The documents and findings were evaluated by another researcher and the similarities between the two evaluations were taken into consideration. For the consistency of this study, Miles & Huberman (1994) calculation formula [Reliability=Agreement/(Agreement+Disagreement)x100] was used. As a result, an acceptance rate of 90% was obtained. At the same time, artificial intelligence drawing and debriefing phases also contributed in this sense (Fraenkel et al., 2012). With the debriefing technique, participants were made to talk about the visual (Image 1.). The compatibility of the data obtained from these conversations and the metaphors presented regarding the situation of art education in unified classrooms is expressed as a percentage in Table 7. Thus, the research was supported in terms of internal consistency.

Results

Visual arts theme

Under the visual arts theme, there are social, cognitive, kinesthetic, artistic and spatial categories. Categories and subcategories were tabulated and analyzed.

Table 1.
Participants' opinions about the visual arts course

Theme	Category	Sub-Category	Frekans(n)
Visual Arts	Social	Self-expression	6
		Reflective	2
	Cognitive	Original thinking	5
		Synapse	1
	Kinesthetic	Skill development	3
	Artistic	Creativity	3
		Development of aesthetic perception	1
	Spatial	Imagination	5
		Detachment from reality	3
		Three-dimensional thinking	1

Looking at the data (Table 1.); it is seen that the participants constructed the visual arts course in their minds in five categories. At the top of these categories are the *"social"* (*f*=8) and *"cognitive"* (*f*=6) benefits of the visual arts course. The *"social"* benefits of the course: *"expressing oneself"* (*f*=6) and using competencies in a *"reflective"* way (*f*=2). In terms of *"cognitive"* benefits, *"original thinking"* (*f*=5) and *"synapses"* in the brain (*f*=1) becoming effective are among the schemas that participants have in their minds about the course. When the positioning of the course in the minds of the participants is analyzed, it is seen that *"kinesthetic"*, *"artistic"* and *"spatial"* benefits are also expressed by many participants. Three participants stated that the course supported skill development in the kinesthetic sense. In terms of *"artistic"*, participants stated that the course contributed more to the development of *"creativity"* (*f*=3), while one participant emphasized the effect on *"aesthetic perspective"*. In the category of *"spatial"* intelligence, the participants emphasized the concepts of *"imagination"* (*f*=5), *"getting away from reality"* (*f*=3) and *"three-dimensional thinking"* (*f*=1). P2 expressed her opinion on this theme in one-to-one interviews as follows: “It expresses the imagination of the students to me. Because it allows students to get away from the real world by going out of their own world and discover their imaginary world” (P2, 2023).

When these data are evaluated, it can be concluded that the participants schematized the visual arts course as *"what can be the benefits?"* in relation to real life. Especially in terms of its contribution to students, they stated that the visual arts course can make a difference and support the development of

people in many subjects. It can be inferred from the data that creative, reflective, original and self-expressive individuals who can get away from reality can be possible with visual arts education.

The theme of art education in combined classrooms

Under this theme are the categories of culture, psychomotor benefit, social need and psycho-social benefit. Similar to the previous theme, a tabulation and analysis process was carried out.

Table 2.
Participants' opinions on the necessity of art education in unified classrooms

Theme	Category	Sub-Category	Frekans(n)
Art education in combined classrooms	Culture	Love of art	6
	Cognitive	Higher order thinking	6
		Ability to express	4
	Psychomotor	Skill development	5
	Social need	Aesthetic life	4
		Making sense of life	2
	Psycho-social	Getting to know the child	3
		Fun mode	2

The participants responded to the interview question about the necessity of art education in unified classrooms with answers in the categories of *"culture"*, *"psychomotor"*, *"social need"* and *"psycho-social"*. As *"culture"*, the necessity of the course was emphasized for the formation of *"love of art"* (*f*=6) in individuals. As *"cognitive"*, the concepts frequently expressed by the participants that art education develops situations such as *"high-level thinking"* (*f*=6) and *"expression ability"* (*f*=4) in individuals were included in Table 2. In terms of *"psychomotor"*, the importance of *"skill development"* (*f*=5), which reflects the internal dynamics of the course, is shown. The necessity of art education as a *"social need"* is associated with *"aesthetic life"* (*f*=4) and *"making life meaningful"* (*f*=2). At the same time, the *"psycho-social"* aspects of art were expressed in terms of *"getting to know children"* (*f*=3) and *"having fun"* (*f*=2). Participant P5 gave the following response to this question: "In this activity that children will do all together, I include more group work, which increases cooperation, responsibility and sociability skills" (P5, 2023).

These data show that art education (visual art education) is very necessary as a life-oriented and individual need according to the statements of teachers who are in the kitchen. It emerges that art education has a great role in shaping the individual and life and should be thought about in a real sense.

The theme of self-efficacy

How do the participants evaluate themselves in terms of being able to provide and conduct art education? The answers revealed by the interviews were analyzed under this theme with the categories of negative emotion, positive perception and dedication and related subcategories.

Table 3.
Participants' thoughts on their self-efficacy in providing art education

Theme	Category	Sub-Category	Frekans(n)
Domain knowledge/self-efficacy	Negative emotion	Feeling incomplete in implementation	6
	Positive perception	An enjoyable process	1
		Everyone is happy	1
		Theoretically I'm fine	1
	Dedication	Preparing thoughtfully	5
		Outstanding effort	4

Table 3 shows the participants' views on their ability to provide art education. According to this, the participants mostly saw themselves as deficient in terms of being able to provide art education. This *"negative feeling"* (*f*=6) was expressed as *"feeling incomplete"* in the presentation of the course in terms of practice. The participants stated that they had more or less knowledge, but they did not have enough equipment to be able to practice. Regarding this situation, P6 and P1 stated the following:"I am someone who reads and writes on my own. However, I do not consider myself very competent in terms of visual arts" (P6, 2023).

Some of the participants also had a *"positive perception"* about self-efficacy in art education. They defined this situation as *"enjoyable"* and *"a process where everyone can be happy"* (*f*=1). In addition, only one of the participants stated that he was *"theoretically"* good in the context of art education. Continuing with the analysis of the data, it is seen that the participants have a *"dedication"* to art education. *"Preparing for the lesson by thinking"* (*f*=5) and spending *"superior effort"* (*f*=4) are at the forefront. The statements of K1, one of the participants regarding this situation are given below.

> Since it is a field that I love and am interested in, I enjoy doing these activities with my students. I try to teach students what I have learned about this subject. I do not think that I am inadequate in providing art education. Of course, there may be some points where I am lacking because I am not an expert in this subject. But I try to do my best to help primary school students gain the skills I mentioned above within the limits of the possibilities. Maybe if our possibilities were different, I could express more clearly that I could get better results. But unfortunately not (P1, 2023).

When these data are evaluated, it is seen that the participants are sensitive about art education as a teacher and that they put forth their best efforts. However, it is revealed that the participants are insufficient in field-based practical issues. The suggestions of the participants about "what can be done" regarding this situation are presented in Table 4.

What can be done to improve art education (visual arts) in schools with unified classrooms?

In this section, what can be done in schools with unified classrooms to improve art education? The question was addressed. In this sense, the situations experienced by the participants and their experiences were deciphered as suggestions. The analysis process related to this was included.

Table 4.
Participants' opinions on improvements in art education

Theme	Category	Sub-Category	Frekans(n)
Improvement of schools with unified classrooms	Economic investment	Workshop	6
		Transportation	1
		Travel	1
		Technological capability	1
	System	Lesson hours	3
		Village Institutes	1
	Auxiliary resources	Guidebook	4

When the data in Table 4 are analyzed, it is seen that the idea that measures in terms of *"economic investments"*, *"system"* and *"auxiliary resources"* can contribute to art education in unified classrooms is dominant. Especially in terms of *"economic investment"*, the creation of *"workshop"* (*f*=6) opportunities was expressed by more than half of the participants. In addition, improving *"technology"*, *"excursion"* and *"transportation"* opportunities (*f*=1) are among the other economic investments that should be considered by the participants. In terms of "system", participants suggested *"increasing the number of class hours"* (*f*=3) and *"village institutes"* style education (*f*=1). Many participants (*f*=4) emphasized that a *"guide book"* that they can refer to when they get into a deadlock can also be important in this sense. Some one-to-one excerpts of the participants' responses under this theme are as follows:

> In order to create a common art culture in students, I would prepare a guidebook for teachers to use in their lessons. There could be works that teachers could do at their fingertips, appropriate to the level of the students, that they could enjoy. The other contribution I would like to make would be technology. Since technology is in our lives, creative artistic coding training could be included in this course (P1, 2023). The achievements that should be given in other courses can be simplified and the lesson hours allocated for art can be increased (P4, 2023).

When these data are evaluated, it is seen that when teachers are provided with sufficient help and opportunities, a much more effective structure will be formed in the name of art education. The most important of these aids are workshop facilities, guidebooks and increasing the number of class hours. Thus, it may be possible to create healthy individuals in terms of healthy education and the healing power of art.

The metaphorical depictions of art education (visual arts) in the minds of the participants in unified classrooms

In this section, the analysis of the participants' metaphorical perceptions about the visual arts course being given in unified classrooms and the process of concretizing the resulting data through artificial intelligence are presented.

Table 5.
Participants' metaphorical descriptions of art education in unified classrooms

Theme	Category	Frekans(n)
Art education in combined classes	Rainbow	3
	A riot of colors	3
	Diversity	2
	Holding hands	2
	Potential	2
	Cooperation	2
	Colorful brush strokes	2
	White	2
	Gray	1
	Excitement	1
	Discovering	1
	Black	1
	Creativity	1
	Colored palette	1
	Joy	1

Participants associated art education in unified classrooms with colors, differences, unity and originality in terms of representation. The categories of *"rainbow"* and *"riot of colors"* (*f*=3) were mostly produced as metaphors for art education in unified classrooms. In addition, *"diversity"*, *"holding hands"*, *"potential"*, *"cooperation"*, *"colorful brush strokes"* and *"white"* (*f*=2) color categories are also seen as the most frequently used metaphors for the theme of art education in unified classrooms. In this sense, some of the direct quotations for the metaphors produced by the participants are as follows: "Art education in unified classrooms is like a rainbow, because there are every color in art" (P7, 2023). "..... is like joy, it is a cause of happiness for every student I see" (P8, 2023).

When we look at the other metaphors produced, it is seen that the concepts of *"gray"* and *"black"* in terms of color, *"excitement"*, *"discovery"*, *"creativity"*, *"colored palette"* and *"joy"* are categorized as the dynamism provided by the course (*f*=1). Some of the direct quotations for the metaphors produced by the participants related to these categories are as follows:

> I think art education in unified classrooms is gray, because I think village children have a great potential artistically because they live in nature, they are not buried in concrete, they are in a very favorable environment for art, this is a white color. On the one hand, the fact that they are forgotten evokes a black color. When both are mixed, it becomes gray" (P6, 2023). ..... It is like a riot of colors that come together with colorful brush strokes, because it is complex, potential, ready to be discovered, where differences are together, exciting (P1, 2023).

When we look at the metaphors produced by the participants, art education can be described as an artistic and socially unifying, entertaining, creativity-enhancing field that has the potential to include many colors. In this sense, unified classrooms can be an opportunity for empathic skills and collaborative attitudes in terms of art education. When all these metaphorical descriptions come together, what kind of a picture would emerge if art education was transformed into a picture? In this sense, an artificial intelligence supported product (Image 1.) was created to concretize the metaphors. This artificial intelligence description below belongs to the picture that emerged from this text after the metaphors were transformed into a meaningful text. The text is presented together with the picture.

I would say it is a riot of colors coming together with colorful brushstrokes. It would be an exciting work where differences come together, complex but with potential, ready to be explored. In this work, there will be creativity that will emerge by shifting the brushstrokes and creating new combinations. A work that evokes the impression of diversity, unity and collaboration. A palette of various colors in a painting, different figures coming together and holding hands, would symbolize students learning together in diversity and the unifying power of art.

Figure 1. The Participants' Responses for the Metaphor Study Applied as "Art Education is Like ...., Because ....." Were Transformed into a Picture with an Artificial İntelligence Application After Being Transformed into aMeaningful Paragraph

At the same time, the accuracy of this picture of the participants' metaphorical perceptions was also reviewed for the participants. The internal consistency of the study was supported by asking the participants to what extent the picture created with artificial intelligence reflects your metaphorical perceptions of art education. In this sense, the percentage data regarding the participants' responses to this question are given in Table 6.

Table 6.
Percentage responses of the participants regarding the extent to which artificial intelligence drawing overlaps with the metaphorical perceptions they produced for their own art education

Participant	%
P1	60
P2	100
P3	70
P4	80
P5	85
P6	85
P7	90
P8	85
P9	85
P10	85

Most of the participants stated that the picture created with the artificial intelligence application reflected their own views to a great extent. When the averages of the answers given by the participants in percentages are taken, a rate of 92.5% emerges. This shows that there is consistency between the drawing and the opinions. In this sense, it can be shown among the results of the study that the data of the artificial intelligence application can be used as an important factor in concretizing the research data.

Discussion and Conclusion

The practice of merged classrooms continues for some reasons. The most prominent ones are geographical and economic conditions. Population distribution and variable population rates are other factors. The definitions of rural and urban due to the insufficiency of the population have created effects at this level. In addition, there are problems in teacher assignments in rural and less populated areas. For this reason, it is inevitable that the classes are combined and transformed into combined classes. This situation creates different positive-negative situations (such as efficiency-inefficiency, success-failure, job satisfaction, etc.) on behalf of education.

In this study, a phenomenological evaluation was made on art education in the Visual Arts course from the perspective of classroom teachers who are the implementers of the lessons in unified classrooms. The aim is to create a perspective and to reveal the experiences. The results of the unified classroom practice, which can be seen as a problem in terms of education, in terms of art education were revealed with the views of the participants.

When the literature was examined, a study was found in which unified classrooms and Visual Arts course were handled together. Kayalıoğlu (2020) comparatively examined the course hours of the Visual Arts course in independent and combined classes in the curricula between 1948-2019. As a result of this examination, it was stated that the duration of the Visual Arts course in grades 1-4 was not sufficient for grades and should be increased rapidly. For this reason, this study can be seen as the first study in the literature in terms of analyzing the positive and negative situations related to the Visual Arts course implemented in combined classes. In the study, the opinions of primary school teachers, their metaphorical descriptions and the conversations (debriefing) on the image obtained from the artificial intelligence application (Figure 1.) were evaluated as sources.

Studies (Aydın, Coşkun, & Sidekli, 2015; Özdemir, Özdemir, & Gül, 2020; Tabur, 2023; Temizyürek, 2019) have revealed that the curriculum should be reviewed in the context of art education and branch teachers should be evaluated in terms of course presentation. It was observed that the theoretical knowledge that classroom teachers received during their undergraduate education about unified classrooms could not find its equivalent at the application stage. As a result of the studies, it was revealed that the teaching practices in the undergraduate education process are generally carried out in city centres, and teachers who encounter this practice in villages without seeing the unified classroom practice experience adaptation problems. In addition, the collection of combined and independent classroom curricula and course materials under the same roof causes problems for education stakeholders (Aydın, Coşkun, & Sidekli, 2015; Özdemir, Özdemir, & Gül, 2020). Classroom teachers may consider themselves inadequate in terms of presenting these lessons. Kahraman (2007), in his study examining the problems encountered by classroom teachers in the implementation of the visual arts curriculum, expressed the opinions and suggestions that the curriculum is incomplete in terms of suitability to the level and that the curriculum should be restructured, that branch teachers should teach the course based on the opinions that the course is not important, and that classroom teachers should get in-service training due to their inadequacy in most studies. Adıgüzel & Tomsur (2010) revealed the problems of classroom teachers that the Visual Arts course is ignored by administrators and parents, that there is a lack of suitable areas and materials for the course, and that teachers are insufficient in supporting students' artistic works. There are similar situations with this study. Especially in terms of materials, workshops and reviewing the course hours.

Likewise, there are studies (Gökdemir & Filiz 2018; Özcan, 2017) that reveal similar results with this study in terms of the contributions of the course to students. Researchers have determined that the Visual Arts course develops creativity, self-confidence, self-discipline and imagination skills in students. In addition, they suggested taking steps such as increasing the course hours in the programme, making the achievements suitable for age and level, raising awareness of parents and administrators towards the course, and providing workshops and materials in order to teach the course in a better quality. Similarly, Gökdere (2018) presented the gains provided by the use of activities in the implementation of the general objectives of the visual arts course taught at the primary school level to the opinions of classroom teachers. The general aims of the course were analysed in three categories: perceptual, aesthetic and technical aims. According to the results of the study, the teachers commented that at the perceptual level,

students' level of perception and imagination improved, their creative thinking and action skills improved, their visual perception level increased and artistic expressions were formed. In the direction of aesthetic and technical purposes, the teachers expressed the opinions that the students' perspectives on the concepts of art, artist and artwork changed, that they benefited from aesthetic art values while expressing themselves, that they were able to make appropriate choices in the use of tools and equipment, and that they improved their ability to make use of different techniques.

The results of this study revealed a more positive perspective compared to other studies. As a result of the research, it was revealed that teachers constructed the lesson more on the basis of its benefits. That is to say, they considered the course in terms of utilitarianism (in terms of society and students; individuals who can get away from reality, creative, reflective, original and self-expressive). The statements of the teachers who are in the kitchen revealed that art education (visual art education) is very necessary as a life orientation and an individual need. It was seen that the role of art education in shaping the individual and life is great and should be considered in real terms. It is seen in the results of some studies (Adıgüzel & Tomsur 2010; Kahraman 2007; Tabur, 2023; Temizyürek, 2019) that classroom teachers feel inadequate in providing art education. Similar results were also found in this study. However, it was observed that there were idealistic teachers who were self-confident and tried to put forth their best efforts at the highest level. Contrary to the literature; in this study, it was reflected in the results of the research that art education in unified classes had positive results and had a positive effect on both social development and artistic development. Especially the metaphor study and the artificial intelligence supported picture study created in this context revealed this. The picture study concretised the teachers' views on art education in unified classrooms and revealed a positive perspective according to their own views. It is thought that the subjective structure of art, its unifying / calming and impressive power is an effective situation in this regard.

The research can be repeated by implementing visual art training (in-service training) to classroom teachers. In addition, it can be reconsidered through a similar situation in a regional or another country. A new study supported by artificial intelligence can be designed. Teachers' opinions after the creation of the guidebook can also be evaluated.

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Data Availability Statement: The data produced within the scope of the research and the resulting evaluations can be obtained and used at this address.

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References

Abay, S. (2007). *Birleştirilmiş sınıflarda sosyal bilgiler öğretimindeki sorunlar.* (Yüksek Lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 205393)

Adıgüzel, A. & Tomsur, N. (2010). Sınıf öğretmenlerinin görsel sanatlar dersi öğretiminde karşılaştıkları sorunlar. *Education Science, 5*(4), 1677-1689. http://www.dergipark.org.tr/tr/pub/nwsaedu/issue/19822/212235 adresinden edinilmiştir.

Aksoy, N. (2008). Birleştirilmiş sınıflarda eğitim-öğretim: Genç ve deneyimsiz öğretmenlerin görüşlerine dayalı bir araştırma. *Eğitim, Bilim ve Toplum Dergisi, 6*(21), 82-108.

Al, H. (2019). *Birleştirilmiş sınıflarda görev yapan müdür yetkili öğretmenlerin sınıf yönetimi becerileri ile iş doyumları arasındaki ilişkinin incelenmesi.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 600796)

Amaç, Z. & Yıldırım, F. (2020). Sınıf öğretmeni adaylarının birleştirilmiş sınıf uygulamaları: görüş ve öneriler. *Fırat Üniversitesi Sosyal Bilimler Dergisi, 30*(2), 203-220. https://doi.org/10.18069/firatsbed.752224 adresinden edinilmiştir.

Artut, K. (2006). *Sanat eğitimi kuramları ve yöntemleri*. Ankara: Anı.

Aslantaş, S. (2014). *Görsel sanatlar dersine yönelik tutum ölçeği geliştirilmesi*. *Uluslararası Türk Eğitim Bilimleri Dergisi,* (2), 185-196.

ATP. (2015, Ocak 02). *Teaching in multiage and multigrade classrooms*. ATP. https://alaskateacher.org/multigrade_teaching.php

Aydın, Y., Coşkun, İ. & Sidekli, S. (2015). Köyde öğretmen olmak: birleştirilmiş sınıf. *Trakya Üniversitesi Sosyal Bilimler Dergisi, 17*(1), 311-331.

Bakırhan, A. (2019). *Sınıf öğretmenlerinin görsel sanatlar dersine ilişkin tutumları ve alan bilgisi yeterlilikleri üzerine bir araştırma*. (Doktora tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 550954)

Balcı, Y. B & Say, N. (2013). *Temel sanat eğitimi.* İstanbul: Ya-Pa.

Başbuğ, F. & Başbuğ, Z. (2016). Görsel sanatlar eğitimi üzerine notlar. *Akdeniz Sanat Dergisi, 9*(18), 74-98.

Berg, B. L. & Luna, H. (2019). *Sosyal bilimlerde nitel araştırma yöntemleri* (A. Arı, Çev. Ed.) Eğitim Yayınevi. (Çalışmanın orijinali 2016`da yayımlanmıştır)

Bilir, A. (2008). Teacher and educational fact at multigraded classrooms rural primary schools. *Ankara University Journal of Faculty of Educational Sciences (JFES), 41*(2), 1-22. doi.org/10.1501/Egifak_0000001130

Binbaşıoğlu, C. (1983). *Birleştirilmiş sınıflarda öğretim rehberi.* İstanbul: Binbaşıoğlu.

Blease, B. & Condy, J., (2015). 'Teaching of writing in two rural multigrade classes in the Western Cape', *Reading & Writing 6*(1), 1-9. doi.org/10.4102 / rw.v6i1.58

Çellek, T. (2003). Sanat ve bilim eğitiminde yaratıcılık. *PİVOLKA, 2*(8), 4-11.

Demir, S. (2014). *Sınıf öğretmenlerinin öğrencilerin görsel sanatlar dersinin amaçlarına erişi düzeylerine ilişkin görüşlerinin belirlenmesi.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 381225)

Demirel, Ö. (2019). *Eğitim sözlüğü* (7. baskı). Ankara: Pegem.

Erdem, A.R. (2011). *Birleştirilmiş sınıflarda öğretim* (6. Baskı). Ankara: Anı.

Erinç, S. M. (2010). *Kültür sanat – sanat kültür* (1. baskı). Ankara: Ütopya.

Ersoy, A. F. (2016). Fenomenoloji (3. baskı). A. Saban & A. Ersoy (Ed.) *Eğitimde nitel araştırma desenleri* içinde. Ankara: Anı.

Fraenkel, R. J., Wallen, E. N., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th edition). New York: McGraw-Hill.

Göçer, V. & Palavan, Ö. (2017). Sınıf öğretmenlerinin birleştirilmiş sınıflarda karşılaştıkları problemler (Malatya ili örneği) . *Kırıkkale Üniversitesi Sosyal Bilimler Dergisi, 7*(2), 69-96.

Gökdemir, M. A. & Filiz S. B. (2018). Sınıf öğretmenlerinin görsel sanatlar dersinde karşılaştıkları sorunlar ve bu sorunlara ilişkin çözüm önerileri (Mardin örneği). *Turkish Studies, 13*(19), 775-793. doi.org/10.7827/TurkishStudies.13976

Gökdere, E. (2018). *İlkokul 1-4.Sınıf Görsel Sanatlar Dersinin genel amaçlarının etkinlikler yoluyla kazandırılabilmesine yönelik sınıf öğretmenlerinin görüşlerinin incelenmesi.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 527571)

Gözbaba, Y. (2020). *Birleştirilmiş sınıfta bütünleştirilmiş öğretim programı uygulamaları.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 672341)

Gürbüz, S., & Şahin, F. (2018). *Sosyal bilimlerde araştırma yöntemleri: felsefe-yöntem-analiz* (5. baskı). Ankara: Seçkin.

Gül, M., Özdemir, M. & Özdemir, O. (2020). Birleştirilmiş sınıflı okullarda görev yapan sınıf öğretmenlerinin birleştirilmiş sınıf uygulamalarına ilişkin görüşleri. *Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi, 7*(6), 87-101.

Kahraman, D. (2007). *Sınıf öğretmenlerinin Görsel Sanatlar dersi programının uygulanmasında karşılaşılan sorunlara ilişkin görüşleri ve çözüm önerileri.* (Yüksek Lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 210092)

Kayalıoğlu, S. (2020). 1948-2019 Yılları arasında birleştirilmiş sınıflı olan ve olmayan ilkokullarda görsel sanatlar dersi sürelerinin incelenmesi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi, 21(1), 544-594.* https://doi.org/10.29299/kefad.2020.21.01.015

Kırışoğlu, O. T. (2009*). Sanat kültür yaratıcılık görsel sanatlar ve kültür eğitimi öğretimi.* (1. baskı). Ankara: Pegem.

Köklü, M. (2000). *Birleştirilmiş sınıfların yönetimi ve öğretim.* İstanbul: Beta.

Köksal, K. (2009). *Birleştirilmiş sınıflarda öğretim*. Ankara: Pegem.

Little, W. A. (2004). *Learning and teaching multigrade settings.* UNESCO 2005 EFA. http://multigrade.ioe.ac.uk/fulltext/fulltextLittle.pdf adresinden edinilmiştir.

MEB (2012). Birleştirilmiş sınıflar haftalık ders programları. Erişim adresi: https://www.memurlar.net/common/news/documents/288521/25105720_14043746_birlestirilmis_snflar_haf_ders_prg.pdf

MEB (2018). Görsel Sanatlar öğretim programı. Erişim adresi: http://mufredat.meb.gov.tr/dosyalar/2018121111026326-gorsel%20sanatlar.pdf

Miles, M. B. & Huberman, A. M. (1994). *Qualitative data analysis: an expanded sourcebook* (2. Baskı). Thousand Oaks, CA: Sage.

Miller, B. (1989). *The multigrade classroom: A resource handbook for small, rural schools. Portland,* OR: Nortwest Regional Educational Laboratory.

Ocakcı, E. (2017). *Birleştirilmiş sınıf öğretmenlerinin sınıf yönetimi yeterlilikleri ve sınıf yönetimi ile ilgili görüşlerinin incelenmesi***.** (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 469425)

Özcan, M. (2017). *Görsel sanatlar (1- 8 sınıflar) dersi programına yönelik görsel sanatlar öğretmenlerinin görüşleri ve çözüm önerileri.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 481291)

Read, H. (1981). *Sanat ve toplum*. (S. Mülayim, Çev. Ed.). İstanbul: Umran.

Saadet, A. (2020). *Birleştirilmiş sınıf ile ilgili yapılan çalışmaların sistematik bir literatür incelemesi.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 631279)

Samancı, O. (2016). *Birleştirilmiş sınıflarda öğretim.* Ankara: Pegem.

San, İ. (1977). *Sanatsal yaratma ve çocukta yaratıcılık.* İstanbul: İş Bankası.

San, İ. (1983). Sanat Eğitimi. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Dergisi*, *16*(2), 215.doi.org/10.1501/Egifak_0000000828

Statıstık Austrıa (2013) Schulstatistik2012/2013 (Sonderauswertung) [Schoolstatistics2012/2013: specialevaluation].

Şahin, A. (2018). *İlk ve ortaöğretimde görsel sanatlar dersinin yeterliği.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 528208)

Şahin, Ç. (2015). Birleştirilmiş sınıflara ilişkin temel bilgiler. Ç. Şahin (Ed.), *Birleştirilmiş sınıflarda öğretim* içinde (ss.1-30). Ankara: Pegem.

Şenkaya, Ç. S. (2021). *Sınıf öğretmenlerinin Görsel Sanatlar Derslerinde karşılaştıkları sorunlar ve öğretmen görüşlerine göre değerlendirilmesi (Bursa ili örneği).* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 675663)

Tabur, B. (2023). *Birleştirilmiş sınıflarda görev yapan öğretmenlerin karşılaştıkları sorunlar: bir anlatı araştırması.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 782468)

Taşar, H. H. (2014). Birleştirilmiş sınıflarda öğretim uygulamasının nedenleri. T. Dilci (Ed.), *Teoriden pratiğe birleştirilmiş sınıf uygulamaları* içinde (ss. 21-30). İstanbul: İdeal Kültür.

Temizyürek, S. (2019). *Birleştirilmiş sınıfta görev yapan öğretmenlerin karşılaştıkları sorunların incelenmesi (Kayseri ili örneği).* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 597136)

Türkdoğan, G. (1981). *Sanat eğitimi yöntemleri*. Ankara: Ayyıldız.

Türkkan, B. (2008). *İlköğretim görsel sanatlar dersi bağlamında görsel kültür çalışmaları: bir eylem araştırması.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 229220)

Türkoğlu, D., Kandır, A., & Gözüm, A. İ. C. (2021). A portfolio inventory: an investigation of visual artwork made by children as being tool or art oriented in structure. *International Online Journal of Education and Teaching (IOJET), 8*(4). 2825-2850.

Uygun, M. (2019). *06-10 yaş grubu ilkokul öğrencelerine yönelik görsel sanatlar dersi portre çalışmalarının öğrencelerin duygularını aktarmadaki yeri ve öneminin incelenmesi.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 588642)

Yılmaz, F. (2021). *4. ve 5. sınıf öğrencilerinin görsel sanatlar dersine yönelik tutumlarının incelenmesi.* (Yüksek lisans tezi).Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 693349)

Yılmaz, M. (2011). *2005 Sosyal Bilgiler dersi öğretim programının birleştirilmiş sınıflarda uygulanabilirliğinin öğretmen görüşlerine göre değerlendirilmesi.* (Yüksek lisans tezi). Yükseköğretim Kurulu Ulusal Tez Merkezi'nden edinilmiştir. (Tez No. 296367)

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The Effect of a Sense of School Belonging on Academic Achievement: A Meta-Analytical Review

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Abstract

The concept of a sense of school belonging has gained increasing attention in the educational community due to its numerous developmental and educational advantages. Nevertheless, research on a sense of school belonging has been scattered and has missed certain clarity for the terminology ambiguity. Therefore, it is necessary to conduct a meta-analysis to eliminate the ambiguity regarding the terminology of 'a sense of school belonging' and to determine the relationship between a sense of school belonging and academic achievement. The aim of this study is to determine the effect of a sense of school belonging on academic achievement and to explore the factors that may moderate this relationship. The publication year and the measurement tool are determined as moderator variables for this study. A pool of 6,891 studies was created, including titles containing the terms 'a sense of school belonging' and 'academic achievement'. Twenty-two studies that met the inclusion criteria were selected for the analysis. The findings indicate a statistically significant, albeit small, effect of a sense of school belonging on academic achievement. Notably, the effect of a sense of school belonging varied across publication years and the effect size gradually decreased over time. Furthermore, the analysis found no statistically significant differences among the measurement tools. This finding suggests that the effect of a sense of school belonging on academic achievement remains consistent across different measurement tools. This is significant as it implies researchers can use various measurement tools to study this relationship without worrying about bias or unreliability.

Keywords: academic achievement, a sense of school belonging, meta-analysis.

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Introduction

There has been a growing focus on educational research concerning the exploration of social and environmental factors and their impact on student academic performance. As one of the important factors, a sense of school belonging contributes to higher levels of academic achievement and protects students from dropping out (Anderman, 2002). Goodenow (1993) defines a sense of school belonging as the feeling that a student develops that he or she is personally accepted and supported by others in the school. Goodenow (1993) also states that this feeling is gained as a result of mutual social relations between the students and their friends and teachers. On the other hand, Osterman (2000) views a sense of belonging as a crucial aspect in understanding students' behavior and performance, pointing out that students who share common values and have high expectations towards the school will also have high academic expectations. Ma (2003) emphasizes that students who feel a sense of school belonging will have high academic motivation to be successful. Students who are accepted, respected, and supported at school by other students may feel connected to their school and may perform better. In other cases, students' performance and school attendance might decline as a result of exclusion from the classroom and alienation (Osterman, 2000).

A sense of school belonging has been broadly investigated in the current literature, utilizing differing terms. These include such things as school connectedness (Prelow et al., 2016; Frydenberg et al., 2009); sense of community (Sanchez et al., 2015); school bonding (Dotterer & Wehrspann, 2016); school climate (Wilkinson-Lee et al., 2011); student engagement (Perry et al., 2009; Wang & Holcombe, 2010); school relatedness (Deci, 1992); and school identification (Fall & Roberts, 2012). Although it is addressed using different terminology, a sense of school belonging is viewed as one of the significant factors associated with students' positive experiences of school. Within the conceptual limits of this study, it is critically important to note that the terms and definitions used herein are regarded as identical and relate to a single underlying concept, as stated by Goodenow (1993).

Numerous studies have provided evidence demonstrating that a sense of belonging, which refers to an individual's subjective perception of being welcomed and supported by fellow members of the educational environment, plays a vital role in academic achievement. According to Goodenow (1993) and Pittman and Richmond (2008), there is a positive relationship between a sense of school belonging and multiple outcomes for students. A number of these outcomes is listed as follows: commitment to the school; involvement in school activities (Goodenow, 1993; Perry et al., 2009); educational expectations (Smerdon, 2002); a sense of well-being (Jose et al., 2012); and academic performance (Li et al., 2020; Lam et al., 2015).

A sense of belonging can be driven by the need to connect with others and develop a common identity. Ryan and Deci (2000) identify three basic psychological needs; the need for autonomy, relatedness, and competence in the self-determination theory in which a sense of belonging is included under the need for relatedness. In line with the concept of the self-determination theory, Korpershoek (2016) asserts that students have an innate drive to establish and maintain meaningful relationships with their peers and teachers and that they also have a psychological need to establish bonds to the school as an institution. To foster a sense of school belonging, school settings should fulfill students' needs for social bonds and interpersonal relationships to stimulate motivation, participation, and learning (Osterman, 2000). Ryan and Deci (2000) state that a poor school setting including bullying, social exclusion, or peer rejection can undermine a sense of school belonging. Therefore, students' sense of school belonging can be regarded as a vital factor in determining their academic performance and overall well-being. Research has shown that students with a sense of belonging are more engaged in school activities (Perry et al., 2009; Wang & Holcombe, 2010), maintain regular attendance (Cemalcılar, 2010; Warne et al.,2020), and build deep connections with their teachers and peers (Booker, 2021; Booker, 2023). Consequently, this can lead to an increase in academic performance.

Purpose of the Study

A significant number of studies in the literature have examined the correlation between a sense of school belonging and academic achievement (Boston & Warren, 2017; Dotterer & Wehrspann, 2016; Okilwa, 2016; Lam et al., 2015; Li, et al., 2020). The present body of literature provides a wide range of results in regard to the direct correlation between the variables. Fall and Robert (2012) identified a negative

correlation between a sense of school belonging and academic achievement, whereas Okilwa (2016) and Lam et al. (2015) demonstrated a very weak correlation between the two variables. Additionally, certain studies report the weak relationship between the variables (Boston & Warren, 2017; Dotterer & Wehrspann, 2016; Rostosky et al., 2003). The main reason behind the inconsistent findings may be attributed to methodological concerns, such as variations in the definition of a sense of school belonging and disparities in the assessment of academic achievement (Booker, 2004). The different terms used to describe the notion of belonging may result in overlapping dimensions across studies. Therefore, conducting a meta-analysis is crucial in gaining a deeper insight into the effects of school belonging on academic achievement with the hypothesis that a sense of school belonging has a positive effect on students' academic achievement (H1)**.**

When conducting a meta-analysis identifying moderator variables may help explain differences in the results or correlations between studies. The present study employs the publication year and measurement tool as moderator variables. Including these moderator variables aims to produce a more detailed and refined comprehension of the phenomenon and offers guidance for future research in this field.

The publication year is an important moderator variable because it reflects research theories and technological changes over time. Avvisati (2019) asserts that a sense of school belonging was weakened from 2003 to 2015 in the Programme for International Student Assessment (PISA) in the focus report. According to this report the percentage of students who indicated they felt like outsiders at school increased by ten percentage points, from 7% to 17%, over those twelve years. This trend appears to accelerate after 2012, which is consistent with the massive increase in mobile internet services as students find new opportunities in online networks, but this time spent online may also cut into offline interactions with peers (Avvisati, 2019). In order to support the aforementioned pattern, further evidence is required. Therefore, the publication year has been determined as a moderator variable for this study. It analyzes the studies published between 2000 and 2020. Before 2000, there was only a little correlational research on a sense of school belonging. However, there has been a substantial increase in the number of studies since then, and that is why the search for relevant studies began in the year 2000. In the context of these statements, this study has tested whether the year of publication moderates the positive effect of a sense of school belonging on students' academic achievement (H2).

Another important moderator variable is the measurement tool which can significantly impact the study's findings. Different measurement tools might assess distinct parts of a construct, or they may have varying levels of reliability or validity. Meta-analysis allows for the determination of how various assessment procedures can affect the empirical results. This is particularly relevant for a sense of school belonging, as no widely accepted measurement tool accurately reflects its conceptual definition (Booker, 2004). While a number of studies measure a sense of school belonging using an engagement questionnaire (Mo & Singh,2008; Wang & Holcome, 2010) or a classroom climate scale (Benner et al., 2008; Wilkenson-Lee et al., 2011), others measure it using scales aimed at assessing adolescent health (Dotterer & Wehrspann, 2016; Wang & Eccless, 2012). Many studies have used the correlation coefficient *(r),* allowing for a standardized metric for comparing results among various measurement tools. Controlling for measurement tools helps to compare them in terms of the constructs. As a result, the hypothesis that the measurement tool used in the study moderates the positive effect of a sense of school related to students' academic achievement has been tested in this study (H3).

Method

Study Design

The meta-analysis aims to summarize and interpret the data from different independent studies to produce a statistical application. It involves combining the results of other studies on the same topic and reviewing the criticisms (Jak, 2015). It is one of the research syntheses defined by Borenstein et al. (2009) as a combination of the statistical results from quantitative studies. Ethics committee approval is not required as the research data is based on the literature.

Review Strategy and Inclusion/Exclusion Criteria

This study focuses on research published in peer-reviewed publications in English between January 2000 and December 2022. The selection of studies published from January 2000 onwards is determined because the studies conducted after this year are more likely to have employed rigorous methodological standards, enhancing the reliability and validity of the results. Over the past two decades, the constructs of a sense of school belonging and academic achievement have seen more standardized and consistent measurement approaches. This uniformity helps in comparing and synthesizing data across different studies, thereby providing more robust meta-analytic conclusions. ERIC, ScienceDirect, and EBSCO are among the online databases searched. For the literature review process, a combination of terms isused: (school or education) and (belonging or connectedness or identification with school or school membership or relatedness) and (academic achievement or grade point average).

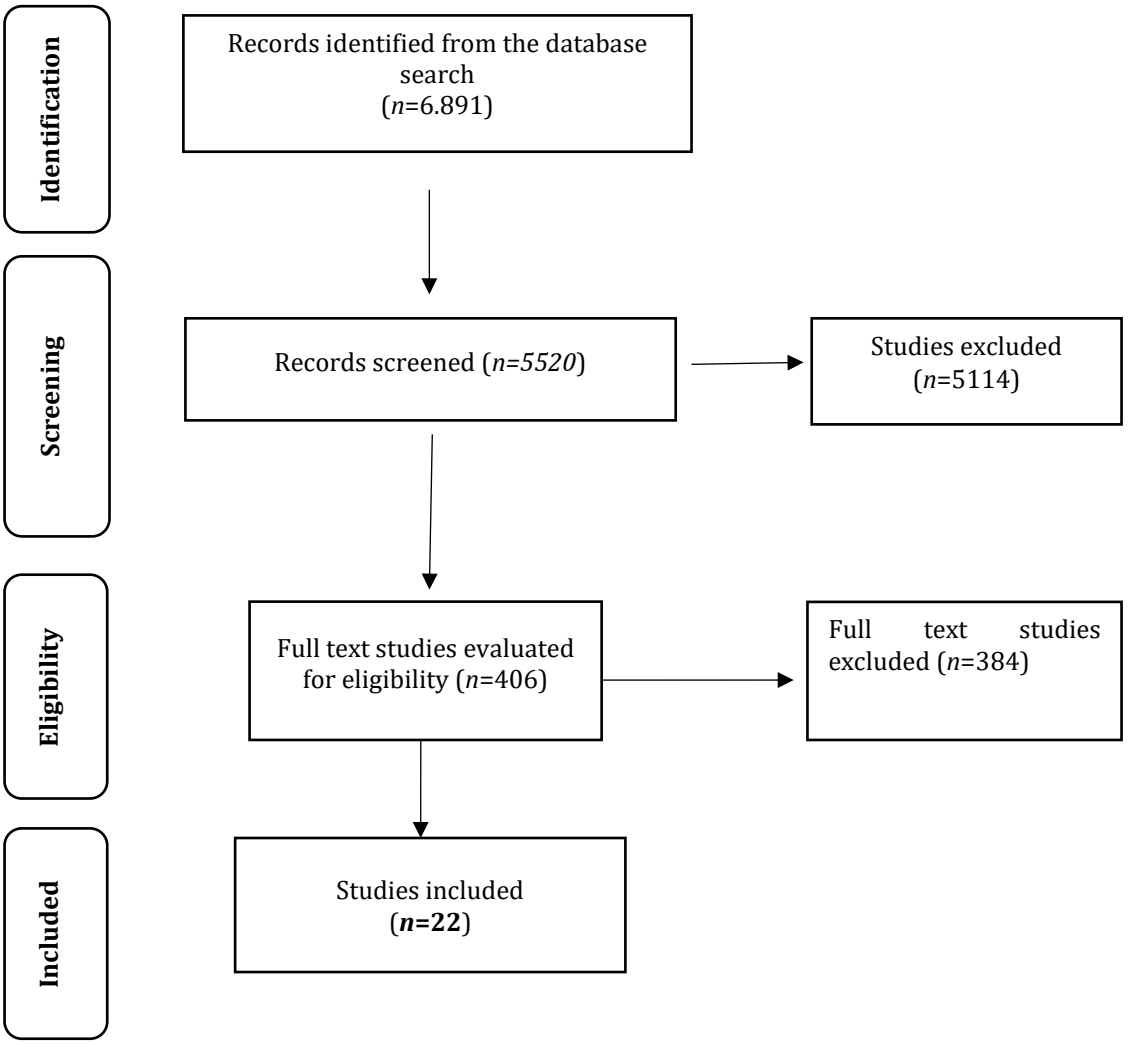

Figure 1. The PRISMA Flow Chart (Moher et al., 2009).

This study includes only studies published in peer-reviewed journals between January 2000 and December 2022 in the English or Turkish language. Regarding the study design, only quantitative research that reported a correlation coefficient is included. The focus of the included studies is primarily on examining the relationship between a sense of school belonging and overall academic achievement.

Studies that focus on topics such as engagement, adjustment, and acceptance are not included, nor are studies that report success for a single course or academic motivation. The aim is to keep the analysis focused on a specific set of criteria. Qualitative studies are excluded from this meta-analysis. While qualitative research provides deep insight into the contexts and perceptions of a sense of school belonging, this study focuses solely on quantitative studies that report correlation coefficients, allowing for a statistical synthesis of data and more definitive conclusions regarding the strength and nature of

the relationship between a sense of school belonging and academic achievement. Studies solely aimed at measuring perceptions of a sense of school belonging, and studies that are not suitable for meta-analysis evaluation, in other words, those lacking appropriate statistical data or where sufficient statistical analysis has not been conducted, have not been included. A PRISMA flow chart for the screening process is presented in Figure 1.

In order to discover the studies for meta-analysis, several methodologies were employed. First, a pool of 6,891 studies was generated which included titles containing the terms 'a sense of school belonging' and 'academic achievement'. Of these, 5,520 records underwent initial screening where duplicates and clearly irrelevant studies (based on their titles and abstracts) were removed. A total of 5,114 studies were excluded at this stage for studies not published within the specified period (January 2000-December 2022), articles not in English or Turkish, qualitative studies or quantitative studies that did not include sufficient statistical data for a robust meta-analysis, and studies measuring only perceptions of school belonging without reporting quantitative results on academic achievement. The remaining 406 full-text studies were evaluated more thoroughly. Exclusion at this stage was due to the study failing to report correlation coefficients or the focus of the studies on irrelevant topics, such as student engagement, adjustment, or acceptance, which did not directly assess the relationship between a sense of school belonging and academic achievement. Out of the 406 studies assessed, 384 were excluded for additional specific reasons, such as studies reporting success for only a single course or focusing solely on academic motivation, After this process, twenty-two studies met all the criteria for inclusion in the meta-analysis, focusing directly on the correlation between a sense of school belonging and academic achievement. An overview of the studies included in the analysis is presented in Table 1.

Table 1.
An Overview of the Studies Included in the Meta-Analysis

No	**Study**	**Sample**	**n**	**Operational Definition**	**r**	**Measurement Tool**
1	Adelabu (2007)	High school students	232	Sense of school belonging	0.25	The Psychological Sense of School Membership Scale (Goodenow, 1993)
2	Benner, Graham and Mistry (2008)	Middle school students	1.120	Sense of school belonging	0.17	The School Interracial Climate Scale (Green, Adams, & Turner, 1988)
3	McMahon, Wernsman and Rose (2009)	Primary school students	149	Sense of school belonging	0.12	The Psychological Sense of School Membership Scale (Goodenow, 1993)
4	Perry, Liu and Pabian (2010)	Middle school students	285	School identification	0.29	The School Engagement Questionnaire (Dornbusch & Steinberg, 1990)
5	Sanchez, Colon and Esparza (2005)	High school students	140	Sense of community	0.12	The Psychological Sense of School Membership Scale (Goodenow, 1993)
6	Singh, Chang and Dika (2007)	High school students	373	Sense of school belonging	0.28	The Psychological Sense of School Membership Scale (Goodenow, 1993)
7	Wang and Holcombe (2010)	Middle school student	1.046	School identification	0.23	The School Engagement Index (Eccles et al., 1993).
8	Bonny et al. (2000)	High school students	1.959	School connectedness	0.31	National Longitudinal Study of Adolescent Health/The school connectedness score (SCS)
9	Kaminski et al. (2011)	High school students	4.131	School connectedness	0.15	The Centers for Disease Control and Prevention's Student Health and Safety Survey
10	Mo and Singh (2008)	Middle school student	1.971	Sense of school belonging	0.20	Emotional Engagement/Belonging (Items derived from various existing scales)

Table 1. continuing

No	Study	Sample	n	Operational Definition	r	Measurement Tool
11	Rostosky et al. (2003)	High school students	1.725	Sense of school belonging	0.29	The Psychological Sense of School Membership Scale (Goodenow, 1993)
12	Wilkinson and Lee (2011)	High school students	4.198	School connectedness	0.19	CDC Classroom Climate Scale (Dahlbert et al. 2005)
13	Prelow, Bowman and Weaver (2007)	Middle school students	206	School connectedness	0.13	The Perceived School Connectedness National Longitudinal Study on Adolescent Health
14	Liu and Lu (2011)	High school students	567	Sense of school belonging	0.02	The Psychological Sense of School Membership Scale (Goodenow, 1993)
15	Wang and Eccles (2012)	Middle school students	1.148	Sense of school belonging	0.10	The Maryland Adolescent Development in Context Study
16	Kuperminc, Darnell and Alvarez Jimenez (2008)	High school students	324	Sense of school belonging	0.27	The Psychological Sense of School Membership Scale (Goodenow, 1993)
17	Fall and Roberts (2012)	High school students	14.781	School identification	-0.01	Identification with School (Fall & Roberts 2012)
18	Boston and Warren (2017)	High school students	105	Sense of school belonging	0.22	California Healthy Kids Survey; School Connectedness (WestEd, 2008)
19	Dotterer and Wehrspann (2016)	Middle school students	108	School bonding	0.22	The National Longitudinal Study of Adolescent Health (Add Health; Udry, 1998)
20	Okilwa (2016)	Primary school students	12.026	Sense of school belonging	0.16	School belonging (Items derived from various existing scales)
21	Lam et al. (2015)	High school students	406	Sense of school belonging	0.17	The Psychological Sense of School Membership Scale (Goodenow, 1993)
22	Li, Chen and Li (2020)	High school students	813	Sense of school belonging	-0.13	The Psychological Sense of School Membership Scale (Goodenow, 1993)

The descriptive statistics encompassing the twenty-two studies are detailed in Table 2. This table describes the characteristics of the studies based on the moderator variables.

Table 2.
Characteristics of the Studies Included in the Meta-Analysis

Variables	1	2	3	Total
Year of Publication	2000-2010	2011-2020		
n	12	10		22
%	54	46		100
Measurement Tool	The Psychological Sense of School Membership Scale	Adolescent Health	Others (engagement/climate/school bonding/connectedness/identification)	
n	9	6	7	22
%	41	27	32	100

As shown in Table 2, 54% of the research studies included in the meta-analysis were conducted between 2000 and 2010, while the remaining 46% were conducted between 2011 and 2020. Regarding the measurement tools, it was discovered that the Psychological Sense of School Belonging Scale was used in nine of the studies, the Adolescent Health Scale developed in the field of adolescent health was used in six of the studies, and the remaining seven studies assessed school belonging using definitions such as engagement/climate/school bonding/connectedness/and identification.

Coding Process

Before statistical analysis began, a coding form was created to ensure comprehensive data capture. This form was designed to encompass all the components of the studies and to establish a specific coding system tailored to capture the unique characteristics of each study. The following categories were included in the study coding form: (i) research references; (ii) sample details; (iii) data collection instrument; and (iv) quantitative values.

Statistical Process

A Pearson's correlation coefficient (r) was used to calculate the effect size. The estimated r value was evaluated by converting it to the z-score identified in the z-table (Hedges & Olkin, 1985). When multiple correlation values were available for the same structural categories, this study utilized the conservative estimate if the correlations were dependent (Borenstein et al., 2009). A random effects model was considered appropriate for this research because it accounts for variability that exceeds subject-level sampling error (Lipsey & Wilson, 2001). This study assumed that the variability above the sampling error at the subject level may be attributable to systematic differences that could be identified.

Moderator Variables

The moderator variables of this study were the publication year and the measurement tool, both of which were expected to have an average effect on a sense of school belonging and academic achievement. The significance of the difference between the moderators was determined using the Qb statistic. The Qb statistic is commonly employed in meta-analyses to test for the presence of heterogeneity between groups, and a significant result indicates that the effects observed in the groups are significantly different from each other (Hedges & Olkin, 1985).

Publication Bias

The relationship between the standard error and the effect size was visualized using a funnel plot, and the level of bias was calculated using the Duval and Tweedie's trim-and-fill test. This test may help identify and adjust for potential bias in the meta-analysis results that may arise from any publication bias in the included studies (Duval & Tweedie, 2000). Figure 2 shows evidence of the publication bias effect in the research studies included in the meta-analysis.

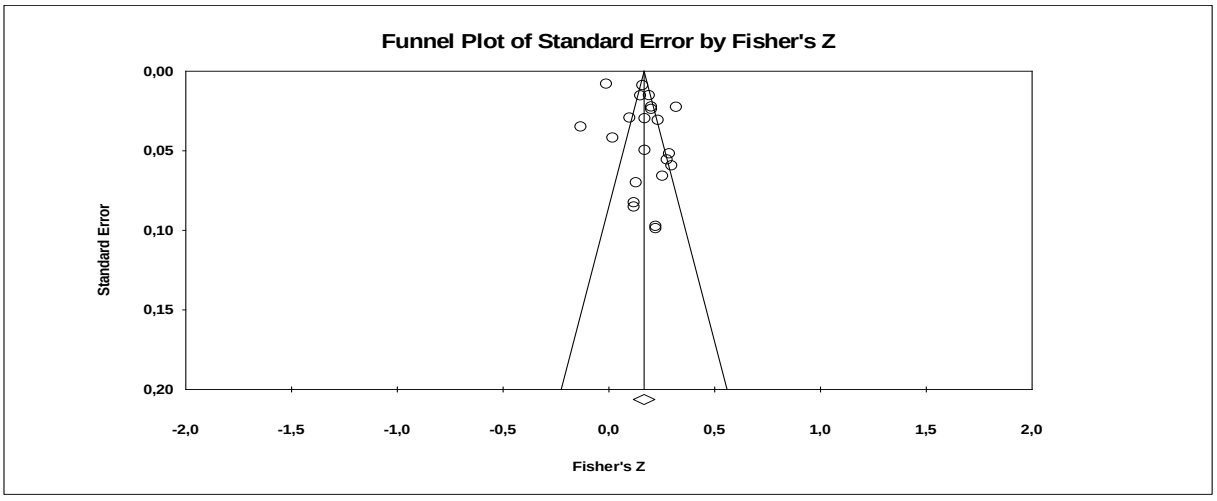

Figure 2. Funnel Plot

If a publication bias is present, a significant asymmetry in the funnel plot would be expected (Duval and Tweedie, 2000). However, in this research, the funnel plot displays symmetrically on both sides of the center line, suggesting a non-disparity. The trim-and-fill test results for publication bias are also shown in Table 3.

Table 3.
Duval and Tweedie's trim and fill test results.

	Excluded Study	Point Estimation	CI (Confidence Interval)		Q
			Lower Limit	Upper Limit	
Observed Value		0.11666	0.10768	0.12564	506.30161
Adjusted Value	0	0.11666	0.10768	0.12564	506.30161

There are no differences between the observed and adjusted values created to mitigate the effects of publication bias as seen in Table 2. This indicates that the meta-analysis results are not significantly affected by publication bias and the estimated effect size is likely an accurate representation of the actual effect size.

Findings

Graph 1 contains a forest plot that provides a visual summary of the results from individual studies included in the analysis. This plot systematically displays each study's effect size alongside its confidence intervals and the weight assigned of each study within the meta-analysis.

Model	Study name	Statistics for each study					Correlation and 95% CI
		Correlation	Lower limit	Upper limit	Z-Value	p-Value	-1,00 -0,50 0,00 0,50 1,00
	Adelabu	0,250	0,125	0,367	3,865	0,000	
	Benner,	0,170	0,113	0,226	5,737	0,000	
	Bonny et al.	0,310	0,269	0,350	14,089	0,000	
	Kaminski et	0,150	0,120	0,180	9,711	0,000	
	McMahon,	0,120	-0,042	0,275	1,457	0,145	
	Perry, Liu, &	0,290	0,180	0,393	5,014	0,000	
	Sanchez,	0,120	-0,047	0,280	1,411	0,158	
	Rostosky et	0,200	0,154	0,245	8,413	0,000	
	Singh &	0,280	0,184	0,371	5,534	0,000	
	Mo& Singh	0,200	0,157	0,242	8,994	0,000	
	Wang &	0,230	0,172	0,287	7,563	0,000	
	Wilkinson&L	0,190	0,161	0,219	12,457	0,000	
	Prelow,	0,130	-0,007	0,262	1,863	0,062	
	Liu d Lu	0,020	-0,062	0,102	0,475	0,635	
	Wang and	0,100	0,042	0,157	3,395	0,001	
	Kuperminc	0,270	0,166	0,368	4,960	0,000	
	Fall &	-0,010	-0,026	0,006	-1,214	0,225	
	Boston &	0,220	0,030	0,395	2,259	0,024	
	Dotterer &	0,220	0,032	0,393	2,292	0,022	
	Okilwa	0,160	0,143	0,177	17,696	0,000	
	Lam et al.	0,170	0,074	0,263	3,446	0,001	
	Li, Chen&Li	-0,130	-0,197	-0,062	-3,721	0,000	
Fixed		0,116	0,107	0,125	25,472	0,000	
Random		0,165	0,115	0,214	6,412	0,000	

Graph 1. Forest Plot

Upon examining the forest plot derived to display the confidence intervals and estimated results for each study included in the meta-analysis, it can be observed that the studies by Liu and Lu (2011), Li, Chen and Li (2020), and Fall and Roberts (2012) represent the extremes in terms of effect sizes.

The findings, which state a positive relationship between a sense of school belonging and academic achievement, supported the H1 hypothesis. The effect size of a sense of school belonging on academic achievement was calculated to be 0.16, indicating that a sense of school belonging has a small effect on academic achievement (see Cohen, 2013). The findings are shown in Table 4.

Table 4.

The correlation between a sense of school belonging and academic achievement: Meta-analysis result

Variable	k	N	r	CI (Confidence Interval)		Q	Qb
				Lower Limit	Upper Limit		
Academic Achievement	22	47.993	.16*	.11	.21	506.302*	
Moderator [Year of Publication]							7.38
2000-2010	10	13.455	.22*	.16	.28		
2011-2020	12	34.538	.09*	.02	.16		
Moderator [Measurement Tool]							
The Psychological Sense of School Membership Scale	9	4.731	.17*	.09	.25		0.55
Adolescent Health	6	7.451	.19*	.08	.29		
Others (engagement/climate/school bonding/connectedness/identification)	7	35.831	.14*	.05	.22		

*p<.001

The H2 was supported by the findings, which suggested that the year of publication would play a moderating role in the effect of a sense of school belonging on academic achievement. The results of the moderator analysis showed a statistically significant difference between the effect sizes of publication years (Qb=7.38, p <.05). The effect size for the studies included in the meta-analysis from 2000 to 2010 [r =0.22] and 2011 to 2020 [r =0.09] was found to be small.

The findings did not support H3 where the measurement tool would play a moderating role in the effect of a sense of school belonging on academic achievement. The difference between the measurement tools was not statistically significant (Qb=0.55, p >.05). The effect size for the measurement tools, 'Psychological sense of belonging to the school' [r =0.17], 'Adolescent health' [r =0.19], 'Other-engagement/climate/school attachment/connectedness/and identification' [r =0.14], was found to be small.

Discussion and Conclusion

The findings of this study support the hypothesis proposing a positive relationship between a sense of school belonging and academic achievement. The results reveal a statistically significant yet small effect of a sense of belonging on academic achievement. It is, however, important to note that findings with relatively low levels of explained variance should not necessarily be viewed as negative outcomes (Cohen, 1977). Even effects accounting for as small as 1.0 percent of the variance explained could hold significant theoretical or practical importance (Cohen, 2013). The positive relationship between a sense of school belonging and academic achievement indicates that students who experience a strong sense of belonging and acceptance in their school environment are more likely to perform well in school. This relationship has been identified in several studies (Booker, 2004; Rostosky et al., 2003, Korpershoek et al., 2020) and proposes that a sense of belonging may help students feel more motivated to acquire knowledge, become more involved in academic tasks, and be more willing to ask for help when needed.

The results from recent meta-analyses underscore the significance of a sense of school belonging on various academic outcomes. The correlation between a sense of school belonging and academic achievement, as reported by Moallem (2013) with a coefficient of r = .24. This finding suggests that students who feel a greater sense of belonging at school are likely to achieve at higher levels academically compared to their peers who do not feel as connected to their school environment. The relationships between a sense of school belonging with both academic achievement and dropout rates were found to be small, showing correlation coefficients of r = .18 and r = -0.16, respectively (Korpershoek et al., 2020). This suggests that students who feel more belonged to their school are somewhat less likely to drop out. Furthermore, the correlation between academic motivation and a sense

of school belonging (Allen et al., 2018) at r = .31, underscores the motivational aspect of feeling connected to one's school. This implies that a sense of school belonging not only influences academic outcomes through direct involvement in school activities, but also by fostering an internal drive towards academic pursuits (Allen et al., 2018). These findings collectively underscore the positive albeit small effect of a sense of school belonging on students' academic achievement. The finding of this study aligns with the broader literature, suggesting that enhancing students' sense of school belonging may lead to modest improvements in academic achievement. The difference in magnitudes could be attributed to varying methodologies or demographic factors across studies but consistently points toward a positive effect of a sense of school belonging on academic achievement. According to Fong Lam et al. (2015), a sense of belonging may be one of the primary determinants of students' academic emotions, impacting academic engagement and achievement. On the other hand, a lack of school belonging might be associated with poorer academic achievement and life satisfaction. Students who feel like outsiders at school are almost three times more likely to be unsatisfied with their lives (Avvisati, 2019). Learning among peers who feel the same sense of belonging may encourage positive learning attitudes, leading to improved academic achievement. The subjective experience of being accepted and supported by other members of the school community fosters a sense of belonging in school, motivating students to engage in more academic activities and achieving higher levels of academic achievement (Fong Lam et al., 2015).

In addition, it is essential to acknowledge that a number of studies have reported contradictory findings from the results of this study. For instance, Fall and Robert (2012) identified a negative correlation between school belonging and academic achievement, while Okilwa (2016) and Lam et al. (2015) demonstrated a weak correlation between the two variables. Furthermore, additional studies, such as those conducted by Boston and Warren (2017), Dotterer and Wehrspann (2016), and Rostosky et al. (2003), also reported a weak relationship between school belonging and academic achievement. Therefore, it is important to recognize the variability in findings across different studies and to consider potential factors contributing to these discrepancies for a more comprehensive understanding.

Furthermore, according to the self-determination theory (Ryan & Deci, 2000), when three psychological needs are met, individuals can become self-motivated and initiate their behavior without any external influence. A stronger sense of school belonging may help meet students' needs for competence and may foster a positive evaluation of their own learning capacities, both of which may contribute to student academic achievement. To summerize, students who feel more a part of their school community may experience better psychological well-being and a more positive outlook on school life, which will foster their academic achievement. Therefore, it is critical for schools to develop a sense of belonging among their students to support academic achievement.

The results also demonstrate that the effect of a sense of school belonging on academic achievement varies depending upon the year of publication. However, the differences between the years (2000 to 2010 0.13; 2011 to 2020 0.09) were relatively small, and the effect size gradually decreased over the years. With this in mind, it can be asserted that schools have evolved over time (Van Houtte & Maele, 2012), which can impact the relationship between these variables. There may be a possible correlation between historical educational institutions emphasizing the development of a cohesive community and fostering a sense of belonging among students, potentially resulting in improved levels of academic achievement. As schools underwent changes in policies, curriculum, and teaching approaches, the emphasis on fostering a cohesive community and promoting a sense of belonging among students may have fluctuated. This may have caused a decrease in the effect size of a sense of school belonging on academic achievement over the years. Additionally, societal shifts, technological advancements, and cultural influences could have also played a role in shaping students' perceptions of belonging within the school environment. Therefore, a more thorough analysis or theorizing on these factors could provide a deeper understanding of the decreased effect size.

According to Milner IV (2012), there has been a potential trend in schools toward priotizing academic rigor and testing during the last decade. It is possible that the decreasing sense of belonging at school is an indication of a general decrease in offline communities as online social networks become more popular for making friends and expressing one's identity (Avvisati, 2019). While students find new opportunities in online forums, the rapid growth of mobile internet services may also reduce the time

spent offline interacting with others in the school community. This trend could have led to a decreased emphasize on the importance of a sense of belonging compared to academic achievement.

Furthermore, it is essential to note that the research methodologies used to assess a sense of belonging and academic achievement may have undergone changes over time. Therefore, previous studies may have used diverse instruments or surveys to assess these constructs, potentially influencing the documented relationship between the variables. It should be considered that changes in research methodologies over time may have influenced the assessment of both a sense of school belonging and academic achievement. For instance, studies conducted between 2000 and 2010 typically employed correlational research designs with self-report data, focusing on assessing the relationship of a sense of school belonging with a limited number of variables (for example, Adelabu, 2007; McMahon et al., 2009; Prelow et al., 2006). In contrast, more recent studies have utilized cross-sectional or correlational designs to examine more complex models related to a sense of school belonging and academic achievement (for example, Boston and Warren, 2017; Kuperminc et al., 2020; Li and Li, 2020). These differences in methodologies could lead to variations in how the constructs are operationalized and measured, potentially affecting the observed relationship between school belonging and academic achievement.

The results of this study also reveal that there was no statistically significant difference between the moderators of the measurement tool. Therefore, hypothesis 3 was not supported. This finding indicates that the effect of a sense of belonging on academic achievement remains consistent regardless of the measurement tool used. This is a significant result because it implies that researchers can employ various measurement tools to explore the relationship between these variables without the need for concern regarding bias or unreliability.

This finding extends on prior research by highlighting the role of measurement tools as moderators, which could otherwise limit the generalization of results across studies using different measurement tools and assessing academic achievement. It also suggests that it would be helpful for researchers to keep investigating the correlation between these variables by applying various measurement tools, thereby enhancing their understanding of the factors contributing to academic achievement.

Implications and Limitations

The finding that a sense of school belonging positively affects academic achievement confirms the importance of examining the impact of students' experiences on their educational achievements. The findings of this meta-analysis provide statistical evidence for the assertion made by Goodenow (1993) regarding the significance of teachers establishing clear guidelines and expectations related to social interactions within the classroom to foster a sense of belonging among students. This finding illustrates the necessity of considering both objective metrics of academic success and students' personal perceptions within the educational setting, as well as how these perceptions can influence their motivation and academic outcomes.

The results show that the effect size has decreased over time. This finding points out the necessity to conduct continuous research into the potential impact of transforming contexts on the variables that contribute to academic achievement. Furthermore, according to the results of this meta-analysis, the hypothesis that the measurement tool moderates the relationship between the variables is not supported. The significance of this result proves the necessity of cautiously selecting measurement tools that are both valid and reliable in order to evaluate the complex structures of academic achievement and a sense of school belonging. It also encourages researchers to utilize a range of measurement tools to gain a deep insight of these structures. In conclusion, this study, presents a synthesis of what is known in regard to school belonging and academic achievement, while also revealing conceptual and methodological patterns that have remained relatively unexplored.

The implications of this study are significant for educators, school leaders, and counselors, who can focus on strategies to promote a sense of belonging among students. These strategies may involve creating opportunities for peer communication and collaboration, as well as recommendations for inclusive policies and practices. Despite the recent decrease in the association between the variables, the results still point out a positive relationship between the structures. In order to develop a broad

comprehension of the factors that contribute to academic achievement, it is necessary for researchers to remain open to employing varied measurement tools to assess the efficacy of interventions to foster a sense of school belonging. Scholars could next work on developing theories to explain the various moderator effects discovered in this study. Several research questions and early hypotheses have been proposed in the area of contextual moderators. As a result, it is critical to emphasize that this meta-analysis acts as a guide for future studies rather than a definitive conclusion.

It is essential to acknowledge the potential influence of varying school levels, student age groups, and national contexts on the relationship between a sense of school belonging and academic achievement. These factors could serve as significant moderators in understanding how educational environments and developmental stages affect students' sense of school belonging and their academic achievement. By not incorporating these moderators into the analysis, the study may not fully capture the nuanced ways in which the constructs of a sense of school belonging and academic achievement interact across different educational and developmental contexts. Future research should consider these moderators to enhance the generalizability and applicability of the findings. This approach will help in tailoring interventions aimed at improving a sense of school belonging and academic achievement to be more context-specific.

When compared to typical literature reviews, meta-analysis provides an efficient way to combine study data (Hunter & Schmidt, 2004), shifting the emphasis away from individual studies and toward a comprehensive investigation of a particular area of study. However, it is important to highlight that the quality and reporting of original investigations are beyond meta-analyses. The present study also had certain potential limitations because only a relatively small number of studies met the criteria for inclusion and were analyzed, which may have limited the findings' generalizability. In addition, the meta-analysis consisted of only papers published in English, which could lead to a language bias.

Acknowledgment

Ethics statement: In this study, I declare that the rules stated in the 'Higher Education Institutions Scientific Research and Publication Ethics Directive' are complied with and that I have not taken any of the actions based on the 'Actions Against Scientific Research and Publication Ethics'. At the same time, I declare that there is no conflict of interest between the authors, with all the authors contributing to the study, and that all the responsibility belongs to the article authors in the case of any ethical violations.

Author Contributions: The author confirms sole responsibility for the following: conceptualization; methodology; validation; formal analysis; writing; review and editing; supervision; and project administration.

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References

*Adelabu, D.H. (2007). Time perspective and school membership as correlates to academic achievement among African American adolescents. *Adolescence,* 42 (167), 525-538.

Allen, K., Kern, M. L., Vella-Brodrick, D., Hattie, J., & Waters, L. (2018). What schools need to know about fostering school belonging: A meta-analysis. *Educational Psychology Review*, *30*, 1-34.

Anderman, L. H., & Freeman, T. M. (2004). Students' sense of belonging in school. In P. R. Pintrich & M. L. Maehr (Eds.), *Advances in motivation and achievement* (pp. 27–63). Elsevier.

Avvisati, F. (2019). Have students' feelings of belonging at school waned over time? *PISA in Focus* (Report No. 69).OECD. https://www.oecd.org/pisa/PISA_in_Focus_100.pdf

*Benner, A.D., Graham, S., & Mistry, R.S. (2008). Discerning direct and mediated effects of ecological structures and processes on adolescents' educational outcomes. *Developmental Psychology,* 44 (3), 840-854.

*Bonny, A. E., Britto, M. T., Klostermann, B. K., Hornung, R. W., & Slap, G. B. (2000). School disconnectedness: Identifying adolescents at risk. *Pediatrics*, *106*(5), 1017-1021.

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. (2009). *Introduction to meta-analysis*. Hoboken, NJ: John Wiley & Sons, Ltd.

*Boston, C., & Warren, S. R. (2017). The Effects of Belonging and Racial Identity on Urban African American High School Students' Achievement. *Journal of Urban Learning, Teaching, and Research*, *13*, 26-33.

Booker, C. K. (2004). Exploring school belonging and academic achievement in African American adolescents. *Curriculum and Teaching Dialogue*, 6, 131–143.

Booker, K. (2021). Rules without relationships lead to rebellion: secondary teachers and school belonging. *School Community Journal*, *31*(1), 65-84.

Booker, K. C. (2023). Praise publicly, correct privately: how secondary teachers cultivate school belonging and classroom community. *Teachers and Teaching*, 1-17.

Cemalcilar, Z. (2010). Schools as socialisation contexts: Understanding the impact of school climate factors on students' sense of school belonging. *Applied Psychology*, *59*(2), 243-272.

Cohen, J. (1977). *Statistical power analysis for the behavioral sciences*, Rev. Ed. San Diego: Academic Press.

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Academic press.

Deci, E. L. (1992). Article commentary: on the nature and functions of motivation theories. *Psychological Science, 3*(3), 167-171.

*Dotterer, A. M., & Wehrspann, E. (2016). Parent involvement and academic outcomes among urban adolescents: examining the role of school engagement. *Educational Psychology*, 36, 812–830.

Duval, S., & Tweedie, R. (2000). Trim and fill: a simple funnel-plot–based method of testing and adjusting for publication bias in meta-analysis. *Biometrics, 56*(2), 455-463.

*Fall, A. M., & Roberts. (2012). High school dropouts: Interactions between social context, self-perceptions, school engagement, and student dropout. *Journal of Adolescence*, 35, 787–798.

Fong Lam, U., Chen, W. W., Zhang, J., & Liang, T. (2015). It feels good to learn where I belong: School belonging, academic emotions, and academic achievement in adolescents. *School Psychology International*, *36*(4), 393-409.

Frydenberg, E., Care, E., Freeman, E., & Chan, E. (2009). Interrelationships between coping, school connectedness and wellbeing. *Australian Journal of Education*, 5, 261–276.

Goodenow, C. (1993). The psychological sense of school membership among adolescents: Scale development and educational correlates. *Psychology in the Schools*, 3, 79–91.

Hedges, L. V., & Olkin, I. (1985). *Statistical methods for meta-analysis*. New York, NY: Academic.

Hunter, J. E., & Schmidt, F. L. (2004). *Methods of meta-analysis: Correcting error and bias in research findings*. Sage.

Jak, S. (2015). *Meta-analytic structural equation modelling* (pp. 1-88). Dordrecht, Neth: Springer.

Jose, P. E., Ryan, N., & Pryor, J. (2012). Does social connectedness promote a greater sense of wellbeing in adolescence over time?. *Journal of Research on Adolescence,* 22, 235–251.

*Kaminski, J. W., Puddy, R. W., Hall, D. M., Cashman, S. Y., Crosby, A. E., & Ortega, L. A. (2010). The relative influence of different domains of social connectedness on self-directed violence in adolescence. *Journal of Youth and Adolescence*, *39*, 460-473.

Korpershoek, H. (2016). Relationships among motivation, commitment, cognitive capacities, and academic achievement in secondary education. *Frontline Learning Research, 4*(3), 28-43.

Korpershoek, E. T. Canrinus, M. Fokkens-Bruinsma & H. de Boer (2020) The relationships between school belonging and students' motivational, social-emotional, behavioral, and academic outcomes in secondary education: a meta-analytic review. *Research Papers in Education,* 35(6), 641-680

*Kuperminc, G. P., Darnell, A. J., & Alvarez-Jimenez, A. (2008). Parent involvement in the academic adjustment of Latino middle and high school youth: Teacher expectations and school belonging as mediators. *Journal of Adolescence*, *31*(4), 469-483.

*Lam, U. F., Chen, -W.-W., Zhang, J., & Liang, T. (2015). It Feels Good to Learn Where I Belong: School Belonging, Academic Emotions, and Academic Achievement in Adolescents. *School Psychology International*, 36, 393–409.

*Li, L., Chen, X., & Li, H. (2020). Bullying victimization, school belonging, academic engagement and achievement in adolescents in rural China: A serial mediation model. *Children and Youth Services Review*, *113*, 1-8.

*Liu, Y., & Lu, Z. (2011). Trajectories of Chinese students' sense of school belonging and academic achievement over the high school transition period. *Learning and Individual Differences*, *21*(2), 187-190.

Lipsey, M. W., & Wilson, D. B. (2001). *Practical meta-analysis*. SAGE publications, Inc.

Ma, X. (2003). Sense of belonging to school: Can schools make a difference?. *The Journal of Educational Research*, *96*(6), 340-349.

*McMahon, S.D., Wernsman, J., & Rose, D.S. (2009). The relation of classroom environment and school belonging to academic self-efficacy among urban fourth- and fifth-grade students. *The Elementary School Journal*, 109 (3), 267-281.

Milner IV, H. R. (2012). Beyond a test score: Explaining opportunity gaps in educational practice. *Journal of Black Studies*, *43*(6), 693-718.

*Mo, Y., & Singh, K. (2008). Parents' relationships and involvement: Effects on students' school engagement and performance. *RMLE online*, *31*(10), 1-11.

Moallem, I. (2013). *A meta-analysis of school belonging and academic success and persistence.* [Unpublished doctoral dissertation]. Loyola University Chicago.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group*, T. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of Internal Medicine*, *151*(4), 264-269.

*Okilwa, N. S. (2016). Exploring School-and Home-Related Protective Factors for Economically Disadvantaged Middle School Students. *Journal of At-Risk Issues*, *19*(1), 34-46.

Osterman, K. F. (2000). Students' need for belonging in the school community. *Review of Educational Research*, 70, 323–367.

*Perry, J.C., Liu, X., & Pabian, Y. (2010). School engagement as a mediator of academic performance among urban youth: The role of career preparation, parental career support, and teacher support. *The Counseling Psychologist*, 38, 269-295.

Pittman, L. D., & Richmond, A. (2008). University belonging, friendship quality and psychological adjustment during the transition to college. *The Journal of Experimental Education*, 76, 343–361.

*Prelow, H. M., Bowman, M. A., & Weaver, S. R. (2006). Predictors of psychosocial well-being in urban African American and European American youth: the role of ecological factors. *Journal of Youth and Adolescence*, 36, 543–553.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), 68-72.

*Rostosky, S. S., Owens, G. P., Zimmerman, R. S., & Riggle, E. D. (2003). Associations among sexual attraction status, school belonging, and alcohol and marijuana use in rural high school students. *Journal of Adolescence*, *26*(6), 741-751.

*Sanchez, B., Colon, Y., & Esparza, P. (2005). The role of sense of school belonging and gender in the academic adjustment of Latino adolescents. *Journal of Youth and Adolescence*, 34(6), 619-628.

*Singh, K., Chang, M., & Dika, S. (2010). Ethnicity, self-concept, and school belonging: effects on school engagement. *Educational Research & Policy Practice*, 9, 159-175.

Smerdon, B. (2002). Students' perceptions of membership in their high schools. *Sociological Education,* 75(4): 287–305.

Van Houtte, M., & Van Maele, D. (2012). Students' sense of belonging in technical/vocational schools versus academic schools: the mediating role of faculty trust in students. *Teachers College Record, 114*(7), 1–36.

*Wang, M. T., & Eccles, J. S. (2012). Adolescent behavioral, emotional, and cognitive engagement trajectories in school and their differential relations to educational success. *Journal of Research on Adolescence, 22*(1), 31-39.

*Wang, M, T., & Holcombe, R. (2010). Adolescents' perceptions of school environment, engagement, and academic achievement in middle school. *American Educational Research Journal*, 47, 633–662.

Warne, M., Svensson, Å., Tirén, L., & Wall, E. (2020). On time: a qualitative study of Swedish students', parents' and teachers' views on school attendance, with a focus on tardiness. *International Journal of Environmental Research and Public Health*, *17*(4), 1430.

*Wilkinson-Lee, A. M., Zhang, Q., Nuno, V. L., & Wilhelm, M. S. (2011). Adolescent emotional distress: The role of family obligations and school connectedness. *Journal of Youth and Adolescence, 40*, 221-230.

*References marked with an asterisk indicate studies included in the meta-analysis

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Adaptation of Artificial Intelligence Literacy Scale into Turkish: A Sample of Pre-Service Teachers

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Abstract

This study aims to adapt the Al-LS translated by Wang et al. (2022) into Turkish and create a scale suitable for assessing the AI-L of pre-service teachers. The study used the survey method within the scope of the quantitative method. The sample of the study consisted of 440 pre-service teachers (pre-school and primary pre-service teachers) from a state university in the Eastern Anatolia Region of Turkey. The original scale consists of 12 items, 4 factors, and a 5-point Likert-type structure. In the first stage, we conducted translation studies to assess the language validity of the adapted scale. Then, the data collected from the part of the sample determined for EFA (Exploratory Factor Analysis) were analyzed. The results show that the adapted scale preserves the original scale structure. The data collected from the part of the sample designated for CFA (Confirmatory Factor Analysis) was also analyzed. The results of the analysis show that the scale has acceptable and good-fit indices. In terms of reliability, Cronbach's Alpha reliability coefficients show that the scale has a reliable structure. The results of the analysis indicate that the scale adapted to Turkish has a valid and reliable structure.

Keywords: Artificial intelligence, artificial intelligence literacy (AI-L), Al literacy, scale adaptation

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Introduction

In this so-called "Age of Artificial Intelligence" (Davenport & Ronanki, 2018), the competencies required to survive and adapt to this era are becoming increasingly critical skills. With the advent of artificial intelligence (AI) technology, our lives have changed dramatically. The proliferation of smart devices and applications developed with AI integration has increased the knowledge level of ordinary users about AI, causing them to become more aware of AI (Wang et al., 2022). Many researchers have emphasized that there is an urgent need for individuals to develop the skills to use AI in the future (Kandlhofer et al., 2016; Su, 2018; Tarafdar et al., 2019) and that high AI competence can have a positive impact on human-AI interactions (Jarrahi, 2018; Stembert & Harbers, 2019). Despite summarizing the basic competencies required to use AI technology (Long & Magerko, 2020), a standard framework or practical tool to measure them is still lacking. To fill this gap, Wang et al. (2022) proposed the concept of "AI literacy" to describe individuals' competencies in using AI technology (Wang et al., 2022).

Artificial intelligence literacy

Due to the complexity of the concept of intelligence and its use in a wide variety of fields, the definition of AI remains unclear (Jiang et al., 2022). However, AI-L is defined as having the competence to understand basic knowledge and concepts. Burgsteiner et al. (2016) and Kandlhofer et al. first used this term (Burgsteiner et al., 2016; Kandlhofer et al., 2016). Long and Magerko (2020) characterize this literacy as the capacity of individuals to critically assess, articulate, and cooperate with AI (Long & Magerko, 2020). They also emphasize a set of skills necessary to ensure the effective use of AI in daily life.

AI literacy is necessary for the workforce to make the most of AI and develop a harmonious relationship with the technology (Kong et al., 2024). Wang et al. (2022) define AI-L as the ability to recognize, use, and evaluate AI products in accordance with ethical standards (Wang et al., 2022). Scholars generally recognize literacy as a fundamental skill that includes the ability to read, write, and communicate (Searle, 2020). The new generation's literacy skills are necessary for integration into the digital world. In this context, Chenqi and Guoqing (2020) emphasized the concept of “smart literacy” and expanded this term to include digital and AI-L (Chenqi et al., 2023). Information literacy is associated with the ability of individuals to search, evaluate, and use information effectively (Lanning & Gerrity, 2022; Nzomo et al., 2021; Seifi et al., 2020). 21st-century teachers are able to transfer new knowledge and skills to students by using smart technology with these technical skills (Almazroa & Alotaibi, 2023; González-Pérez & Ramírez-Montoya, 2022; Kennedy & Sundberg, 2020). The rapid proliferation of AI technologies makes it imperative for teachers to consider ethical issues in how to use and integrate these technologies into their teaching processes (Adams et al., 2023; Akgun & Greenhow, 2022; Lavidas et al., 2022; D. T. K. Ng et al., 2023). As a result, AI literacy includes critical skills necessary for individuals to effectively manage the processes of learning and living with AI-supported technologies (Kong et al., 2024; Long & Magerko, 2020; Markauskaite et al., 2022; Zhang, 2022).

Pre-service teachers' artificial intelligence literacy

AI literacy has rapidly gained importance as one of the critical skills of the 21st century (Muthmainnah et al., 2022). Long and Magerko (2019) define AI-L as the ability of individuals to critically analyze AI technologies, communicate with them, and collaborate effectively with them. This skill has an interdisciplinary nature that intersects with information and digital literacy (Ng, 2012). The increasing role of AI in education requires teachers to master these technologies (Ahmad et al., 2021; Aravantinos et al., 2024; Kim, 2024). The rapid development of educational technologies necessitates pre-service teachers' ability to integrate AI into pedagogical processes (Ahmad et al., 2021). Increasing pre-service teachers' professional competencies by using AI technologies also enables them to provide a more qualified education to students (Kirschner & Selinger, 2003).

The wide range of applications of these technologies and the demand for advanced programming skills have led to the spread of AI education to different levels, despite its initial limitation to computer science departments (Ayanwale et al., 2024). In this setting, pre-service teachers must develop the competencies necessary for the efficient utilization of AI in pedagogical practices (Lameras & Arnab, 2021). Advances in technological devices and age-appropriate software provide opportunities for pre-service teachers to

improve the learning experiences of young learners (Aravantinos et al., 2024; Ayanwale et al., 2024). This further increases the necessity of pre-service teachers knowing and understanding AI literacy in their future classrooms. Teachers with AI-L will both equip their students to interact safely with these technologies and integrate AI seamlessly into their teaching processes (Ayanwale et al., 2024; Shah, 2023). AI-L requires teachers to learn not only how to use technology but also its ethical use (Ng et al., 2023). Since the use of AI in education brings about various ethical issues, pre-service teachers must gain awareness of these issues and increase their ability to develop solutions (Holmes & Porayska-Pomsta, 2023). Ethical and responsible technology use plays a critical role in the healthy integration of AI into educational processes. AI-L enables pre-service teachers to direct this technology in accordance with pedagogical purposes and contributes significantly to their professional development (Ayanwale et al., 2024). Teachers with AI literacy can respond more effectively to the educational needs of the future by gaining a competitive advantage in the digitalized education world (Aravantinos et al., 2024; Ng et al., 2023; Zhang, 2022).

Today, AI has profound effects in many areas, from education to health, economy to social life (Ahmad et al., 2021). For this reason, it is of great importance for individuals to gain artificial intelligence literacy in order to use technology consciously and effectively (Wang, 2022). Especially in education, the acquisition of AI literacy by pre-service teachers plays a critical role in terms of both learning how to use these technologies and preparing the students they will be educating for the digital world in the future (Ng et al., 2023).

In this study, the AI-LS adapted for pre-service teachers is considered a tool that will contribute to the effective use of technology in education. The scale aims to determine the extent to which pre-service teachers can use AI technologies effectively and serves to increase their awareness and skills in this field. In addition, taking into account the linguistic and cultural differences specific to Turkish in the scale adaptation will increase the validity and reliability of the scale and provide more robust data on the integration of AI technologies in education.

Although some scales for AI literacy have been translated into Turkish, there are not enough studies on whether they fully meet the needs of pre-service teachers (Çelebi et al., 2023). Preservice teachers have different requirements in terms of technology integration and digital pedagogical competencies compared to other professional groups. This situation reveals the necessity of adapting AI-LS specifically for pre-service teachers. Existing scales usually target the general population or different professional groups but do not fully reflect the pedagogical needs of pre-service teachers in their educational processes (Çelebi et al., 2023).

Çelebi et al. (2023) adapted the AI-LS developed by Wang et al. into Turkish (Çelebi et al., 2023). However, this study focused on adults under the age of 20 and over 40 and did not include an application for pre-service teachers. Similarly, Eniş-Erdoğan and Ekşioğlu's (2024) adaptation study was conducted with a sample of 226 teachers, and data were collected through both face-to-face and online surveys (Google Form) (Erdoğan & Ekşioğlu, 2024). In contrast, this study was conducted with a sample of pre-service teachers (440 participants), and the validity and reliability of the scale were tested by taking into account the specific pedagogical needs of this group. This difference emphasizes the critical importance of providing pre-service teachers with AI-L in their professional development process. Since AI-L supports pedagogical practices associated with the effective use of educational technologies, this adaptation study conducted on pre-service teachers is thought to make a unique and meaningful contribution to the literature. In addition, the fact that our study had a large sample size and the data were collected entirely by face-to-face method increased the reliability and general validity of the results obtained. This provided a more robust statistical basis for the Turkish adaptation of the scale. In conclusion, our study provides original and important findings on language validity and scale adaptation processes in a sample of pre-service teachers and differs significantly from previous studies in this field.

This study aims to adapt the translated AI-LS into Turkish by Wang et al. (2022) for pre-service teachers in Turkey, and to develop a valid and reliable scale for measuring their AI-L. In this context, the validity and reliability of the scale were tested in terms of both linguistic adaptation and psychometric properties. The aim is to provide the Turkish education system with a tool that can reliably measure the AI-L levels of pre-service preschool and primary school teachers. This evaluation of pre-service teachers' AI

knowledge and skills allows for the improvement of educational programs. In this context, the following question was sought to be answered. *"What are the validity and reliability evidences of the AI-LS adapted to Turkish culture?"*

Method

Research Model

This study aims to create a scale that can be used to determine the AI-L levels of pre-service teachers by adapting a measurement tool developed to examine the AI-L levels of adults in Turkish culture. In this direction, scale adaptation, validity, and reliability studies were conducted. The scale adaptation process includes language validity, content validity, construct validity, and reliability analysis (Yasir, 2016). The two-way translation method translated the scale items into Turkish during the language validity stage, and expert opinions ensured cultural adaptation. Experts evaluated the adequacy of the scale items in terms of scope for content validity. Construct validity was tested with confirmatory factor analysis (CFA), and Cronbach's alpha coefficient was calculated for reliability. These validity and reliability studies were designed to answer the research problem and aim to reveal whether the scale is a valid and reliable measurement tool suitable for Turkish culture. The research was conducted within the framework of the survey method, which is a descriptive model. This method collected and analyzed the participants' current AI-L levels over a specific period. The survey model aims to describe certain characteristics of a group and to reveal the current situation (Büyüköztürk, 2018). The data collected were examined in alignment with the aim of the research, demonstrating the validity and reliability of the AI-LS adapted to Turkish culture.

Process

For the adaptation, validity, and reliability studies of the AI-LS', the necessary information about the scale and permission for use were obtained by contacting the responsible author, one of the researchers who developed the scale, via e-mail. After the scale permission, the adaptation studies of the scale were started by obtaining the permission of the ethics committee of Fırat University. The adaptation of the scale went through a two-stage linguistic translation process. First, two academics with a PhD in the English language and literature translated the scale from English into Turkish. Next, they examined the translation and made linguistic corrections. Afterward, four academics who adapted the scale came together to form the final version of it. In the pilot application phase, the scale was first applied with a small group of 36 pre-service teachers, and missing or incomprehensible items were corrected during this application. The revised scale was compared to the original scale, revealing no significant differences across the items. A total of 440 pre-service teachers received the final 12-item scale.

Study Groups

The study employed convenience sampling, a non-random sample method, to establish the study groups among pre-service instructors at Elazığ Fırat University. Convenience sampling consists of individuals that the researcher can easily reach and collect data from (Robinson, 2014). Therefore, the research scope entailed the formation of three distinct study groups.

Table 1.
Demographic data of the participants

Variable	Category	EFA Group		CFA Group	
		N	%	N	%
Gender	Female	169	80.48	204	92,3
	Male	52	19.52	15	7.7
Department	Pre-School Education	116	52.49	101	46.12
	Primary Classroom Education	105	47.51	118	53.88

We conducted the language translation study on the first group, which consisted of 36 people. The second group consisted of 221 participants, and exploratory factor analysis (EFA) was conducted with the data collected from this group. The third group consisted of 219 participants, and this group was

used for confirmatory factor analysis (CFA). These candidates were volunteer students studying in the departments of preschool and classroom education at Fırat University, Faculty of Basic Education. Since participation in the study was completely voluntary, no coercive reminder was made. Table 1 displays the demographic information of the pre-service teachers who participated in the study.

Data Collection Tool

Wang et al., (2022) developed the AI-LS to aid individuals in deepening their understanding of AI (Wang et al., 2022). This scale was based on theoretical frameworks for measuring AI literacy and literature considered important in this field by the researchers. Wang et al. (2022) emphasized that digital literacy and AI literacy are not the same concepts and stated that digital literacy contents are not suitable for directly defining AI literacy. Therefore, Wang et al. (2022) assert that while digital literacy tools may not be sufficient to directly measure AI literacy, they can contribute to the development of AI literacy through their theoretical framework. Given the challenges in defining AI literacy, Wang et al. (2022) identified the technological-cognitive-ethical model and the KSAVE model. These models, comprising knowledge (Knowledge-K), skills (Skills-S), attitudes (Attitudes-A), values (Values-V), and ethics (Ethics-E) components, are deemed suitable for this field. Since the KSAVE model offers a more general framework beyond digital skills, it can inclusively assess AI literacy skills (Wang et al., 2022). According to this framework, AI literacy is defined as the ability to be aware of, apply, and use AI technologies, perform tasks competently, analyze data critically, and evaluate this data considering ethical responsibilities (Wang et al., 2022).

Wang et al. (2022) developed the AI-LS to improve the understanding of artificial intelligence (Wang et al., 2022). In this study, the ‘AI-LS' developed by Wang et al. (2022) was used to determine pre-service teachers' AI-L. This scale consists of seven Likert scale items (1: strongly disagree-7: strongly agree). The scale consists of 4 factors with 3 items each. The authors define AI literacy as the ability to be aware of and comprehend AI technology in practical applications; to be able to apply and use AI technology to perform tasks competently; and to be able to analyze, select, and critically evaluate data and information provided by AI while promoting awareness of one's own personal responsibilities and respect for mutual rights and obligations (Wang et al., 2022). From this point of view, an item pool of 65 items ranging from 10 to 24 under each dimension was created in the first stage. For this part of the study, five subject-matter experts classified the 65 items under the four specified factors. The items that did not fit into these factors were asked to be added to the uncategorized category. An item that at least four of the five experts categorized similarly was considered to address a construct. A total of 42 items met this criterion, while 15 items were either unclassified or misclassified by one domain expert. Furthermore, more than one domain expert categorized or misclassified 23 items, resulting in their exclusion from further steps. Experts reviewed the items selected in the first step and rated the extent to which each item corresponded to the construct on a three-point Likert scale (1 = no fit, 2 = moderate fit, and 3 = good fit). Experts accepted an item if at least three of them rated it as a 'good fit' and none rated it as a 'poor fit'. Based on this criterion, the researchers eliminated 10 items and selected 31 items for the remaining steps. Finally, three experts participated in a focus group to complete the items, improve their wording, and enhance their format. The authors interviewed the other two experts separately who could not participate in the focus group. The authors eliminated two items and rephrased 14 items after completing the focus group discussion and interviews. All experts suggested and approved the addition of one more item. Thus, the researchers obtained a 31-item scale consisting of nine items related to AI awareness, nine items related to AI use, six items related to AI evaluation, and seven items related to AI ethics. Data from two different samples were collected in the final version of the form: Sample 1, consisting of 601 data points, was used for item reduction, and Sample 2, consisting of 325 data points, was used for model validation. After finalizing the items in the scale, we conducted CFA using the data from Sample 2, and determined the scale to have a structure consisting of 14 items and 4 factors. The CFA analysis conducted using the data from Sample 2 confirmed that the theoretical model used for AI literacy is acceptable, with good fit indices (CFI = 0.99, TLI = 0.99, GFI = 0.98, RMSEA = 0.01, SRMR = 0.03). Cronbach's alpha for the final version of the scale was 0.83, while the alpha values for the four constructs were 0.73, 0.75, 0.78, and 0.73, respectively. Although all four constructs exhibited reliability

above 0.70, the instrument itself scored above 0.80, indicating that the instrument as a whole is more reliable than the individual constructs.

Data Analysis

In order to determine the psychometric properties of the 'Artificial Intelligence Literacy Scale' (AILS-TR) adapted to Turkish, validity and reliability analyses were conducted with the data obtained from a total of 440 pre-service teachers. In the analyses conducted with this data set, exploratory factor analysis (EFA) was first applied, and the factor structure of the scale was examined using this method. EFA is an appropriate analysis method for exploring the structure of the scale and determining the factors (Yang, 2005). The goal was to confirm the factor structure unique to the pre-service teacher sample. Confirmatory Factor Analysis (CFA) was conducted with the data obtained from a different sample of 219 pre-service teachers to determine whether the obtained structure was valid or not. CFA is an appropriate analysis to ensure the validation of the identified factor structure in another sample (Brown & Moore, 2012). The data were analyzed with SPSS 22 and AMOS 23 packages. In CFA, model fit indices (RMSEA, NFI, CFI, IFI) were analyzed to determine whether the factor structure of the scale was valid and reliable in the general sample. These fit indices are necessary for verifying the structure of the scale because they show how well the model fits the data (Marsh et al., 2004). The validity studies analyzed factor eigenvalues, the slope-accumulation graph of these values, and the variance ratios of the factors. According to the results obtained from EFA, model fit indices were tested with CFA to confirm the factor structures (Asparouhov & Muthén, 2009). The model was tested with accepted criteria in RMSEA (Root Mean Square Error Approximation), NFI (Normed Fit Index), CFI (Comparative Fit Index), and IFI (Incremental Fit Index) fit indices. Within the scope of reliability studies, the internal consistency coefficient (α) was calculated for the total scale and each factor. According to Tavakol and Dennick (2011), the internal consistency coefficient, also known as Cronbach's alpha, serves as an appropriate reliability analysis to evaluate if the scale consistently measures the intended construct (Tavakol & Dennick, 2011). Cronbach's alpha values calculated for each factor in the scale were used to assess whether the sub-dimensions of the scale were reliable.

Findings

Exploratory Factor Analysis (EFA) Findings

For the construct validity analysis of the scale, the suitability of the data set was first examined. Various criteria specified in the literature were considered to evaluate the suitability of the data set. These criteria include checking the normal distribution of the data set, the suitability of the sample size, and the adequacy of the sample (KMO and Barlett's Sphericity Test) (Field, 2013; Pallant, 2020). Field (2013), examined the normality assumptions of the data of 221 pre-service teachers for EFA. The skewness and kurtosis values of the data were calculated. Skewness and kurtosis values should be between +1.96 and -1.96 (Can, 2017). The analysis revealed that the skewness value of the items in the data set ranged between -.260 and .701, and the kurtosis value ranged between -1.005 and .577. The obtained values showed that the data met the normal distribution criteria. Therefore, it was concluded that the data set followed a normal distribution. Then, Bartlett's test of sphericity and KMO statistics were used to test the suitability of the data set for EFA. The analysis determined that the data set was suitable for factor analysis (Barlett's Test of Sphericity: $\chi 2=1361.313$; df=66; p=.000<.05; KMO=.806). Here, a KMO value greater than.70 indicates that the data set is large enough to allow factorization (Bryman & Cramer, 2002), and according to the Bartlett Sphericity Test, the data set is sufficient for multivariate normal distribution criteria. Principal component analysis was used in EFA. Additionally, factor analysis involved the application of rotation techniques (Tabachnick et al., 2013). The researchers commonly used the varimax vertical rotation technique to examine scale structures with two or more factors by rotating the items (Büyüköztürk, 2018). Heckler (1996) determined the lower cut-off points of the calculated factor loadings as.40, while Costello & Osborne (2019)set the common factor variance at .40. In addition, it was ensured that the load differences of the item loadings between different subscales were at least .10 (Menard, 2002). The exploratory factor analysis revealed a 4-factor structure for the scale, with eigenvalues greater than 1.00. Table 2 displays the results of the exploratory factor analysis.

Table 2
Exploratory Factor Analysis Findings

	Factors and Item Factor Loadings				Co-Variance
Item No	*Factor1*	*Factor2*	*Factor3*	*Factor4*	
1	.917				.890
2**	.719				.737
3	.904				.865
4		.717			.705
5**		.793			.760
6		.757			.801
7			.838		.805
8			.794		.748
9			.852		.803
10				.738	.722
11**				.710	.740
12				.783	.776
Explained Variance	21.213	19.124	16.799	15.793	
Total Variance %	21.213	40.337	57.136	72.928	

p*<.001 ** *Items are reverse-coded.

As seen in Table 2, the factor loadings of the scale ranged between .719 and .917 in Factor 1, .717 and .793 in Factor 2, .794 and .852 in Factor 3, and .710 and .783 in Factor 4. The common variances of the scale varied between .737 and .890 in Factor 1, .705 and .801 in Factor 2, .748 and .805 in Factor 3, and .722 and .776 in Factor 4. As a result of EFA, a 12-item scale with factor loadings ranging between .710 and .850 and common variances ranging between .705 and .890 was obtained. Figure 1 shows the slope accumulation graph for the scale.

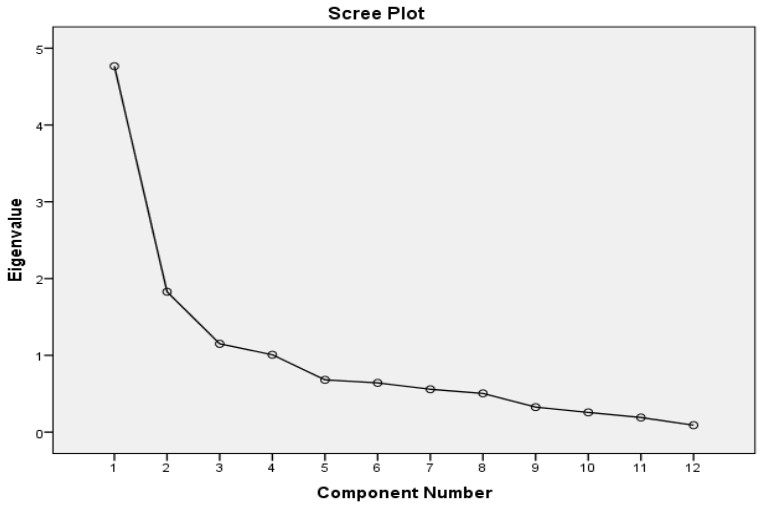

Figure 1. Slope Accumulation Graph of the Scale

The agglomeration points in the slope accumulation graph shown in Figure 1 confirmed the 4-factor structure. Thus, the 12-item, 4-factor, 7-point Likert-type scale was found to meet the prescribed conditions without removing any item from the original scale (Cattell, 1966). Confirmatory Factor Analysis (CFA) Findings To confirm the 4-factor scale structure determined by EFA, we conducted CFA using a separate data set. For this reason, the accuracy of the structure was examined with CFA using data obtained from 219 more pre-service teachers. CFA was developed as an analysis technique to measure the construct validity of the scale (Büyüköztürk, 2018). First, skewness and kurtosis values were calculated to examine the normality of the data set. The skewness and kurtosis values of the data

were calculated. Skewness and kurtosis values should be between +1.96 and -1.96 (Can, 2017). Skewness values vary between -1.268 and .580, and kurtosis values vary between -.926 and 1.375. These values show that the data meet the normal distribution criteria. Accordingly, the data set was accepted as normally distributed, and CFA analysis was conducted. The analysis examined the fit indices of the four-factor structure. Table 3 displays the fit indices of the scale, including $\chi 2/df$, root mean square error of approximation (RMSEA), adjusted goodness of fit index (AGFI), goodness of fit index (GFI), comparative fit index (CFI), tucker-lewis index (TLI), normalized fit index (NFI), and root mean square of standardized residuals (SRMR) (Schermelleh-Engel et al., 2003).

Table 3.
Fit Indices and Value Ranges

Index	Good Fit	Acceptable Fit	The fit indices in this study
$\chi 2/df$	$0 \leq \chi 2/df \leq 2$	$2 \leq \chi 2/df \leq 3$	.943
RMSEA	$0 \leq RMSEA \leq 0{,}05$	$0.05 \leq RMSEA \leq 0.10$	.018
AGFI	$0.90 \leq AGFI \leq 1.00$	$0.85 \leq AGFI \leq 0.90$	.947
GFI	$0.95 \leq GFI \leq 1.00$	$0.90 \leq GFI \leq 0.95$	.997
CFI	$0.97 \leq CFI \leq 1.00$	$0.95 \leq CFI \leq 0.97$	.997
TLI	$0.95 \leq TLI \leq 1.00$	$0.90 \leq TLI \leq 0.95$	.996
NFI	$0.95 \leq NFI \leq 1.00$	$0.90 \leq NFI \leq 0.95$	.967
SRMR	$0 \leq SRMR \leq 0.05$	$0.05 \leq SRMR \leq 0.10$	.0317

(Brown & Moore, 2012; Tabachnick et al., 2013)

As seen in Table 3, the fit indices revealed that the model was compatible. Figure 2 shows the path diagram based on the asymptotic covariance matrix calculated from the results of the confirmatory factor analysis.

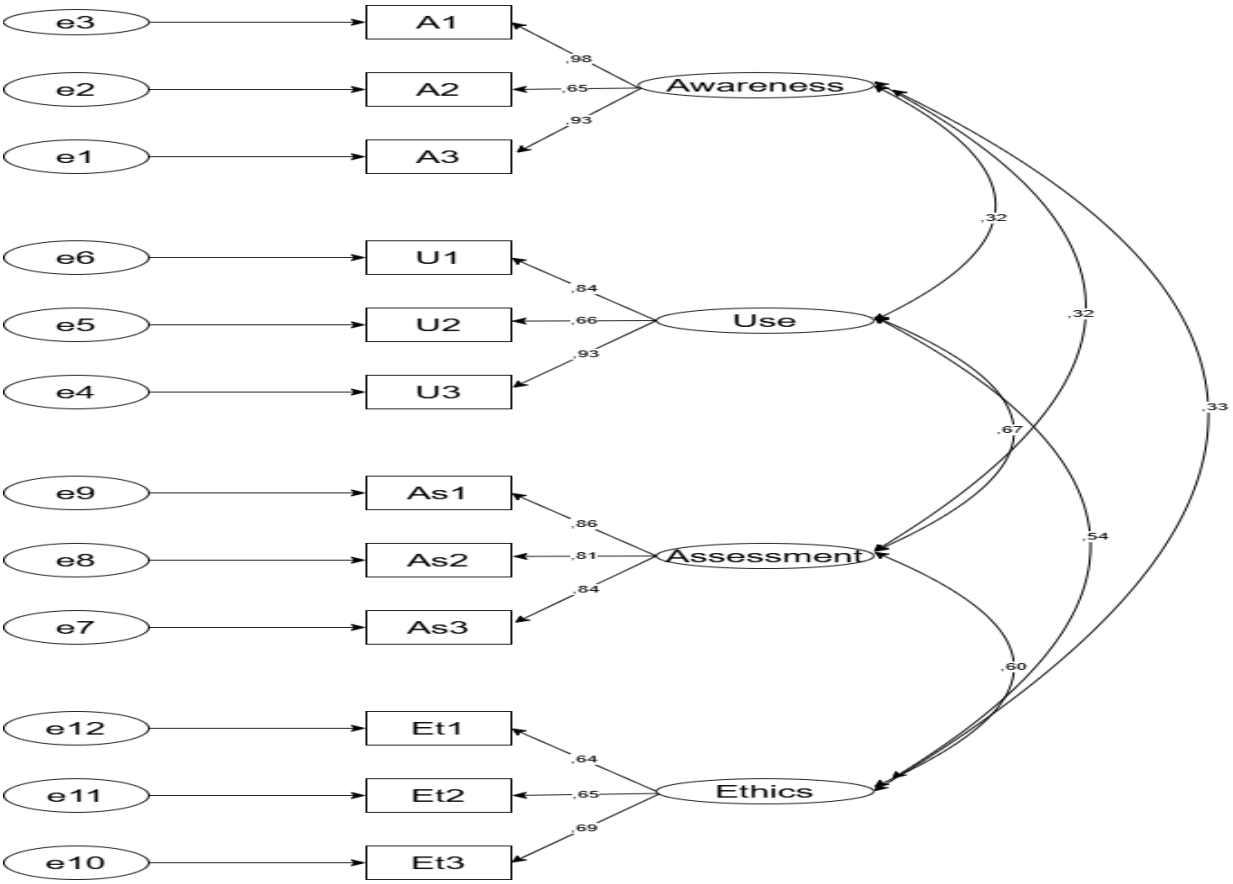

Figure 2. Confirmatory Factor Analysis Results

When the measurement model presented in Figure 2 is examined, the theoretical structure of the four-factor scale consisting of 12 items (awareness, use, evaluation, and utilization) proposed as a result of EFA is confirmed as a result of CFA. The CFA confirmed that the scale met the construct validity criteria. Factor loadings ranged between .65 and .98 for the awareness sub-dimension, between .66 and .93 for the 'use' sub-dimension, between .81 and .86 for the 'evaluation' sub-dimension, and between .64 and .69 for the 'ethics' sub-dimension.

Findings on Item Analysis and Reliability

Table 4.
Findings Related to Item Analysis

Item	Item Total Correlation	Mean		t	*p*
		upper %27	lower %27		
1	.759	6.6667	5.4444	9.099	.000
2	.551	6.0741	5.5185	4.523	.000
3	.773	6.6667	5.3704	9.084	.000
4	.919	6.8519	4.4815	18.019	.000
5	.741	6.4815	4.8519	8.444	.000
6	.919	6.8889	4.5556	18.364	.000
7	.887	6.8889	4.7407	14.295	.000
8	.892	6.9630	4.9630	15.344	.000
9	.853	6.4815	4.6296	11.245	.000
10	.755	6.5185	4.7407	8.087	.000
11	.816	6.9259	5.2963	11.759	.000
12	.801	6.6296	4.2222	11.110	.000

According to the independent t-test results in Table 4, the relationship levels of all items belonging to the AI literacy scale were found to be significant between the upper 27% and lower 27% groups. In addition, the item-total correlation values of the scale items ranged between .551 and .919. It is stated that item-total correlations above .30 measure the expected property of the item (Pallant, 2020). All of the scale items intend to measure the same behavior.

Findings related to reliability

Cronbach's alpha internal consistency coefficient was calculated for the reliability study of the AI literacy scale. Cronbach's alpha for the total scale was calculated as .85, while Cronbach's alpha values for the subscales were calculated as .82, .79, .87, and .69, respectively. When Cronbach's alpha value is .70 or higher, it is known that the items consistently measure the same feature and there is item homogeneity (Johnson & Christensen, 2019), but it has been stated that. 60 or higher can be accepted in newly developed factors or factors with fewer questions (Alemdar & Köker, 2013). Therefore, these calculated internal consistency coefficients indicate a high level of reliability in three factors and a good level in one factor for the scores obtained from the scale.

Discussion, Conclusion, and Recommendations

In this study, it was aimed at adapting the "AI-LS" developed by Wang et al. (2022) to Turkish to create a scale suitable for testing the AI-L of pre-service teachers. To ensure linguistic validity, we first translated the scale into Turkish and then back-translated it. The scale was finalized by taking expert opinions, and the analysis phase started.

EFA and CFA were conducted on the data obtained from different study groups to determine the construct validity of the scale. EFA revealed that the scale structure consisted of four factors similar to the original scale. The four-factor structure and fit indices were analyzed using CFA. The analysis determined that the scale had good fit indices. These findings support the conclusion that the Turkish AI-LS has a strong foundation in terms of validity and reliability. The researchers used Cronbach Alpha

values to evaluate the reliability of the scale within the scope of the study. The Cronbach's alpha value obtained for the overall scale (α = .856) showed that the reliability was at a good level. Similarly, the Cronbach's alpha values obtained for the subscales of the scale are as follows: awareness (α= .820), use (α= .793), evaluation (α= .876), and ethics (α= .688). These values indicate that the subscales are also at a good level in terms of reliability. The results of the analysis clearly showed that the scale has a valid and reliable structure. In summary, we concluded that the 4-factor structure consisting of 12 items met the necessary conditions of the scale without removing any item. These findings indicate that the Turkish AI-LS has a solid foundation in terms of reliability. As a result of the factor analysis, each of the four factors of the scale was divided into sub-dimensions measuring specific skill areas. The first factor, "awareness," contains three items measuring the ability to understand and identify technology during AI applications. The second factor, "Use," contains three items measuring the ability to effectively apply and utilize AI technology. The third factor, "evaluation," includes three items measuring the ability to analyze, select, and critically evaluate AI applications. The fourth factor, "Ethics," includes three items measuring responsibility and risk awareness in the use of AI technology. These sub-dimensions represent different abilities within the structure of the scale.

A small number of studies include explanations for the conceptualization of literacy related to AI (Ng, 2012). AI, which has become increasingly important in daily life and business life, and AI literacy have been associated with literacy definitions in different disciplines (Long & Magerko, 2020; İpek et al., 2023). By assessing the AI literacy of pre-service teachers, who are highly focused on technology learning, it is possible to develop more advanced technology teaching programs and implement effective applications. These findings offer crucial insights into the integration of pre-service teachers' AI literacy levels into education curricula. In curriculum development processes, it is necessary to set goals for pre-service teachers to gain AI literacy and to include AI literacy skills in education programs. In this direction, the analysis of findings based on curriculum development models can significantly contribute to the development of educational policies. In the Turkish adaptation, the scale demonstrated successful results in terms of validity and reliability compared to the original research (Wang et al., 2022) where the scale was developed. In the original study, the scale proved suitable for adults, and in the Turkish adaptation, it was used to determine the AI literacy levels of pre-service teachers who continue their university education. The adapted AI literacy scale emerged as an important tool in determining the literacy levels of pre-service teachers in the field of AI. The contribution of this scale to the literature stands out by providing the opportunity to evaluate the knowledge, skills, and awareness levels of AI. In this context, future comprehensive studies can further strengthen the validity and reliability of the scale. These studies can also aid in the development of new models for curriculum development that incorporate AI literacy into teacher education programs. Research, especially with larger study groups, can increase the general validity of the scale and evaluate the AI literacy levels of individuals in different populations more comprehensively. Lubin (2021) states that digital literacy should be linked to data literacy, while Faruqe et al. (2021) argue that AI literacy should be linked to other types of literacy. Different types of literacy and AI literacy can be considered together. Furthermore, qualitative studies support the use of this scale to gain a deeper understanding of individuals' mindsets and experiences regarding AI. In terms of curriculum development models, these findings provide an opportunity to examine more deeply the necessity of incorporating AI literacy into teacher training programs and the impact of studies in this area on curricula. In light of the recommendations of this study, determining pre-service teachers' AI literacy can be an important step in terms of continuing research on AI literacy, adapting the scale to a wider user base, and contributing to the knowledge in this field. Thus, creating a foundation for more comprehensive studies to evaluate and enhance individuals' interaction with AI technologies can be achieved in today's world where these technologies are becoming increasingly prevalent.

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Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

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References

Adams, C., Pente, P., Lemermeyer, G., & Rockwell, G. (2023). Ethical principles for artificial intelligence in K-12 education. *Computers and Education: Artificial Intelligence*, *4*, 100131. https://doi.org/10.1016/j.caeai.2023.100131

Ahmad, S. F., Rahmat, M. K., Mubarik, M. S., Alam, M. M., & Hyder, S. I. (2021). Artificial intelligence and its role in education. *Sustainability*, *13*(22), 12902. https://doi.org/10.3390/su132212902

Akgun, S., & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI and Ethics*, *2*(3), 431–440. https://doi.org/10.1007/s43681-021-00096-7

Alemdar, M. Y., & Köker, N. E. (2013). Öğrencilerin Okul Kültürü Algisi Üzerine Amprik Bir Araştirma: Ege Üniversitesi İletişim Fakültesi Örneği. *Global Media Journal: Turkish Edition*, *3*(6).

Almazroa, H., & Alotaibi, W. (2023). Teaching 21st century skills: Understanding the depth and width of the challenges to shape proactive teacher education programmes. *Sustainability*, *15*(9), 7365. https://doi.org/10.3390/su15097365

Aravantinos, S., Lavidas, K., Voulgari, I., Papadakis, S., Karalis, T., & Komis, V. (2024). Educational Approaches with AI in Primary School Settings: A Systematic Review of the Literature Available in Scopus. *Education Sciences*, *14*(7), 744. https://doi.org/10.3390/educsci14070744

Asparouhov, T., & Muthén, B. (2009). Exploratory structural equation modeling. *Structural Equation Modeling: A Multidisciplinary Journal*, *16*(3), 397–438. https://doi.org/10.1080/10705510903008204

Ayanwale, M. A., Adelana, O. P., Molefi, R. R., Adeeko, O., & Ishola, A. M. (2024). Examining artificial intelligence literacy among pre-service teachers for future classrooms. *Computers and Education Open*, *6*, 100179. https://doi.org/10.1016/j.caeo.2024.100179

Brown, T. A., & Moore, M. T. (2012). Confirmatory factor analysis. *Handbook of Structural Equation Modeling*, *361*, 379.

Bryman, A., & Cramer, D. (2002). *Quantitative data analysis with SPSS release 10 for Windows: A guide for social scientists*. Routledge. https://doi.org/10.4324/9780203471548

Burgsteiner, H., Kandlhofer, M., & Steinbauer, G. (2016). Irobot: Teaching the basics of artificial intelligence in high schools. *Proceedings of the AAAI Conference on Artificial Intelligence*, *30*(1). https://doi.org/10.1609/aaai.v30i1.9864

Büyüköztürk, Ş. (2018). Sosyal bilimler için veri analizi el kitabı. *Pegem Atıf İndeksi*, 001–214. https://doi.org/10.14527/9789756802748

Can, A. (2017). Quantitative data analysis with SPSS. *Ankara: Pegem Akademi*.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research*, *1*(2), 245–276. https://doi.org/10.1207/s15327906mbr0102_10

Çelebi, C., Yılmaz, F., Demir, U., & Karakuş, F. (2023). Artificial intelligence literacy: An adaptation study. *Instructional Technology and Lifelong Learning*, *4*(2), 291–306. https://doi.org/10.52911/itall.1401740

Chenqi, L., Guoqing, L., & Xiangchun, H. (2023). Measuring Artificial Intelligence Literacy of Pre-service Teachers at a University in Northwest China. *2023 Twelfth International Conference of Educational Innovation through Technology (EITT)*, 100–105. https://doi.org/10.1109/EITT61659.2023.00027

Costello, A. B., & Osborne, J. (2019). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research, and Evaluation*, *10*(1), 7.

Davenport, T. H., & Ronanki, R. (2018). Artificial intelligence for the real world. *Harvard Business Review*, *96*(1), 108–116.

Erdoğan, T. E., & Ekşioğlu, S. (2024). Yapay Zekâ Okuryazarlığı Ölçeği'nin Türkçeye Uyarlanması. *Türk Eğitim Bilimleri Dergisi*, *22*(2), 1196–1211. https://doi.org/10.37217/tebd.1496716

Faruqe, F., Watkins, R., & Medsker, L. (2021). Competency model approach to AI literacy: Research-based path from initial framework to model. *arXiv Preprint arXiv:2108.05809*. https://doi.org/10.54364/AAIML.2022.1140

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. sage.

González-Pérez, L. I., & Ramírez-Montoya, M. S. (2022). Components of Education 4.0 in 21st century skills frameworks: Systematic review. *Sustainability*, *14*(3), 1493. https://doi.org/10.3390/su14031493

Heckler, C. E. (1996). *A step-by-step approach to using the SAS™ system for factor analysis and structural equation modeling*. Taylor & Francis. https://doi.org/10.2307/1270628

Holmes, W., & Porayska-Pomsta, K. (2023). *The ethics of artificial intelligence in education*. Routledge Taylor. https://doi.org/10.4324/9780429329067

İpek, Z. H., Gözüm, A. İ. C., Papadakis, S., & Kallogiannakis, M. (2023). Educational Applications of the ChatGPT AI System: A Systematic Review Research. *Educational Process :International Journal*, *12*(3), 26–55. https://doi.org/10.22521/edupij.2023.123.2

Jarrahi, M. H. (2018). Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. *Business Horizons*, *61*(4), 577–586. https://doi.org/10.1016/j.bushor.2018.03.007

Jiang, J., Yang, Z., Ferreira, A., & Zhang, L. (2022). Control and autonomy of microrobots: Recent progress and perspective. *Advanced Intelligent Systems*, *4*(5), 2100279. https://doi.org/10.1002/aisy.202100279

Johnson, R. B., & Christensen, L. (2019). *Educational research: Quantitative, qualitative, and mixed approaches*. Sage publications.

Kandlhofer, M., Steinbauer, G., Hirschmugl-Gaisch, S., & Huber, P. (2016). Artificial intelligence and computer science in education: From kindergarten to university. *2016 IEEE Frontiers in Education Conference (FIE)*, 1–9. https://doi.org/10.1109/FIE.2016.7757570

Kennedy, T. J., & Sundberg, C. W. (2020). 21st century skills. *Science Education in Theory and Practice: An Introductory Guide to Learning Theory*, 479–496. https://doi.org/10.1007/978-3-030-43620-9_32

Kim, J. (2024). Leading teachers' perspective on teacher-AI collaboration in education. *Education and Information Technologies*, *29*(7), 8693–8724. https://doi.org/10.1007/s10639-023-12109-5

Kirschner, P., & Selinger, M. (2003). The state of affairs of teacher education with respect to information and communications technology. *Technology, Pedagogy and Education*, *12*(1), 5–17. https://doi.org/10.1080/14759390300200143

Kong, S.-C., Cheung, M.-Y. W., & Tsang, O. (2024). Developing an artificial intelligence literacy framework: Evaluation of a literacy course for senior secondary students using a project-based learning approach. *Computers and Education: Artificial Intelligence*, *6*, 100214. https://doi.org/10.1016/j.caeai.2024.100214

Lameras, P., & Arnab, S. (2021). Power to the Teachers: An Exploratory Review on Artificial Intelligence in Education. *Information*, *13*(1), 14. https://doi.org/10.1016/j.caeai.2024.100214

Lanning, S., & Gerrity, C. (2022). *Concise guide to information literacy*. Bloomsbury Publishing USA. https://doi.org/10.5040/9798400630101

Lavidas, K., Apostolou, Z., & Papadakis, S. (2022). Challenges and opportunities of mathematics in digital times: Preschool teachers' views. *Education Sciences*, *12*(7), 459. https://doi.org/10.3390/educsci12070459

Long, D., & Magerko, B. (2020). What is AI literacy? Competencies and design considerations. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–16. https://doi.org/10.1145/3313831.3376727

Lubin, I. A. (2021). *ICT and International Learning Ecologies: Representation and Sustainability Across Contexts*. Routledge. https://doi.org/10.4324/9780429345463

Markauskaite, L., Marrone, R., Poquet, O., Knight, S., Martinez-Maldonado, R., Howard, S., Tondeur, J., De Laat, M., Shum, S. B., & Gašević, D. (2022). Rethinking the entwinement between artificial intelligence and human learning: What capabilities do learners need for a world with AI? *Computers and Education: Artificial Intelligence*, *3*, 100056. https://doi.org/10.1016/j.caeai.2022.100056

Marsh, H. W., Hau, K.-T., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling*, *11*(3), 320–341. https://doi.org/10.1207/s15328007sem1103_2

Menard, S. (2002). *Applied logistic regression analysis* (Issue 106). Sage. https://doi.org/10.4135/9781412983433

Muthmainnah, Ibna Seraj, P. M., & Oteir, I. (2022). Playing with AI to Investigate Human-Computer Interaction Technology and Improving Critical Thinking Skills to Pursue 21st Century Age. *Education Research International*, *2022*(1), 6468995. https://doi.org/10.1155/2022/6468995

Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educational Technology Research and Development*, *71*(1), 137–161. https://doi.org/10.1007/s11423-023-10203-6

Ng, W. (2012). Can we teach digital natives digital literacy? *Computers & Education*, *59*(3), 1065–1078. https://doi.org/10.1016/j.compedu.2012.04.016

Nzomo, P., McKenzie, P., Ajiferuke, I., & Vaughan, L. (2021). Towards a definition of multilingual information literacy (MLIL): An essential skill for the 21st century. *Journal of Library Administration*, *61*(7), 897–920. https://doi.org/10.1080/01930826.2021.1972737

Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*. McGraw-hill education (UK). https://doi.org/10.4324/9781003117445

Robinson, O. C. (2014). Sampling in interview-based qualitative research: A theoretical and practical guide. *Qualitative Research in Psychology*, *11*(1), 25–41. https://doi.org/10.1080/14780887.2013.801543

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online*, *8*(2), 23–74.

Searle, J. (2020). Developing literacy. In *Developing vocational expertise* (pp. 51–80). Routledge. https://doi.org/10.4324/9781003115342-5

Seifi, L., Habibi, M., & Ayati, M. (2020). The effect of information literacy instruction on lifelong learning readiness. *IFLA Journal*, *46*(3), 259–270. https://doi.org/10.1177/0340035220931879

Shah, P. (2023). *AI and the Future of Education: Teaching in the Age of Artificial Intelligence*. John Wiley & Sons.

Stembert, N., & Harbers, M. (2019). Accounting for the human when designing with AI: challenges identified. *CHI'19-Extended Abstracts, Glasgow, Scotland Uk—May 04-09, 2019*.

Su, G. (2018). Unemployment in the AI Age. *AI Matters*, *3*(4), 35–43. https://doi.org/10.1145/3175502.3175511

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2013). *Using multivariate statistics* (Vol. 6). pearson Boston, MA.

Tarafdar, M., Beath, C. M., & Ross, J. W. (2019). Using AI to enhance business operations. *MIT Sloan Management Review*, *60*(4). https://doi.org/10.7551/mitpress/12588.003.0015

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53. https://doi.org/10.5116/ijme.4dfb.8dfd

Wang, B., Rau, P.-L. P., & Yuan, T. (2022). Measuring user competence in using artificial intelligence: Validity and reliability of artificial intelligence literacy scale. *Behaviour & Information Technology*, *42*(9), 1324–1337. https://doi.org/10.1109/AICIT59054.2023.10277876

Wang, H. (2023). Formation Mechanism and Practice Path Model of Teachers' Intelligent Literacy in the Context of Artificial Intelligence. *2023 2nd International Conference on Artificial Intelligence and Computer Information Technology (AICIT)*, 1–6.

Yang, B. (2005). Factor analysis methods. *Research in Organizations: Foundations and Methods of Inquiry*, 181–199.

Yasir, A. S. (2016). Cross cultural adaptation & psychometric validation of instruments: Step-wise. *International Journal of Psychiatry*, *1*(1), 4. https://doi.org/10.33140/IJP/01/01/00001

Zhang, A. (2022). Human Computer Interaction System for Teacher-Student Interaction Model Using Machine Learning. *International Journal of Human–Computer Interaction*, 1–12. https://doi.org/10.1080/10447318.2022.2115645

e-Kafkas Journal of Educational Research e-KJER Research Article

The Effect of A Number Sense Education Program Supported By Web 2.0 Tools on The Number Sense Development of First Grade Elementary School Students*

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Abstract

This research was designed to evaluate the effectiveness of a Number Sense Education Program enhanced by Web 2.0 Tools on the development of number sense among first-grade elementary students. The study's cohort comprised 44 children, divided into an experimental group of 23 and a control group of 21. Employing a quasi-experimental design from quantitative research methodologies, data was collected using the "Number Sense Screener (NSS)"—originally developed by Jordan et al. (2012) and later adapted for Turkish first-grade students by Uyanık Aktulun (2019) alongside a "General Information Form" to collect personal data from families. Over the course of 12 weeks, the experimental group participated in the Web 2.0 Tools-supported Number Sense Education Program, conducted by the researcher, while the control group engaged in regular curriculum lessons. The findings revealed statistically significant improvements in the experimental group's pre-test and post-test scores across several NSS subdimensions, including Number Recognition, Number Comparisons, Nonverbal Calculation, Story Problems, and Number Combinations, as well as in their overall NSS scores ($p<.05$). However, no significant change was detected in the Counting Skills subdimension ($p>.05$). Furthermore, a statistically significant difference emerged between the experimental and control groups' post-test average scores in the NSS subdimensions and overall score ($p<.05$), underscoring the beneficial impact of Web 2.0 Tools-supported educational processes on enhancing number sense skills.

Keywords: Elementary school, mathematics, number sense, number sense skills, web 2.0 tools

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Introduction

In recent years, technological advancements have facilitated the integration of digital tools into all areas of life, including educational processes (Aytan & Başal, 2015). This rapidly popularizing situation has led to the formation of contemporary educational processes (Alkan, 2011). Considering that 83% of learning experiences are visual, 11% are auditory, 3.5% are olfactory, 1.5% are tactile, and 1% are gustatory, educational and instructional technologies offer quality learning opportunities with visualization, sound addition, and interactive touch features. This situation enables students to be involved in more quality educational processes, thereby supporting the development of their higher-order cognitive skills (Çalışkan & Karadağ, 2013; Sarsar, 2017).

In the process of integrating advancing technologies into education, the use of Web 2.0 tools, in particular, has become very widespread (Çakır et al., 2019). Web 2.0 technologies facilitate the transition from being merely internet readers to becoming internet literates. This shift has transformed the internet from a space where pre-existing information is consumed into a platform where participants are involved in the production and sharing of information, gathering and transferring knowledge (Horzum, 2010). According to Çelebi and Satırlı (2021), Web 2.0 tools assist in making learning both effective and enjoyable for students, positively affect their level of technological literacy, and increase their motivation. At the same time, these tools provide teachers with opportunities that simplify teaching, such as lesson planning, implementing activities, enrichment, recording, and evaluation.

Web 2.0 tools are user-friendly programs known for their ease of use. Literature reviews indicate that researchers have classified Web 2.0 tools under specific headings based on the functionality of the tools used and their suitability for the educational environment, making them easily accessible to teachers or those interested in Web 2.0 Tools (Elmas & Geban, 2012). Some of these classifications include: Çopur (2020) categorized Web 2.0 tools used in education under various headings: For classroom management; Edmodo, Voki, ClassDojo. For quizzes and exams; Kahoot, Quizlet, Quibblo. For online gaming and content creation; LearningApps.org, Goconqr, Oppi. For presentation creation; Prezi, Emaze, Powtoon. For mapping and concept mapping; Mindmeister, Datawrapper, Bubbl.us. For animation or cartoon creation; Moovly, Vyond, Animoto. For coding education; Scratch Mit Edu, Code.org, Tynker. For online learning platforms; EBA, Khan Academy, Udemy. For augmented reality; Metaverse, QuiverVision, Cospaces. For teaching foreign languages; Duolingo, Lyricstraining, Voscreen Çelebi and Satırlı (2021) in their study on the use of Web 2.0 tools at the elementary level, included 38 Web 2.0 tools categorized into 15 categories. These categories are listed as follows: Survey tools; Surveymonkey, Kahoot, Google Form. Animation tools; FlipaClip, Animaker. Photo and image tools; Camera360, Canva. Virtual wall board tools; Padlet, Twinspace. Online quiz and exam tools; Quickkey, Exam Reader, Quizlet, Plickers, Quizizz. Remote management tools; Zoom, Microsoft Teams. Classroom management tools; Voki, Google Classroom, Class Dojo. 3D tools: Unity 3D, Anatomy 3D-Anatronica. Math tools; Matific. e-book creation tools; Bookcreator, Joomag, My Storybook. Web page creation tools; Blogger, Weebly, WordPress. Coding tools; Code.Org, Kodable. Story writing tools; BookPress, Storybird, StoryJumper. Video and music creation tools; Kizoa, iMovie, Animoto. Slide and presentation tools; Prezi, Powtoon, Emaze.

These classifications highlight the diversity and potential of Web 2.0 tools in education, providing guidance for teachers and educators on how to integrate these tools into their lesson plans. Web 2.0 tools such as Voki, LearningApps.org, Wordwall, and Storybird, which are among the most used in educational processes, offer features that enrich learning processes, making learning more interactive and enjoyable. For instance, Voki is a Web 2.0 tool that allows for the creation of various characters and enables these characters to speak with written texts. This application allows users to select a character from an online environment, type a text into a textbox to vocalize the character, and ultimately generate a link for sharing with students independently of time and location (İnal & Arslanbaş, 2021). LearningApps.org is a Web 2.0 tool that offers the possibility to create educational games and activities with interactive elements to support the teaching and learning process. It allows for the creation of new online elements as well as the reorganization of existing ones. The goal is to compile reusable elements and make them available to the public. Referred to as applications, these

elements do not have a fixed framework or a concrete mold, yet they interact within the digital environment. The content of these elements is not finalized; instead, they can be integrated by users into different classroom environments (LearningApps, 2012). Wordwall is a Web 2.0 tool that provides the ability to create interactive tests of various types, such as multiple-choice, matching, true or false, drag and drop, offering students the pleasure of game-playing rather than just learning outcomes. This online assessment tool encourages students to engage in the process and enjoy their lessons, while also providing teachers with the opportunity to design exercises, activities, and games. The application, with an interface in English, offers users the choice of 26 languages and access through Google or Gmail personal accounts. Wordwall, with its rich content, is available for use across different subjects and levels (İnal & Arslanbaş, 2021). Templates in Wordwall are available in both interactive and printable versions. Interactive activities can be played on computers, tablets, phones, or interactive whiteboards, while content that can be downloaded as PDFs can be directly printed. Activities are created using a template system, which includes examples like Quiz, Crossword, Maze Chase, Airplane, and Seating Plan. Existing activities can be customized to suit one's class and teaching style. Themes within the app can be presented with different themes, with each theme allowing the addition of different graphics, fonts, and sounds. Wordwall activities can be embedded into another website using an HTML code, functioning similarly to embedding playable videos from YouTube or Vimeo, offering an embed feature that allows users to play activities directly on their own sites (Wordwall, 2023). The diversity offered by these Web 2.0 tools facilitates the adoption of innovative approaches in teaching methodologies while enabling students to interact with materials that are suitable for their individual learning styles.

The integration of technology into educational processes has brought significant changes to access to information, communication, and action, particularly manifesting in the field of mathematics education (Karaaslan et al., 2013). The development of Web 2.0 tools and the understanding, monitoring, and effective use of these tools in mathematics education have led to significant differentiations in learning and teaching processes (Ersoy, 2003). As a universal language and culture, mathematics, one of the oldest branches of science, enables individuals to acquire mathematical concepts and skills through concrete experiences in their daily lives. These experiences play a critical role in laying the foundations of mathematical thinking. Mathematical thinking is the ability to analyze information, use it, and freely generate and evaluate ideas. Acquiring these fundamental skills lays the groundwork for the mathematics knowledge and concepts necessary for school life, positively reflecting on children's subsequent learning processes, enhancing their success, and contributing to becoming more productive and efficient individuals (Kandır et al., 2016). In this context, the inclusion of technology, especially Web 2.0 tools, in mathematics education emerges as a significant factor in developing mathematical thinking skills and deepening the learning of mathematics.

Mathematics, as a discipline that is influenced by technological advancements and continuously evolving, encompasses a diverse range of topics (Dennis & Hamm, 2010). In this context, the National Council of Teachers of Mathematics (NCTM) emphasizes that number sense is particularly important for 21st-century mathematics education (Şengül, 2013). Number sense is critically important for understanding numbers, making comparisons between numbers, establishing relationships, and developing advanced mathematical skills (Berch, 2005). Definitions of the concept of number sense by scientists from various disciplines generally include the ability to identify and count numbers, understand relationships between numbers, make magnitude comparisons, perform basic numerical operations, comprehend estimation and measurement concepts, determine and complete a missing number as key components of this concept (Kalchman et al., 2001; Lago & DiPerna, 2010). The skills expressed in these definitions enable the use of mathematical knowledge and the rapid execution of mathematical operations (Gersten & Chard, 1999). The study conducted by Jordan and colleagues (2006) identifies the essential elements of number sense in preschool and early elementary children as counting, number knowledge, number transformation, estimation, and Number Combinations / Number Patterns. These components represent children's relationships with numbers and their capacity to understand mathematical operations. Counting is related to children's grasp of number sequences and their ability to accurately count objects in various quantities, where understanding the basic principles of counting such as one-to-one correspondence, stable order, and cardinality is fundamental (Jordan et al., 2006; Jordan et al., 2007). Number knowledge encompasses the ability to recognize

numbers and directly identify small quantities (Jordan et al., 2007), while number transformation refers to the skill of transitioning between numerical sets through addition and subtraction operations. Estimation ability allows children to approximately assess the magnitude of numerical sets, and Number Combinations / Number Patterns enable them to understand the intricate structure of numbers and how a number can be associated with different numbers. These five fundamental components are critically important for developing children's mathematical thinking and problem-solving skills, enabling them to apply their knowledge to new and unknown situations to find solutions. As children gain experience, they develop the ability to perform mathematical operations more quickly and efficiently (Confer, 2005).

Research across various disciplines on the effects of number sense development underscores the importance of number sense in mathematics instruction and suggests it plays a central role in elementary mathematics teaching by enabling students to connect with real life (Yang et al., 2004). However, it has been observed that the Primary School Mathematics Curriculum in Turkey (2018) does not directly refer to number sense. In this context, Gülbağcı Dede (2015) analyzed the compatibility of the Elementary Mathematics Teaching Program (2009) with number sense and stated that 21 outcomes for the first grade are related to number sense. Şengül (2013), by examining the Primary School Mathematics Teaching Program (2009) without breaking it down into components in terms of number sense, identified that two outcomes in the first grade are related to number sense. Çetin and Öztürk (2020) have identified in the Primary School Mathematics Curriculum (2018) a total of five outcomes related to the learning area of numbers and operations for the 1st-grade level, including one on the meaning of numbers, one on the magnitude of numbers, two on flexible operation and judging the plausibility of results, and one in the learning area of measurement related to the component of estimation. Considering that individuals acquire a significant portion of the mathematical skills they will use throughout their lives from the outcomes included in the mathematics teaching program, and given the contemporary expectation for individuals to utilize high-level numerical skills, the importance of more prominently incorporating number sense in the Mathematics Teaching Program becomes evident. Focusing more on number sense outcomes in Mathematics Teaching Programs has been shown to enable students to achieve better mathematics success in subsequent stages and offer significant opportunities in shaping students' learning regarding number sense (Cheng & Wang, 2012). Research in this area, including studies by Starr et. al., (2017), has found that number sense acquired during infancy predicts mathematics learning in early childhood. Jordan and colleagues (2009) emphasize the importance of early number competence or number sense in predicting children's success in mathematics learning throughout elementary school. Şengül and Gülbağcı Dede (2014) have stated that number sense prepares students for generating different solutions to numerical situations encountered in daily life by directing them to think flexibly and produce various strategies without relying solely on standard algorithms and pen-and-paper calculations. Yarar et al., (2018) have indicated that students with a developed sense of number can successfully overcome problems encountered in daily life, perform quick mental calculations, and reach conclusions through estimation, suggesting that students' overall success in learning is related to their sense of number. This concept plays a crucial role not only in performing numerical operations but also in developing flexible and varied solutions to problems encountered in daily life (Küçükay, 2022). Therefore, the development of number sense is among the fundamental skills for the development of an individual's mathematical abilities and success in mathematics at advanced educational levels, and this development should be supported from the early years of life.

Success in the field of mathematics plays a fundamental role in the development of science, technology, and industry, emerging as a significant factor in enhancing individuals' problem-solving and higher-order thinking skills (Thornton et al., 2009). However, when considering Turkey's perspective, international assessments like TIMSS (2019) and PISA (2018) reveal that students in Turkey perform poorly in mathematics. The results of YKS (2022) and LGS (2022) also indicate that students have weak averages in mathematics, highlighting the need for a fundamental strengthening of mathematics education. Quality mathematics instruction in early education helps children acquire mathematical concepts and skills they will use throughout their life (Seefeldt & Galper, 2004; Jackman, 2012; Henniger, 2012). Therefore, developing technology-supported quality education programs that enhance number sense skills for students attending the first grade of primary school,

which is the starting point for other grades, is crucial. When a literature review is conducted, it is observed that studies related to Web 2.0 tools, which have become a current educational tool with the development of technology and the influence of the remote education process, and number sense have been conducted. In the field literature related to the subject; Bayak (2016) examined the number sense levels of classroom teachers and their usage in elementary school mathematics teaching; Çetin & Öztürk (2020) analyzed the effect of the elementary mathematics curriculum on the fundamental components of number sense; Yapıcı (2013) explored the number sense of 5th, 6th, and 7th-grade students in the topic of percentages; Çekirdekçi, Şengül & Doğan (2020) studied the number sense strategies used by 4th-grade students; Gözüm et al. (2024) investigated how number sense skills develop from preschool education to the transition to elementary school; Zhou et al. (2022) researched the mediating effect of number sense on non-verbal intelligence and children's mathematical performance; Tucker and Johnson (2022) evaluated the impact of a touchscreen digital game named Fingu on the development of preschool children's number sense; Tonizzi et al. (2021) compared the effects of two different intervention programs with low and high intensity on developing number sense in children from low socio-economic status; Gillespie (2021) studied the impact of a mathematical activity called "Number Talks" developed for elementary students on the development of their number sense and mathematical discourse skills. However, there have been no studies found in the field literature that examine the effect of a Number Sense Education Program Supported by Web 2.0 Tools on the development of number sense in first-grade elementary students. Therefore, this research is thought to contribute by revealing the effect of the Number Sense Education Program Supported by Web 2.0 Tools on the development of number sense, enhancing the quality of mathematics teaching, serving as a guide for teachers and parents towards formal and informal experiences, offering a new perspective on the concept of number sense, and attempting to fill a significant gap in the field literature. The primary objective of this study is to examine the effect of a Number Sense Education Program Supported by Web 2.0 Tools on the development of number sense in first-grade elementary students. To this end, the following sub-problems have been explored:

Is there a statistically significant difference between the pre-test average scores of the experimental and control group students in the sub-dimensions and the total of the Number Sense Assessment Tool?

Is there a significant difference between the pre-test and post-test scores of the experimental group students in the sub-dimensions and the total of the Number Sense Assessment Tool?

Is there a meaningful difference between the pre-test and post-test scores of the control group students in the sub-dimensions and the total of the Number Sense Assessment Tool?

Is there a statistically significant difference between the post-test average scores of the experimental and control group students in the sub-dimensions and the total of the Number Sense Assessment Tool?

Is there a significant difference between the post-test and follow-up test scores of the experimental group students in the sub-dimensions and the total of the Number Sense Assessment Tool?

Method

Research Model

In the study, a pre-test, post-test, and follow-up test quasi-experimental design with control groups was used to test the effect of a Number Sense Education Program Supported by Web 2.0 Tools on the number sense development of first-grade elementary students. In this design, the dependent variable is "Number Sense Development," and the independent variable being examined for its effect on the number sense development of first-grade elementary students is the "Number Sense Education Program Supported by Web 2.0 Tools" (Büyüköztürk, 2014; Büyüköztürk et al., 2014). In this research, it was controlled that the pre-tests of the groups in terms of the dependent variable, number sense development, were similar.

In the study, the children in the experimental group were subjected to the Number Sense Education Program Supported by Web 2.0 Tools by the researcher, while the children in the control group were subjected to the mathematics activities in the Ministry of National Education (MEB, 2018) program, also implemented by the researcher.

Population and Sample

The universe of the study consists of first-grade children who attend schools under the Ministry of National Education in the İhsaniye district of Afyonkarahisar during the 2022-2023 academic year, who show normal development and have not previously been subjected to a special program related to numbers. In forming the sample, schools were initially identified. For this purpose, a list of elementary schools in the İhsaniye district of Afyonkarahisar province was obtained from the District National Education Directorate. From this list, schools with a first-grade student population not less than 20 were identified. For the sake of convenience in conducting the study, class 1-A of School A was selected as the experimental group, and class 1-B of the same school was selected as the control group. Necessary permissions were obtained from the Afyonkarahisar Provincial Directorate of National Education before the research commenced at this school. The study engaged a total of 44 students, with 23 in the experimental group and 21 in the control group. The demographic information of the students included in the sample is provided below in Table 1.

Table 1.

The Demographic Information of The Students Included In The Sample.

Demographic Variables	Experimental		Control	
Gender	*f*	*%*	*f*	*%*
Female	12	52.2	9	42.9
Male	11	47.8	12	57.1
Number of Children in the Family	*f*	*%*	*f*	*%*
Only child	2	8.7	-	-
2 children	7	30.4	11	52.4
3 children	11	47.9	6	28.6
4 children	2	8.7	3	14.3
4 or more children	1	4.3	1	4.8
Mothers Age	*f*	*%*	*f*	*%*
29 years and under	1	4.3	7	33.3
30-39 years	18	78.3	7	33.3
40-49 years	4	17.4	7	33.4
Fathers Age	*f*	*%*	*f*	*%*
29 years and under	-	-	1	4.8
30-39 years	11	47.8	12	57.1
40-49 years	12	52.2	8	38.1
Mother's Education	*f*	*%*	*f*	*%*
Primary and middle school	11	47.8	19	90.5
High school	9	39.1	2	9.5
University	2	8.7	-	-
Postgraduate	1	4.3	-	-
Father's Education	*f*	*%*	*f*	*%*
Primary and middle school	9	39.1	14	66.7
High school	10	43.5	6	28.6
University	3	13.0	1	4.8
Postgraduate	1	4.3	-	-

Upon examining Table 1, it was determined that in the experimental group, the majority of students are female (52.2%), 47.9% have 3 siblings, 78.3% of mothers are aged between 30-39, and 47.8% of mothers have completed primary or middle school education. Additionally, 52.2% of fathers are aged between 40-49, and 43.5% have a high school diploma.

In the control group, the majority of students are male (57.1%), 52.4% have 2 siblings, 33.4% of mothers are aged between 40-49, and 90.5% of mothers have completed primary or middle

school education. Moreover, 57.1% of fathers are aged between 30-39, and 66.7% have completed primary or middle school education.

Data Collection Tools

In the research, a "General Information Form" developed by the investigator was utilized to gather personal data about the students. Moreover, to evaluate the number sense abilities of first-grade elementary students, the Number Sense Screener—originally crafted by Jordan et al. (2012) and later adapted for Turkish children by Uyanık Aktulun (2019)—was employed.

General Information Form

The form was prepared by researchers to access information regarding the gender, number of siblings, age of the parents, their educational status, and professions of the students and their parents included in the research scope. For each child, the form was filled out based on the information available in the students' record files at the schools.

Number Sense Screener (NSS)

The Number Sense Screener is a condensed version of the research-based Number Sense Brief (33 items), developed for assessing the early numerical competencies of preschool and first-grade children (e.g., Jordan et al., 2006; Jordan et al., 2007). In this study, the Number Sense Screener consists of six subtests and a total of 29 items (Jordan et al., 2012). The administration time varies between 20-25 minutes for each child. Below are the details of the scale's sub-dimensions:

Counting Skills: This subtest, encompassing principles of counting (one-to-one correspondence, cardinality, and ordering) and rhythmic counting (counting rhythmically up to a given number), consists of a total of three items (Jordan et al., 2012)..
Number Recognition: This section requires children to name shown numbers (e.g., 13, 37). It consists of a total of four items (Jordan et al., 2012).

Number Comparisons: This subtest involves asking children to identify the number that comes after or two numbers after a given number (e.g., 7), and to determine which of the presented numbers (e.g., 5-4) is greater or smaller. Additionally, a series consisting of three numbers (6, 2, and 5) placed at three different points of an equilateral triangle is shown to the children. They are expected to find the number closest to the one at the top of the triangle (e.g., 5). This subtest comprises a total of seven items (Jordan et al., 2012).

Nonverbal Calculation: The items in this subtest are presented to the child using a white mat, a cardboard box, and ten black buttons of the same size included in the assessment tool. For example, for an addition operation, two buttons are placed on the mat within the child's view, and the child is told, "Do you see? There are two buttons here." After allowing the children to observe the buttons, they are covered with the lid of the box and placed inside the box. Then, another button is placed on the mat, and the child is told, "There is also one more button here," asking the child to watch carefully, and the button is similarly slid into the box with the lid. Subsequently, the page related to the item in the assessment tool is opened, and the child is asked to indicate the option that shows the total number of buttons inside the box. This subtest includes three addition and one subtraction operation, making a total of four items (Jordan et al., 2012).

Story Problems: In this subtest, children are told they may use their fingers, a number line (provided with the assessment tool), or paper and pencil to find the answers. Simple Story Problems are presented, such as, "Asya has m apples. Bilgehan gave her n more apples. How many apples does Asya have in total?" This subtest consists of five items, including three addition and two subtraction operations (Jordan et al., 2012).

Number Combinations: In this subtest, children are informed that they can use their fingers, a number line, or paper and pencil to find the answers if it helps. The Number Combinations dimension verbally presents questions like "What does two (2) plus (+) three (3) make?" and "What is left when three (3) is subtracted from five (5)?" This subtest contains four addition and two subtraction operations, comprising six items (Jordan et al., 2012).

Number Sense Education Program Supported By Web 2.0 Tools

In preparing the program content, in addition to literature analyses, outcomes and indicators aimed at supporting number sense skills were identified in collaboration with three field experts, based on the Mathematics Course Instruction Program (2018) for first-grade elementary by the Ministry of National Education. Before preparing lesson plans supported by Web 2.0 tools, the characteristics, needs, and levels of the students forming the experimental group were determined with the input of classroom teachers.

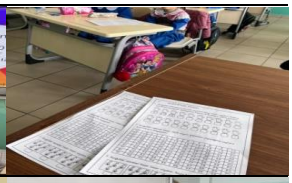
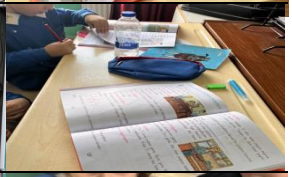
To ensure that the learning environment where students are educated is suitable for support with Web 2.0 tools, the characteristics of the learning and environmental setting were determined. In this context, the materials present in the classroom and the technological infrastructure were examined.

After conducting the necessary preliminary investigations and ensuring the suitability of the environmental conditions, an analysis of the unit outcomes in terms of number sense acquisition was carried out. During these analyses, all outcomes related to number sense were associated through joint decisions made by the researcher and the advisor. In the Ministry of National Education's first-grade mathematics curriculum, outcomes related to number sense are found within the "4 fundamental" subject areas and specifically in units "2, 3, 4, and 6." The learning processes, supported by suitable Web 2.0 tools and tailored to these specific subject areas and units, were then structured into a comprehensive 12-week program, reflecting both the recommended teaching durations and insights from expert opinions. This meticulous planning resulted in the creation of 11 detailed lesson plans, encompassing a total of 60 lesson hours, dedicated to advancing students' number sense through the innovative application of Web 2.0 tools. The lesson plans were meticulously crafted to seamlessly incorporate Web 2.0 tools, detailing aspects like lesson duration, objectives, methodologies, techniques, strategies, and assessing student readiness. They unfold in three structured phases: the introduction (engaging attention, stimulating prior knowledge, motivation, and clarifying objectives), the development phase (encompassing activities, interim recaps, and transitions), and the conclusion (final recap, reinvigoration, closure, and evaluation). The content and activities, devised with Web 2.0 tools, aim to foster students' number sense skills, ensuring they are developmentally suitable and centered around the learner. These plans are designed for an in-depth, systematic exploration of number sense dimensions, embracing a playful learning approach. The objective is for students to find joy in engaging with Web 2.0 tool-based activities, simultaneously attaining specified learning outcomes and developmental milestones.

The activities, engineered with Web 2.0 tools, are methodically organized from the simplest to the most complex tasks, promoting exploratory learning both independently and under adult guidance. Each task is broken down into phases, with numerous exercises contributing to the achievement of targeted outcomes and developmental benchmarks.

Every lesson plan is bolstered by educational tools from the Web 2.0 suite. For every activity, a minimum of three applications designed with Web 2.0 Tools have been integrated, arranged in order of increasing complexity. These applications are developed using freely accessible online platforms, including Wordwall, LearningApps, Storybird, Canva, Derslig, Okulistik, Voki, Math Kids, ABCYa, EBA, Primary Games, Pixton, and Arcademic Basics. The activities, curated or specifically created by researchers to be freely available, are thoughtfully chosen or devised to align with the lesson plans' intended outcomes, systematically presented to students to gradually escalate from straightforward to more demanding tasks. The lesson plans underwent a rigorous evaluation process by three experts specializing in number sense and classroom education. These experts were asked to assess the educational program and its various elements, including learning outcomes and indicators, conceptual understanding, the content of Web 2.0 tool-based activities, the alignment of the program's objectives with educational goals, the effectiveness of the learning methodologies employed, the relevance and sufficiency of the Web 2.0 tool-enhanced activities, the organization of outcomes and indicators, and the precision of the provided instructions. Based on the insights garnered from the expert evaluations, it was determined that certain Web 2.0 tool-incorporated activities necessitated additional refinement. Consequently, modifications were made to better align with the learning outcomes, leading to a more encompassing restructuring of the program.

Table 2.
Web 2.0 Tools and Associated Visuals Applied During the Experimental Study

Duration		Web 2.0	Images	
Week (W)	Hour (H)	Applied Web 2.0 Tool	ExperimentalGroup	Control Group
1W	5H	Digital Story (1 work) Wordwall (3 works) Derslig (34 works)		
2W	4H	Canva (Comic Book) (1 work) LearningApps (3 works) Okulistik (14 works)		
2.-3W	2H	Voki (Virtual Character in Narrative)(1 work) Derslig (10 works)		
3.-4W	5H	Fairy Tale (1 work) Okulistik (29 works) Math Kids (1 work)		
4-5W	7H	ABCYa (2 works) EBA (1 work) Primary Games (2 works)		
5-6W	5H	Wordwall (6 works) LearningApps (1 work)		
6.-7W	10H	Voki (1 work) LeraningApps (3 works)		
8W	5 H	Pixton (Concept cartoons) (1 work) ABCYa (2 works) Arcademic Basics (2 works)		
9W	5 H	Okulistik (12 works) Wordwall (4 works)		
10-11W	10 H	Voki (1 work) LearningApps (2 works) ABCYa (2 works)		
12W	4 H	Canva (1 work) Wordwall (1 work)		

Subsequently, with the objective of conducting a pilot study, the program was implemented according to a two-week planned schedule. This preliminary phase was successfully assessed in terms of time management, the appropriateness of activities to the students' levels, and their attitudes towards the lessons, all yielding positive outcomes.

Throughout the experimental study, activities prepared using Web 2.0 tools and applied each week are presented in Table 2.

As shown in Table 2, lesson plans and the content prepared with associated Web 2.0 tools have been designed and sequenced in a spiral manner, progressing from simple to complex. There are a total of 11 lesson plans and contents prepared using 13 different Web 2.0 tools. Emphasis has been placed on ensuring that activities created with Web 2.0 tools have the flexibility to be altered according to the students' interests, and they exhibit certain differences from conventional daily practices. Additionally, it was crucial that the activities were engaging, designed to entertain children while simultaneously facilitating their learning.

Data Collection Procedures

To assess the number sense skills of first-grade students in both the experimental and control groups, the Number Sense Screener was administered by the researcher as a pre-test between October 24, 2022, and January 20, 2023. The administration of the Number Sense Screener followed the specifications stated in its validity and reliability studies, such as conducting the test in a quiet and calm environment on a one-on-one basis with each child. Before the application, parents were informed about the content of the education program, and it was emphasized how crucial it was for students not to miss school, especially on the specified days and times. Subsequently, the Number Sense Education Program Supported by Web 2.0 Tools was implemented in the math classes of the experimental group by the researcher during the same dates, from October 24, 2022, to January 20, 2023. The education program sessions were conducted five days a week for 12 weeks, with each session lasting approximately 40 minutes. During this period, the math classes for the control group were also conducted by the researcher following the Ministry of National Education's First Grade Mathematics Curriculum. This approach eliminated any instructor (teacher-researcher) differences between the experimental and control groups.

While executing the Number Sense Education Program Enhanced by Web 2.0 Tools, meticulous preparation of the learning environment was undertaken before each session. This preparation involved setting up essential materials and technological resources, such as smart boards and computers, to facilitate the utilization of Web 2.0 tools. The scheduling of the educational program was established in collaboration with the teaching staff to ensure optimal timing. Efforts were made to secure the participation of all students in the classroom for the activities. The structure of each lesson was methodically organized into three segments: the introduction phase (engaging students' attention, activating prior knowledge, fostering motivation, and outlining the lesson's objectives), the development phase (conducting activities, providing interim summaries, and facilitating transitions), and the conclusion phase (delivering the final summary, reinvigorating motivation, concluding the session, and conducting assessments). Upon aligning the lessons with the Ministry of National Education's First Grade Mathematics Curriculum, students were then introduced to Web 2.0 tool-supported educational content designed to achieve specific learning outcomes. Students were assisted in engaging with and completing topic-related educational content using smart boards and computers. Activities developed with Web 2.0 tools were structured to accommodate both individual and small group participation. It is important to note that the educational content devised with Web 2.0 tools for the experimental group was exclusively used within this group and not introduced to the control group in any capacity. Prior to initiating the program, students in the control group were briefed on the upcoming 12-week mathematics curriculum, which would be directed by the researcher in accordance with the Ministry of National Education (2018) First Grade Mathematics Curriculum.

Subsequent to the implementation phase, the Number Sense Screener was administered as a post-test to both the experimental and control groups under the same environmental and procedural conditions

as the pre-test, spanning from October 24, 2022, to January 20, 2023. To evaluate the long-term impact and retention of the Web 2.0 Tools Supported Number Sense Program, the Number Sense Assessment Tool was employed four weeks post the administration of the post-tests. This retention test, conducted by the researcher, aimed to assess the program's enduring effects on all students from both groups during the same timeframe.

Data Analysis

The analysis began with the presentation of demographic details concerning both students and their parents, quantified through frequencies and percentages. The study deployed the Kolmogorov-Smirnoff (K-S) normality test on the scores derived from the Number Sense Screener, revealing a deviation from normal distribution, attributed to the participant count in each group being below 30. To discern differences across groups, the study utilized the Mann-Whitney U Test for inter-group comparisons and the Wilcoxon Signed-Rank Test for intra-group analyses. A critical significance threshold was set at .05, where a p-value less than .05 was interpreted as indicative of a statistically significant difference between groups, whereas a p-value greater than .05 denoted the absence of significant disparities (Büyüköztürk, 2014).

Findings

The quantitative findings obtained from the study investigating the effect of the Web 2.0 Supported Number Sense Program on children's number sense skills are presented between Tables 3 and 9.

Table 3.
Results Related to the Number of Students, Mean, and Standard Deviation Scores for the Pre-Test Scores of the Number Sense Screener for First-Grade Students Attending the Experimental and Control Group

Group	Number Sense Screener	n	$\bar{x}$	SD
Experiment	Counting Skills	23	2.826	.491
	Number Recognition	23	.609	.941
	Number Comparisons	23	3.696	1.743
	Nonverbal Calculation	23	1.913	1.041
	Story Problems	23	1.391	1.033
	Number Combinations	23	1.652	1.873
	Number Sense Screener Total	23	12.087	5.151
Control	Counting Skills	21	2.714	.561
	Number Recognition	21	.952	1.244
	Number Comparisons	21	3.429	1.720
	Nonverbal Calculation	21	1.905	.944
	Story Problems	21	1.381	1.322
	Number Combinations	21	1.095	1.513
	Number Sense Screener Total	21	11.476	5.066

Upon examining the results related to the number of students, mean, and standard deviation scores for the pre-test scores of the Number Sense Screener for first-grade students attending the experimental and control groups in Table 3, it is observed that the number of students in all sub-dimensions for the experimental group is 23. Moreover, in the experimental group, the Counting Skills sub-dimension ($\bar{x}$ =2.826; SD=.491), Number Recognition sub-dimension ($\bar{x}$ =.609; SD=.941), Number Comparisons sub-dimension ($\bar{x}$ =3.696; SD=1.743), Nonverbal Calculation sub-dimension ($\bar{x}$ =1.913; SD=1.041), Story Problems sub-dimension ($\bar{x}$ =1.391; SD=1.033), Number Combinations sub-dimension ($\bar{x}$ =1.652; SD=1.873), and the total Number Sense Screener ($\bar{x}$ =12.087; SD=5.151) are noted. Similarly, for the control group, the Counting Skills sub-dimension ($\bar{x}$ =2.714; SD=.561), Number Recognition sub-dimension ($\bar{x}$ =.952; SD=1.244), Number Comparisons sub-dimension ($\bar{x}$ =3.429; SD=1.720), Nonverbal Calculation sub-dimension ($\bar{x}$ =1.905; SD=.944), Story Problems sub-dimension ($\bar{x}$ =1.381; SD=1.322), Number Combinations sub-dimension ($\bar{x}$ =1.095; SD=1.513), and the total Number Sense Screener ($\bar{x}$ =11.476; SD=5.066) have been determined.

Table 4.
Mann Whitney U Test Results Related to the Pre-Test Scores of the Number Sense Screener for First-Grade Students in the Experimental and Control Groups

Number Sense Screener	Group	n	Mean Rank	Rank Sum	U	Z	P
Counting Skills	Experiment	23	23.59	542.50	216.500	.876	.381
	Control	21	21.31	447.50			
Number Recognition	Experiment	23	20.91	481.00	205.00	.952	.341
	Control	21	24.24	509.00			
Number Comparisons	Experiment	23	23.54	541.50	217.50	.575	.565
	Control	21	21.36	448.50			
Nonverbal Calculation	Experiment	23	22.54	518.50	240.50	.025	.980
	Control	21	22.45	471.50			
Story Problems	Experiment	23	23.35	537.00	222.00	.479	.632
	Control	21	21.57	453.00			
Number Combinations	Experiment	23	24.28	558.50	200.50	1.014	.311
	Control	21	20.55	431.50			
Number Sense Screener Total	Experiment	23	23.52	541.00	218.00	.555	.579
	Control	21	21.38	449.00			

Upon analyzing Table 4, it has been determined that there is no significant difference between the pre-test mean scores of students in the experimental and control groups across all sub-dimensions of the Number Sense Screener; Counting Skills (U=.876, p>.05), Number Recognition (U=.952, p>.05), Number Comparisons (U=.575, p>.05), Nonverbal Calculation (U=.025, p>.05), Story Problems (U=.479, p>.05), Number Combinations (U=1.014, p>.05), and the total score of the Number Sense Screener (U=.555, p>.05). Accordingly, it can be stated that first-grade students in both the experimental and control groups possess similar characteristics in terms of number sense skills at the commencement of the education program. In research employing a pre-test post-test control group design, it is crucial for the pre-test scores of the experimental and control groups to be closely matched (Kaptan, 1998). This condition is significant in demonstrating the effectiveness of the education program applied to the experimental group.

Table 5.
Wilcoxon Signed-Rank Test Results for the Pre-Test / Post-Test Scores of the Number Sense Screener among First-Grade Students in the Experimental Group

Number Sense Screener	Pre / Post-Test	n	Mean Rank	Sum of Rank	z	p
Counting Skills	Negative Rank	0	.00	.00	1.414	0.157
	Positive Rank	2	1.50	3.00		
	Ties	21	-	-		
Number Recognition	Negative Rank	0	.00	.00	4.054	0.000*
	Positive Rank	21	11.00	231.00		
	Ties	2	-	-		
Number Comparisons	Negative Rank	0	.00	.00	3.85	0.000*
	Positive Rank	19	10.00	190.00		
	Ties	4	-	-		
Nonverbal Calculation	Negative Rank	0	.00	.00	3.8	0.000*
	Positive Rank	18	9.50	171.00		
	Ties	5	-	-		
Story Problems	Negative Rank	1	3.00	3.00	4.135	0.000*
	Positive Rank	22	12,41	273.00		
	Ties	0	-	-		
Number Combinations	Negative Rank	0	.00	.00	4.125	0.000*
	Positive Rank	22	11.50	253.00		
	Ties	1	-	-		
Number Sense Screener Total	Negative Rank	0	.00	.00	4.203	0.000*
	Positive Rank	23	12.00	276.00		
	Ties	0	-	-		

*p<.05

Upon reviewing Table 5, the results of the Wilcoxon Signed-Rank Test conducted with the experimental group data indicate statistically significant differences between the pre-test and post-test scores for the Number Sense Screener's sub-dimensions and overall score. Significant improvements were observed in Number Recognition (z= 4.054, p<.05), Number Comparisons (z=3.850, p<.05), Nonverbal Calculation (z=3.800, p<.05), Story Problems (z=4.135, p<.05), Number Combinations (z=4.125, p<.05), and the total score of the Number Sense Screener (z=4.203, p<.05). However, no significant difference was detected in the Counting Skills sub-dimension (z=1.414, p>.05). Consequently, it can be inferred that the post-test mean scores for the sub-dimensions of number sense skills and the total score are higher than the pre-test mean scores. This outcome suggests that the Web 2.0 supported number sense activities within the scope of this research effectively contributed to the development of students' number sense skills.

Table 6.
Wilcoxon Signed-Rank Test Results for the Pre-Test / Post-Test Scores of the Number Sense Screener among First-Grade Students in the Control Group

Number Sense Screener	Pre-Test Post-Test	n	Mean Rank	Sum of Rank	z	p
Counting Skills	Negative Rank	2	3.00	6.00	.447	0.655
	Positive Rank	3	3.00	9.00		
	Ties	16	-	-		
Number Recognition	Negative Rank	1	4.00	4.00	3.411	0.001*
	Positive Rank	15	8.80	132.00		
	Ties	5	-	-		
Number Comparisons	Negative Rank	1	5.50	5.50	3.81	0.000*
	Positive Rank	19	10.76	204.50		
	Ties	1	-	-		
Nonverbal Calculation	Negative Rank	3	5.00	15.00	2.217	0.027*
	Positive Rank	10	7.60	76.00		
	Ties	8	-	-		
Story Problems	Negative Rank	2	5.00	10.00	3.494	0.000*
	Positive Rank	17	10.59	180.00		
	Ties	2	-	-		
Number Combinations	Negative Rank	7	5.14	36.00	3.842	0.000*
	Positive Rank	13	13.38	174.00		
	Ties	1	-	-		
Number Sense Screener Toplam	Negative Rank	1	2.50	2.50	3.933	0.000*
	Positive Rank	20	11.43	228.50		
	Ties	0	-	-		

*p<.05

Upon reviewing Table 6, according to the Wilcoxon Signed-Rank Test conducted with the control group data, it has been determined that there is a statistically significant difference between the pre-test and post-test scores of the Number Sense Screener's sub-dimensions and total; specifically, in the sub-dimensions of Number Recognition (z= 3.411, p<.05), Number Comparisons (z=3.810, p<.05), Nonverbal Calculation (z= 2.217, p<.05), Story Problems (z=3.494, p<.05), Number Combinations (z=3.842, p<.05), and the total score of the Number Sense Screener (z=3.933, p<.05). However, no significant difference was found in the Counting Skills sub-dimension (z= .447, p>.05). Accordingly, it is observed that the mean scores of the post-test for the sub-dimensions and total of children’s number sense skills are higher than the pre-test mean scores. Based on this result, it can be said that the number sense activities applied to the control group within the scope of the research were effective in supporting the development of students' number sense skills.

Table 7.

Results Related to the Number of Students, Mean, and Standard Deviation Scores for the Post-Test Scores of the Number Sense Screener among First-Grade Students in the Experimental and Control Groups

Group	Number Sense Screener	n	$\bar{x}$	SD
Experiment	Counting Skills	23	2.913	.417
	Number Recognition	23	2.608	1.076
	Number Comparisons	23	6.087	1.411
	Nonverbal Calculation	23	3.217	.902
	Story Problems	23	4.043	1.397
	Number Combinations	23	5.087	1.378
	Number Sense Screener Toplam	23	23.956	5.772
Control	Counting Skills	21	2.761	.538
	Number Recognition	21	2.047	1.321
	Number Comparisons	21	4.809	1.860
	Nonverbal Calculation	21	2.476	1.167
	Story Problems	21	2.666	1.238
	Number Combinations	21	3.619	1.856
	Number Sense Screener Toplam	21	18.381	7.003

Upon reviewing the results related to the number of students, mean, and standard deviation scores for the post-test scores of the Number Sense Screener among first-grade students in the experimental and control groups as presented in Table 7, it is noted that the number of students in all sub-dimensions for the experimental group is 23. Furthermore, in the experimental group, the Counting Skills sub-dimension ($\bar{x}$ =2.913; SD=.417), Number Recognition sub-dimension ($\bar{x}$ =2.608; SD=1.076), Number Comparisons sub-dimension ($\bar{x}$ =6.087; SD=1.411), Nonverbal Calculation sub-dimension ($\bar{x}$ =3.217; SD=.902), Story Problems sub-dimension ($\bar{x}$ =4.043; SD=1.397), Number Combinations sub-dimension ($\bar{x}$ =5.087; SD=1.378), and the total Number Sense Screener ($\bar{x}$ =23.956; SD=5.772) have been observed. Similarly, for the control group, the Counting Skills sub-dimension ($\bar{x}$ =2.761; SD=.538), Number Recognition sub-dimension ($\bar{x}$ =2.047; SD=1.321), Number Comparisons sub-dimension ($\bar{x}$ =4.809; SD=1.860), Nonverbal Calculation sub-dimension ($\bar{x}$ =2.476; SD=1.167), Story Problems sub-dimension ($\bar{x}$ =2.666; SD=1.238), Number Combinations sub-dimension ($\bar{x}$ =3.619; SD=1.856), and the total Number Sense Screener ($\bar{x}$ =18.381; SD=7.003) have been determined.

Table 8.

Mann Whitney U Test Results Related to the Post-Test Scores of the Number Sense Screener among First-Grade Students in the Experimental and Control Groups

Number Sense Screener	Group	n	Mean Rank	Rank Sum	U	Z	p
Counting Skills	Experiment	23	23.98	551.50	207.500	1.450	.147
	Control	21	20.88	438.50			
Number Recognition	Experiment	23	25.20	579.50	179.500	1.511	.131
	Control	21	19.55	410.50			
Number Comparisons	Experiment	23	26.76	615.50	143.500	2.397	.017*
	Control	21	17.83	374.50			
Nonverbal Calculation	Experiment	23	26.72	614.50	144.500	2.467	.014*
	Control	21	17.88	375.50			
Story Problems	Experiment	23	28.61	658.00	101.000	3.399	.001*
	Control	21	15.81	332.00			
Number Combinations	Experiment	23	27.74	638.00	121.000	2.928	.003*
	Control	21	16.76	352.00			
Number Sense Screener Toplam	Experiment	23	28.26	650.00	109.000	3.126	.002*
	Control	21	16.19	340.00			

*p<.05

Upon examining Table 8, it has been determined that there is no significant difference between the post-test mean scores of students in the experimental and control groups for the Number Sense Screener in the Counting Skills (U=1.450, p>.05) and Number Recognition (U=1.511, p>.05) sub-dimensions. However, significant differences were found in the Number Comparisons (U=2.397, p<.05), Nonverbal Calculation (U=2.467, p<.05), Story Problems (U=3.399, p<.05), Number Combinations (U=2.928, p<.05) sub-dimensions, and the total score of the Number Sense Screener (U=3.126, p<.05). Therefore, considering the sub-dimensions and total scores of the Number Sense Screener, it can be stated that at the end of the educational intervention, students in the experimental group exhibited superior number sense skills compared to those in the control group.

Table 9.

Wilcoxon Signed-Rank Test Results for the Post-Test / Retention Test Scores of the Number Sense Screener among First-Grade Students in the Experimental Group

Number Sense Screener	Pre-Test Post-Test	n	Mean Rank	Sum of Rank	z	p
Counting Skills	Negative Rank	0	.00	.00	1	0.317
	Positive Rank	1	1.00	1.00		
	Ties	22	-	-		
Number Recognition	Negative Rank	2	6.00	12.00	2.324	0.020*
	Positive Rank	10	6.60	66.00		
	Ties	11	-	-		
Number Comparisons	Negative Rank	4	5.50	22.00	0.632	0.527
	Positive Rank	6	5.50	33.00		
	Ties	13	-	-		
Nonverbal Calculation	Negative Rank	1	5.00	5.00	2.333	0.020*
	Positive Rank	8	5.00	40.00		
	Ties	14	-	-		
Story Problems	Negative Rank	3	3.50	10.50	0.632	0.527
	Positive Rank	4	4.38	17.50		
	Ties	16	-	-		
Number Combinations	Negative Rank	3	4.50	13.50	0.707	0.480
	Positive Rank	5	4.50	22.50		
	Ties	15	-	-		
Number Sense Screener Toplam	Negative Rank	2	4.00	8.00	2.841	0.004*
	Positive Rank	12	8.08	97.00		
	Ties	9	-	-		

*p<.05

Upon reviewing Table 9, according to the Wilcoxon Signed-Rank Test conducted with the experimental group's data, a significant difference was identified between the post-test scores and the retention test scores in the sub-dimensions of the Number Sense Screener and the overall scores statistically; significant differences were found in Number Recognition (z= 2.324, p<.05), Nonverbal Calculation (z= 2.333, p<.05), and the total score of the Number Sense Screener (z=2.841, p<.05). However, no significant difference was detected in the Counting Skills (z= 1.000, p>.05), Number Comparisons (z=0.632, p>.05), Story Problems (z=0.632, p>.05), and Number Combinations (z=0.707, p>.05) sub-dimensions. Accordingly, it can be observed that the children's number sense abilities in the sub-dimensions of Number Recognition, Nonverbal Calculation, and the total retention test scores of the Number Sense Screener were higher than the post-test scores. This outcome may suggest that the continued engagement of students with the Web 2.0 tool-supported content related to the Number Sense activities applied to the experimental group could be attributed to the practices continued by the students after the application phase.

Discussion, Conclusion, and Recommendations

In the study examining the effect of the Number Sense Education Program Supported by Web 2.0 Tools on number sense skills, it was determined that there was no significant difference between the pre-test average scores of the experimental group students, to whom the Web 2.0 Supported Number Sense Education Program was applied, and the control group students, to whom the existing teaching program was applied, across the Number Sense Screener sub-dimensions and total scores. A statistically significant difference was found between the pre-test and post-test scores of the experimental group students in the sub-dimensions of Number Recognition, Number Comparisons, Nonverbal Calculation, Story Problems, Number Combinations, and in the total score of the Number Sense Screener. However, no significant difference was identified in the Counting Skills sub-dimension between the pre-test and post-test scores of the experimental group students. In summary, it can be said that the children's average scores in number sense skills were higher than their average pre-test scores. Based on this research outcome, it can be stated that number sense activities supported by Web 2.0 tools are effective in developing students' number sense skills. When examining the difference between the pre-test and post-test scores of the control group students, a significant difference was found in the sub-dimensions of Number Recognition, Number Comparisons, Nonverbal Calculation, Story Problems, Number Combinations, and in the total score of the Number Sense Screener. However, no significant difference was identified in the Counting Skills sub-dimension. Therefore, it can be said that the children's average scores on the Number Sense Screener were higher than their pre-test average scores. This situation is thought to be due to the acquisition of outcomes and indicators related to number sense included in the Ministry of National Education's First Grade Mathematics Course Teaching Program (2018) during the research process. When comparing the post-test average scores of the experimental and control groups, a significant difference was found in favor of the experimental group across the Number Sense Screener sub-dimensions and the total. This result serves as evidence of the positive effect of educational processes supported by Web 2.0 tools on the development of students' number sense skills. Finally, analyses of the experimental group students' post-test and follow-up test scores revealed that the averages of the Number Recognition and Nonverbal Calculation sub-dimensions, as well as the total follow-up test scores of the Number Sense Screener, were significantly higher than the post-test averages. This outcome is thought to result from the students' continued engagement with the content prepared with Web 2.0 tools even after the experimental application.

In the literature, regarding the developmental trajectory of number sense during the preschool and elementary school periods, Gözüm et al. (2024) conducted a latent profile analysis to identify the number and proportions of distinct number sense profiles, the variables influencing these profiles, and the characteristics of children with different profiles during the transition from preschool to elementary school. The number sense profiles of preschool and first-grade students were identified as significantly below average, below average, and above average. The average scores for both early number knowledge and arithmetic skills of first-grade and preschool children were below average in Profile I (moderate very low, 9.20%) and Profile II (moderate low, 24.50%). It was found that 33.70% of the children, whose arithmetic skills were expected to develop through preschool mathematics education, scored below average in arithmetic skills. However, 66.30% of the children starting first grade displayed an above-average profile (Profile III). Among the preschool children who participated in this study, the proportions of those in Profile I (moderate very low, 51.90%), Profile II (moderate low, 13.00%), and Profile III (moderate high, 35.10%) showed that the majority were in Profile I. A total of 64.90% of preschool children were found to have below-average number sense skills. The researchers suggested that these results indicate that children’s number sense skills develop more significantly in elementary school than during the preschool period, emphasizing the critical importance of mathematical activities conducted in first grade. Additionally, the researchers highlighted that supporting the counting component of the early number knowledge dimension for preschool and first-grade Profile I children is a key method of intervention. This is because the counting component was the critical feature that distinguished Profile I from Profile II and Profile III in both preschool and first-grade students. It was noted that children whose counting component does not develop during the transition from preschool to elementary school may face risks in their number sense development and

mathematics achievement in later years. Similarly, Nelwan et al. (2021) found that number sense contributes to the mathematical development of children with and without mathematical difficulties starting from first grade. These studies collectively underscore the developmental significance of number sense in first grade and the importance of number sense activities conducted at the first-grade level.

Additionally, the literature includes studies demonstrating the impact of intervention programs on students' number sense skills. In Gillespie's (2021) research, while conducting "Number Talks" activities with the experimental group, traditional mathematics lessons were carried out. The study concluded that students in the experimental group significantly outperformed the control group in both number sense and mathematical discourse skills. Similarly, Tucker and Johnson (2022) explored the impact of a touchscreen digital game called Fingu on the development of number sense in preschool children. An increase in number sense skills and mathematical thinking was observed among children who played the Fingu game. In this context, the use of digital tools has been highlighted for its contributions to the development of children's mathematical skills, particularly in enhancing their number sense. Verzosa and colleagues (2021) developed and implemented a number line mobile application using gamification techniques for students from 1st to 7th grade to instill number estimation and number sense skills. The results indicated that the mobile application primarily increased students' motivation and had a positive effect on the development of number estimation and number sense skills. Liang et al. (2020) reported that a Response to Intervention (RtI) model-based mathematics game training for socially disadvantaged preschool children had a positive impact on their development of number sense. Azid and colleagues (2020) investigated the effect of using Web 2.0 tools on students' mathematics achievement; they found that the experimental group, which used Web 2.0 tools, showed improved mathematics achievement, enjoyed the learning process, were motivated to complete tasks during lessons, and exhibited increased interest. Hulse and colleagues (2019) explored the impact of a game-based approach called "From Here to There! Elementary" on developing number sense and early algebra skills among second-grade elementary students. They concluded that the game effectively enhanced students' number sense and early algebra skills in mathematics education. According to Papadakis et al. (2016), technological tools offer innovative opportunities to support mathematical achievement when used appropriately for children's developmental stages. In an experimental study conducted by Papadakis et al. (2018), it was found that mathematical activities involving technological tools supported children's understanding of numbers. Similarly, Benavides-Varela et al. (2020) conducted a meta-analysis of empirical evidence on the effectiveness of digital-based interventions for students with mathematical learning difficulties and found that such interventions generally improved mathematical performance (mean effect size = 0.55). Lastly, Yazıcı et al. (2023) demonstrated in their research that Web 2.0-supported geometry activities effectively improved preschool children's geometry skills. Thus, the research outcomes mentioned above support the findings that the number sense skills of students in the experimental group improved positively from before to after the educational intervention.

In the Number Sense Education Program Supported by Web 2.0 Tools, the activities and lesson plans prepared with Web 2.0 tools were designed to align with students' developmental characteristics and to specifically target their number sense skills. The program is entirely child-centered, allowing for an in-depth, systematic, and sequential exploration of the dimensions of number sense skills. It focuses on game-based learning and ensures that students enjoy engaging in the activities prepared with Web 2.0 tools. The arrangement of activities from simple to complex, the inclusion of both collaborative and individual exploratory learning opportunities, and the integration of multiple activities for each learning outcome and development indicator, suggest that such features have contributed to the development of number sense skills among students in the experimental group.

In this study, limited by the number of children in the group and the activities included in the Web 2.0 Supported Number Sense Education Program, it has been concluded that the program is effective in supporting students' number sense skills. In this context, the following suggestions can be offered:

This research, conducted with first-grade students and limited to the duration of the study, suggests that longitudinal studies with larger groups could be conducted to further investigate the effectiveness of Web 2.0 tools on number sense.

Seminars, conferences, and similar events could be organized for teachers on integrating Web 2.0 tools with lesson topics. This would ensure that teachers become informed about the subject and gain awareness of using Web 2.0 tools.

Elective courses at both undergraduate and postgraduate levels could be offered that include topics on integrating Web 2.0 tools with lesson subjects through example educational practices for teacher candidates.

Building on the effects of Web 2.0 tools on the development of number sense in first-grade students, this method could be explored and applied in number sense topics within mathematics lessons at different grade levels, with results presented in report form.

Following this study, further research could be conducted on the effectiveness of Web 2.0 tools with different course contents. The outcomes of such studies, including both positive and negative results, could be shared with researchers, teachers, students, and administrators.

By integrating Web 2.0 tools with foundational educational practices, students' interest in lessons can be maintained and their motivation increased, supporting the retention of what is learned.

Studies supported by Web 2.0 Tools could be conducted on topics where students generally struggle to learn, allowing for an evaluation of learning processes.

Acknowledgment

Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

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References

Alkan, C. (2011). *Eğitim teknolojisi.* Ankara: Anı Yayıncılık.

Aytan, T., & Başal, A. (2015). Türkçe öğretmen adaylarının web 2. 0 araçlarına yönelik algılarının incelenmesi. *Turkish Studies - International Periodical for the Languages, Literature and History of Turkish or Turkic, 10*(7), 149-166. doi:10.7827/TurkishStudies.8388

Azid, N., Hasan, R., Nazarudin, N. F. M., & Md-Ali, R. (2020). Embracing ındustrial revolution 4.0: the effect of using web 2.0 tools on primary schools students' mathematics achievement (Fraction). *International Journal of Instruction, 13*(3), 711-728. doi:10.29333/iji.2020.13348a

Bayak, N. (2016). *Sınıf öğretmenlerinin sayı duyusu düzeyleri ve ilkokul matematik öğretiminde kullanma durumları*. (Unpublished master's thesis).Pamukkale Üniversitesi, Denizli.

Benavides-Varela, S., Callegher, C. Z., Fagiolini, B., Leo, I., Altoè, G., & Lucangeli, D. (2020). Effectiveness of digital-based interventions for children with mathematical learning difficulties: A meta-analysis. *Computers & Education, 157*, 1-15, 103953. doi: 10.1016/j.compedu.2020.103953

Berch, D. B. (2005). Making sense of number sense: Implications for children with mathematical disabilities. *Journal of Learning Disabilities, 38*(4), 333–339. doi: 10.1177/00222194050380040901

Büyüköztürk, Ş. (2014). *Sosyal bilimler icin veri analizi el kitabi istatistik, arastirma deseni spss uygulamalari ve yorum*. Ankara: Pegem Akademi.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş. & Demirel, F., (2014). *Bilimsel araştırma yöntemleri*. Ankara: Pegem Akademi.

Canbaz, B., ve Yalçın, N., (2021). Eğitim bilimlerinde araştırma ve değerlendirmeler cilt 2. In O. Zahal & Ö. Yahşi (Eds.), *Eğitimde web 2.0 araçları* (pp.55-82), Ankara: Gece Kitaplığı.

Cheng, Q., & Wang, J. (2012). Curriculum opportunities for number sense development: a comparison of first-grade textbooks in china and the united states. *International Journal for Mathematics Teaching & Learning*. Erişi adresi: https://www.cimt.org.uk/journal/cheng.pdf

Confer, C (2005). *Teaching number sense kindergarten.* Sausalito: Math Solutions

Çakır, R., Adsay, C., & Uğur, Ö. A. (2019). Ters-yüz sınıf modelinin ve web 2.0 yazılımlarının bilgisayarca düşünme becerisi, etkinlik tecrübesi ve uzamsal düşünme becerisine etkisi. *Mersin Üniversitesi Eğitim Fakültesi Dergisi, 15*(3), 845-866. doi: 10.17860/mersinefd.528764

Çalışkan, N., & Karadağ, E. (2013). Öğretim teknolojileri ve materyal tasarımı. In M. Sarıtaş (Ed.), *Temel kavramlar* (ss. 1-9). Ankara: Pegem Akademi.

Çekirdekci, S., Şengül, S., & Doğan, M.C. (2020). 4. sınıf öğrencilerinin kullandıkları sayı hissi stratejilerinin belirlenmesi. *International Social Mentality and Researcher Thinkers Journal, 6*(31): 680-695. doi: 10.31576/smryj.512

Çelebi, C. & Satırlı, H. (2021). Web 2.0 araçlarının ilkokul seviyesinde kullanım alanları. *Instructional Technology and Lifelong Learning, 2*(1), 75-110. doi:10.52911/itall.938122

Çetin, H. & Öztürk, Ş. (2020). İlkokul matematik öğretim programının sayı duyusu temel bileşenlerine göre incelenmesi. *Ulusal Eğitim Akademisi Dergisi (UEAD), 4*(2), 163-180.

Çopur, K. D. (2020). *Algoritmik düşünme öğretimi sürecinde web 2.0 araçlarının kullanım*ı. (Unpublished master's thesis). Erciyes Üniversitesi, Kayseri.

Dennis, A. & Hamm, M. (2010). *Demystify Math, Science, and Technology. Creativity, İnnovation, and Problem Solving.* United Kingdom. Rowman & Littlefield Publishers, Inc.

Elmas, R., & Geban, Ö. (2012). 21. Yüzyıl öğretmenleri için web 2.0 araçları. *International Online Journal of Educational Sciences, 4*(1), 243-254.

Ersoy, Y. (2003). Teknoloji destekli matematik eğitimi-1: gelişmeler, politikalar ve stratejiler. *İlköğretim Online, 2*(1), 18-27.

Gersten, R., & Chard, D. (1999). Number sense: rethinking arithmetic instruction for students with mathematical disabilities. *The Journal of Special Education, 33*(1), 18-28.

Gillespie, K. B. (2021). *Effects of number talks on number sense acquisition and mathematical discourse.* (Unpublished pHD. thesis) Wilmington University, Delaware.

Gözüm, A.İ.C., Özberk, E. H., Kaya, Ü. Ü., & Uyanık Aktulun, Ö. (2024). Number sense across the transition from preschool to elementary school: a latent profile analysis. *Early Childhood Education Journal, 52,* 1221-1243. doi: 10.1007/s10643-023-01511-w

Gülbağcı Dede, H. (2015*). İlköğretim ve ortaöğretim matematik öğretmen adaylarının sayı hissinin incelenmesi*. (Unpublished pHD. thesis). Marmara Üniversitesi, İstanbul.

Henniger, M. L. (2012). *Teaching young children: an introduction*. New Jersey: Upper Saddle River.

Horzum, M. B. (2010). Öğretmenlerin web 2.0 araçlarından haberdarlığı, kullanım sıklıkları ve amaçlarının çeşitli değişkenler açısından incelenmesi. *Uluslararası İnsan Bilimleri Dergisi, 7*(1), 603–634.

Hulse, T., Daigle, M., Manzo, D., Braith, L., Harrison, A., & Ottmar, E. (2019). From here to there! elementary: a game-based approach to developing number sense and early algebraic understanding. *Educational Technology Research and Development*, 67, 423-441. doi: 10.1007/s11423-019-09653-8

İnal, E., & Arslanbaş, F. (2021). Türkçenin yabancı dil olarak uzaktan öğretiminde iletişim odaklı web 2.0 araçları ve uygulama örnekleri. *Bayburt Eğitim Fakültesi Dergisi*, *16* (Özel Sayı), 228-249. doi: 10.35675/befdergi.850781

Jackman, H. (2012). *Early education curriculum a child's connection to the World* (5. Baskı). U.S.A.: Wadsworth Cengage Learning.

Jordan, N. C., Glutting, J.J., & Dyson, N. (2012). *Number Sense Screener™ (NSS™) User's Guide, k–1, Research Edition.* Baltimore: Brookes Publishing.

Jordan, N. C., Kaplan, D., Locuniak, M. N., & Ramineni, C. (2007). Predicting first-grade math achievement from developmental number sense trajectories. *Learning Disabilities Research and Practice, 22*(1), 36-46. doi: 10.1111/j.1540-5826.2007.00229.x

Jordan, N. C., Kaplan, D., Nabors Oláh, L., & Locuniak, M. N. (2006). Number sense growth in kindergarten: a longitudinal investigation of children at risk for mathematics difficulties. *Child Development*, *77*(1), 153-175. doi: 10.1111/j.1467-8624.2006.00862.x

Jordan, N. C., Kaplan, D., Ramineni, C. & Locuniak, M. N. (2009). Early math matters: kindergarten number competence and later mathematics outcomes. *Developmental Psychology,* 45(3), 850-867. doi: 10.1037/a0014939

Kalchman, M., Moss, J. & Case, R. (2001). Psychological models for the development of mathematical understanding: rational numbers and functions. In S. M. Carver & D.Klahr (Eds.), *Cognition and instruction* (pp.1-38). NJ: Lawrence Erlbaum.

Kandır, A., Can Yaşar, M., Yazıcı, E., Türkoğlu, D., & Yaman Baydar, I. (2016*). Erken çocukluk eğitiminde matematik*. Ankara: Morpa Yayıncılık.

Karaarslan, E., Boz, B., & Yıldırım, K. (2013, Aralık). Matematik ve geometri eğitiminde teknoloji tabanlı yaklaşımlar. XVIII. Türkiye'de İnternet Konferansı, İstanbul.

Küçükay, S. (2022). *Türkiye'de sayı hissi üzerine hazırlanmış lisansüstü tezlerin incelenmesi.* (Unpublished master's thesis). Eskişehir Osmangazi Üniversitesi, Eskişehir.

Lago, R. M. & DiPerna, J. C. (2010). Number sense in kindergarten: a factor- analytic study of the construct. *School Psychology Review, 39*(2), 164-180. doi: 10.1080/02796015.2010.12087771

LearningApps.org. (2012). *Learningapps hakkında*. Retrieved from: https://learningapps.org/

LGS (2022). Ortaöğretim kurumlarına ilişkin merkezi sınav. Erişi adresi: https://cdn.eba.gov.tr/icerik/2022/06/2022_LGS_rapor.pdf

Liang, Y., Zhang, L., Long, Y., Deng, Q., & Liu, Y. (2020). Promoting effects of rtı-based mathematical play training on number sense growth among low-ses preschool children. *Early Education and Development, 31*(3), 335-353. doi: 10.1080/10409289.2019.1664261

Milli Eğitim Bakanlığı (MEB), (2018). *Matematik dersi öğretim programı (İlkokul ve Ortaokul 1,2,3,4,5,6,7. ve 8. sınıflar*. Ankara: Milli Eğitim Bakanlığı.

Nelwan, M., Friso-van den Bos, I., Vissers, C., & Kroesbergen, E. (2021). The relation between working memory, number sense, and mathematics throughout primary education in children with and without mathematical difficulties. *Child Neuropsychology, 28(2), 143–170*. doi:10.1080/09297049.2021.1959905

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2016). Comparing tablets and PCs in teaching mathematics: An attempt to improve mathematics competence in early childhood education. *Preschool and Primary Education, 4*(2), 241–253. doi:10. 12681/ ppej. 8779

Papadakis, S., Kalogiannakis, M. & Zaranis, N. (2018). The effectiveness of computer and tablet assisted intervention in early childhood students' understanding of numbers. An empirical study conducted in Greece. *Educ Inf Technol* 23, 1849–1871 (2018). doi:10.1007/s10639-018-9693-7

PISA (2018). PISA 2018 Türkiye ön raporu. Erişi adresi: https://pisa.meb.gov.tr/www/pisa-2018-turkiye-on-raporu-yayimlandi/icerik/3

Sarsar, F. (2017). Bilgi ve iletişim teknolojileri ve öğretmen. In S. Z. Genç (Ed.) *Değişen değerler ve yeni eğitim paradigması (*ss. 93-104). Ankara: Pegem Akademi.

Seefeldt, C. & Galper, A. (2004). *Active experiences for active children mathematics*. New Jersey: Pearson.

Starr, A., DeWind, N. K. & Brannon, E. M. (2017). The contributions of numerical acuity and non-numerical stimulus features to the development of the number sense and symbolic math achievement. *Cognition, 168*, 222-233.doi: 10.1016/j.cognition.2017.07.004

Şengül, S. (2013). Sınıf öğretmeni adaylarının kullandıkları sayı duyusu stratejilerinin belirlenmesi. *Kuram ve Uygulamada Eğitim Bilimleri*, *13*(3), 1951-1974. doi: 10.12738/estp.2013.3.1365

Şengül, S., & Gülbağcı Dede, H. (2014). Matematik öğretmenlerinin sayı hissi problemlerini çözerken kullandıkları stratejiler. *Turkish Journal of Computer and Mathematics Education (TURCOMAT), 5*(1), 73-88. doi: 10.16949/turcomat.67936

Thornton, J. S., Crim, C. L., & Hawkins, J. (2009). The impact of an ongoing professional development program on prekindergarten teachers' mathematics practices. *Journal of Early Childhood Teacher Education, 30*(2), 150-161. doi: 10.1080/10901020902885745

TIMMS (2019). TIMMS 2019 Türkiye ön raporu. Erişi adresi: https://www.meb.gov.tr/meb_iys_dosyalar/2020_12/10173505_No15_TIMSS_2019_Turkiye_On_Raporu_Guncel.pdf

Tonizzi, I., Traverso, L., Usai, M. C., & Viterbori, P. (2021). Fostering number sense in low ses children: a comparison between low-and high-intensity interventions. *Mathematics Education Research Journal*, 33, 345-363. doi: 10.1007/s13394-019-00307-9

Tucker, S. I., & Johnson, T. N. (2022). Developing number sense with fingu: a preschooler's embodied mathematics during interactions with a multi-touch digital game. *Mathematics Education Research Journal*, *34*(2), 393-417. doi: 10.1007/s13394-020-00349-4

Uyanık Aktulun, Ö. (2019). Validity and reliability study of turkish version of Number Sense Screener for children aged 72-83 months. *Journal of Education and Training Studies, 7*(2), 64-75. doi: 10.11114/jets.v7i2.3935

Verzosa, D.M.V., De Las Peñas, M.L.A.N., Aberin, M.A.Q., Garciano, A.D., Sarmiento, J.F., & Tolentino, M. A. C. (2021). 29th International Conference on Computers in Education Proceedings Volume 2. In M.M.T. Rodrigo, S. Iyer, & A. Mitrovic (Eds.), *Development of a gamified number line app for teaching estimation and number sense in grades 1 to 7* (pp. 648-656). Asia Pacific Society for Computers. https://icce2021.apsce.net/proceedings/volume2/.

Wordwall, (2023). *Özellikler*. Retrieved From : https://wordwall.net/tr/features

Yang, D. C., Hsu, C. J., & Huang, M. C. (2004). A study of teaching and learning number sense for sixth grade students in Taiwan. *International Journal of Science and Mathematics Education, 2*(3), 407-430. doi: 10.1007/s10763-004-6486-9

Yapıcı, A. (2013). *5, 6 ve 7. sınıf öğrencilerinin yüzdeler konusunda sayı duyularını incelenmesi* (Unpublished master's thesis). Hacettepe Üniversitesi, Ankara.

Yarar, S. H., Es, H. & Gürefe, N. (2018-September). Ortaokul öğrencilerinin sayı duyusundaki başarısı ve özyeterliği. 5th Ifs and Contemporary Mathematics Conference, Kahranmanmaraş, Turkey.

Yazıcı Arıcı, E., Yiğit, N.B., & Uyanık Aktulun O. (2023). The effect of web 2.0 supported geometry activities on children's geometry skills. *International Journal of Technology in Education and Science (IJTES), 7*(4), 454-469. doi:10.46328/ijtes.51

YKS (2022). YKS sayısal verileri. Erişi adresi: https://dokuman.osym.gov.tr/pdfdokuman/2022/YKS/sayisalbilgiler18072022.pdf

Zhou, H., Tan, Q., Ye, X., & Miao, L. (2022). Number sense: the mediating effect between nonverbal intelligence and children's mathematical performance. *Psicol. Refl. Crít.* 35(27), 1-9. doi: 10.1186/s41155-022-00231

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Preschool Teachers' Opinions on Guidance Services*

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Abstract

The aim of the current study is to investigate preschool teachers' perspectives on the guidance and counseling activities they implement in the classroom. Within this scope, the study examines the activities carried out with children, the activities conducted with parents, the problems encountered during these activities, and the strategies teachers use to cope with these challenges. Additionally, the study evaluates preschool teachers' cooperation with school management and school counselors, as well as the extent to which they make use of the guidance and counseling program. A qualitative research method was employed to explore the topic in depth. Participants were selected using the snowball sampling method, and 25 female and 4 male preschool teachers from across Turkey volunteered to participate in the study. A demographic form with 9 items and a survey consisting of 9 open-ended questions, developed by the researchers, were used for data collection. The average response time of participants was 18 minutes, and the data was collected over a period of two weeks. Content analysis was applied to analyze the collected data. The results of the study indicate that the majority of preschool teachers use observation as an informal method and technique to evaluate guidance and counseling practices in the classroom. When the activities implemented by teachers were classified based on the competencies in the Preschool Education Guidance and Counseling Program, it was found that most of the activities focused on self-acceptance, followed by interpersonal relationships. The findings also revealed that no activities were conducted targeting competencies in the family and society areas. Teachers reported that their activities were predominantly carried out in the form of play-based learning and Turkish language activities, often incorporating drama techniques. Family involvement emerged as one of the most commonly addressed themes in activities conducted with parents.

Keywords: Preschool guidance and counseling program, preschool teachers, preschool guidance and counseling activities

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Introduction

The preschool period, deemed critical in human development by many theorists, spans from birth to primary school and represents a phase where a holistic developmental approach supports children's social-emotional, cognitive, language, motor, and self-care skills. This period constitutes one of the most significant investments in an individual's development, influencing children's readiness for school (Forget-Dubois et al., 2009) and the relationship between early language development and reading skills in later years (Stevenson and Newman, 1986). Yeşilyaprak (2010) emphasized that 33% of a child's educational success by the age of eighteen is rooted in the 0-6 age period. Children are born with various temperament traits that predispose them to particular behaviors and emotional reactions (Kartika et al., 2023). These traits, along with environmental social and physical opportunities and parental attitudes, significantly influence the foundations of personality development (Chess and Thomas, 2012). Certain temperament traits may increase vulnerability to mood and anxiety disorders, highlighting the importance of understanding these characteristics within the context of parenting (Sibley, 2022). The relationship between temperament and parenting is reciprocal; children's traits can shape parenting approaches, creating a dynamic cycle that influences personality development (Sibley, 2022). A supportive family environment characterized by love and guidance is essential for fostering healthy personality development (Hanifa and Lestari, 2024). Although temperament and parental attitudes play a profound role, broader socialization and environmental factors must also be considered in the multifaceted process of personality development (Wu, 2024). Therefore, guidance services in the preschool period are crucial in shaping children's attitudes toward school life (Akgün, 2010). Assessing children's developmental needs and providing necessary support are among the fundamental responsibilities of preschool teachers (Katz et al., 2001). In this context, preschool guidance services facilitate school adaptation, support holistic development, and enable children to recognize and cultivate their talents (Bilgin, 2010; İlgar and Gazioğlu, 2010). Psychological and educational support helps children reach their developmental potential while fostering conditions for active social participation in preschool institutions (Eurydice, 2023; Unicef, 2022). These services also play a vital role in helping children develop a positive self-concept, understand themselves, and become aware of their emotional, behavioral, and cognitive characteristics (Yeşilyaprak, 2010). Preschool teachers' understanding of guidance should encompass observing and mentoring children, as well as implementing the Classroom Guidance Program (2020), prepared by the Ministry of Education, within the classroom setting. Teachers are expected to understand the structure of the guidance program, apply it effectively, and coordinate with guidance counselors (MEB, 2012). Preschool guidance activities should be designed to help children acquire essential skills, values, and attitudes. Teachers must act as role models and provide appropriate reinforcements, while outside the classroom, collaboration with families should support participation in guidance activities and development monitoring (MEB, 2012).

To equip preschool teachers with the capacity to offer this comprehensive support, enhancing their knowledge of guidance services is essential. This would increase the functionality of the guidance program and foster effective collaboration with guidance counselors (Akgün, 2010). Successfully and systematically implementing guidance services within the program is critically important (Akgün, 2010; Yeşilyaprak, 2010). Guidance services aim to promote individual well-being, self-awareness, and decision-making through a structured, professional process (Hatunoğlu and Hatunoğlu, 2006). These services are integral at all educational levels and are explicitly included in the Ministry of National Education (MEB) Preschool Education Guidance Program (2012). This program became a feature of the preschool education curriculum implemented in 2013 and gained further recognition with the Classroom Guidance Program published in 2020. The Preschool Education Guidance Program (2012) outlines seven competency areas and 83 learning objectives, supported by sample activities to facilitate these objectives. Both school guidance counselors and preschool teachers can implement these activities. Additionally, the program specifies expectations from school principals, guidance counselors, and preschool teachers (MEB, 2012). The Ministry emphasizes that the quality of preschool education directly impacts subsequent educational stages (MEB, 2012, 2024a, 2024b). In preschool, children develop self-confidence, independence, curiosity, and social roles within an enabling environment. The program ensures continuity in guidance services to support uninterrupted development during this critical period (MEB, 2012, 2024a, 2024b). The Classroom Guidance Program (2020), developed in line with the 2023 Vision educational goals, emphasizes fostering problem-solving, emotional

understanding, environmental adaptation, lifelong learning, and basic value acquisition. It adopts a preventive, adequate, and developmental approach, using positive language to focus on career, academic, and social-emotional competencies (MEB, 2020). At the preschool level, the program highlights academic competencies such as "Adaptation to School and School Environment," career competencies like "Career Awareness," and social-emotional competencies such as "Ensuring Personal Safety," "Self-Awareness," "Interpersonal Skills," and "Understanding Emotions" (MEB, 2020). Achieving these goals requires collaboration among families, preschool teachers, school administrators, and guidance counselors (Gibbons, Diambra, and Buchanan, 2010; Güler and Capri, 2019).

Despite the critical importance of guidance services, research shows that they primarily focus on other education levels (Dilek and Talu, 2021; Dursun, 2023; Gürbüz and Özer, 2023; Hatunoğlu and Hatunoğlu, 2006; Karagüven, 2001; Kutlu, 2002; Pişkin, 1989; Temiz, 2017). Studies have also identified gaps in preschool teachers' understanding of child psychology, their knowledge of children, and their ability to conduct guidance services with parents (Aliyev et al., 2007; Büyükgöncü, 2013; Çevik, 2017; Çitak and Birol, 2019; Dilek and Talu, 2021; Dursun and Özer, 2023; Kabi, 2022; Kanak et al., 2013; Kılıçoğlu, 2013; Peker, 2020; Sağlam et al., 2021; Tekin, 2017; Temiz, 2017). Given the limited literature on preschool guidance services, this study seeks to explore preschool teachers' perspectives on guidance services and their needs in collaborating with guidance teachers. The research examines the guidance activities implemented with children and parents, the challenges faced during these activities, and the strategies used to overcome them. Additionally, it evaluates teachers' participation in preschool guidance programs and their cooperation with school administrators and counselors. By analyzing these practices, the study aims to offer insights into improving guidance services and enriching the literature. It focuses on methods preschool teachers use to evaluate their guidance practices, the activities conducted with children and parents, their collaboration processes with school counselors and principals, and the difficulties they encounter, along with their existing knowledge of guidance programs.

Method

The aim of this research is to examine the opinions of preschool teachers regarding the guidance activities they carry out in the classroom environment. A qualitative research method was chosen to evaluate teachers' detailed opinions and practices. The research design follows a *case study* approach, which aims to describe the current situation as it is, without attempting to change or intervene in it (Karasar, 2009; Yıldırım & Şimşek, 2013).

Participants

The study group was composed of preschool teachers working across Turkey, determined through the snowball sampling method, which aligns with the principle of voluntary participation. A total of 25 female and 4 male preschool teachers participated in the study. Snowball sampling, a type of purposive sampling (Creswell, 2012; Büyüköztürk et al., 2020), was used to identify participants who met the study's criteria, with the sample size growing incrementally like a snowball. Participants were selected based on two primary criteria: they had to be preschool teachers and work in different cities across Turkey. While the snowball sampling method provides limited representativeness and generalizability of the data, it is valuable for obtaining in-depth, detailed opinions. This methodological limitation was accepted as a necessary trade-off for achieving the study's goal of collecting detailed qualitative insights. The participants included 29 preschool teachers working in various regions of Turkey. Demographic information about the participants is presented in Table 1.

According to Table 1, the teachers participating in the study were mostly female (86.2%), most of them were between the ages of 20-30 (75.9%), the number of teachers working in kindergarten was high (58.6%), the majority had 1-10 years (79.3%) of professional seniority, mostly the class size was 20-25 children (44.8%), the number of non-inclusive students in the classrooms was in the majority (62.1%), the number of children without special needs was high (55.2%). According to the status of visiting the classroom, it is seen that the majority do not have a guidance teacher in their class (27.5%), and those who do tend to visit classrooms at most once a month (24.1%).

Table 1.
Demographic Characteristics of the Participants

Characteristic	Group	f	%
Gender	Female	25	86.2%
	Male	4	13.8%
Age	20-30	22	75.9%
	31-45	7	24,1%
School Type	Kindergarten	17	58.6%
	Preschool	12	41.4%
Professional Seniority	1-10	23	79.3%
	11-20	6	20.7%
Class Size	8-13	5	17.3%
	14-19	11	37.9%
	20-25	13	44.8%
Special Education Needs	Yes	11	37.9%
	No	18	62.1%
Special Needs Status	Yes	13	44.8%
	No	16	55.2%
Guidance Teacher Visits	No Counsellor	8	27,5%
	Only when needed	4	13.8%
	Once a week	1	3.5%
	Twice in a month	4	13.8%
	Once in a month	7	24.1%
	Once in a semester	4	13.8%
	Never	1	3.5%

Data Collection Tool

For this research, the researchers developed a data collection instrument consisting of two parts: (1) a 9-item demographic information form and (2) a 13-question survey. The survey included both open-ended and closed-ended questions. According to Creswell (2017), combining open-ended and closed-ended questions allows participants to express themselves freely while ensuring structured data collection. Open-ended questions were particularly useful in eliciting detailed and nuanced responses (Büyüköztürk, 2005). The survey questions focused on evaluation methods used in classroom guidance practices, guidance activities conducted with children and parents, collaboration processes with school counselors and school principals, challenges faced during guidance activities and strategies used to overcome them, and participants' existing knowledge about guidance programs. To ensure validity, the form was reviewed by three experts in psychological counseling and guidance and two experts in preschool education. The consensus rate of expert opinions was calculated at 94%.

Data Collection

Ethical approval for the study was obtained from the Ethics Committee of Trakya University. The demographic and survey forms were shared with preschool teachers via the Google Forms platform. Participants were recruited through social media platforms such as Twitter, Telegram, Facebook, and Gmail. Teachers who volunteered to participate were informed about the research purpose and process. After obtaining their consent, the data collection link was shared. The entire data collection process, including preliminary interviews, participant communication, and survey completion, was completed within three weeks.

Data Analysis

The data were analyzed using content analysis. First, the responses of all 29 teachers were reviewed, and initial codes and subcategories were determined by two coders in collaboration with a preschool education expert. Closed coding was employed to systematically analyze teacher responses. The coders independently examined the data and classified responses into relevant themes. Coding disagreements were identified in 11 of the 50 subthemes. Intercoder reliability was calculated using the formula: Reliability = Consensus / (Consensus + Disagreement) (Miles & Huberman, 1994), and the

reliability rate for this research was determined to be 78%. The themes where disagreements occurred—such as "providing appropriate guidance to children," "collaborating with the guidance counselor," and "getting ideas from colleagues"—were resolved through discussion and consensus. The final categorization included strategies for supporting developmental areas (e.g., guidance for children, collaboration with guidance counselors) and professional development strategies (e.g., consulting colleagues for ideas). Following these steps, remaining differences between coders were resolved, and all data were analyzed consistently.

Limitations

The research is limited by its qualitative design, which involved a relatively small number of volunteer participants. As such, the findings cannot be generalized to the wider population of preschool teachers. Additionally, the use of a researcher-developed data collection tool, participant interviews, and content analysis presents inherent limitations. These factors should be considered when interpreting the results.

Findings

The present study, which focuses on examining the views of participating preschool teachers regarding guidance activities conducted in the classroom, first addresses the assessment methods employed by these preschool teachers in their in-class guidance practices. Figure 1 presents the assessment methods reported to be used by the preschool teachers in the study group.

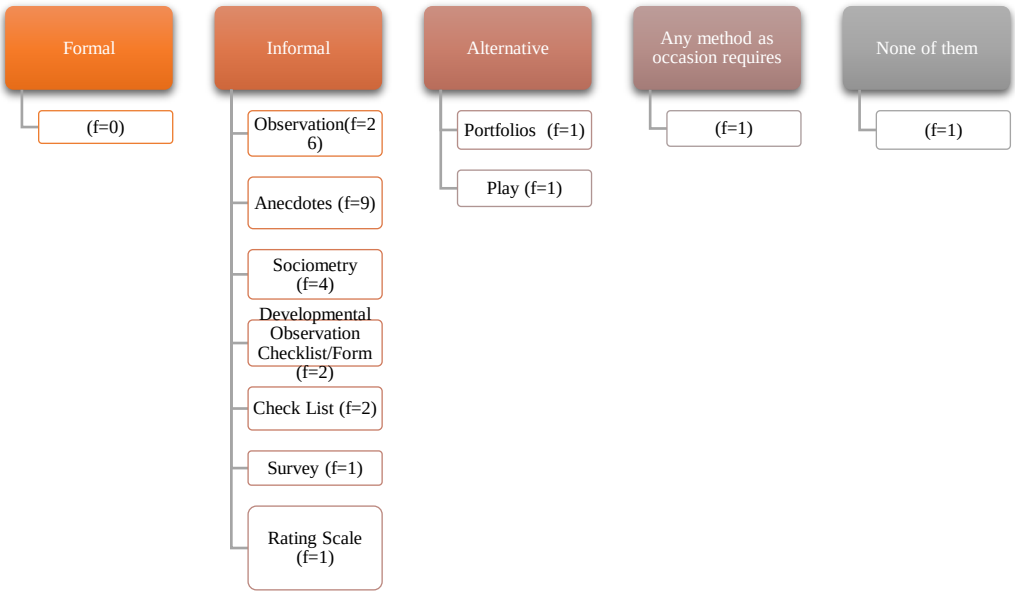

Figure 1. The Assessment Methods Employed By The Preschool Teachers In Their In-Class Guidance Practices

As seen in Figure 1, the majority of preschool teachers in the study group use the observation technique, an informal evaluation method, in their classroom guidance practices. Anecdotal records, another informal evaluation method, were identified as the most frequently used by preschool teachers. According to the teachers' responses, alternative methods are also employed to a limited extent, with one teacher stating that they use any method appropriate to the situation. However, it was determined that some teachers do not use any evaluation methods at all. A striking result is that teachers do not utilize formal evaluation methods. Observation helps teachers assess children's curiosity and engagement, which are vital for cognitive and emotional development (Li, 2023). Regular observations can improve educational practices tailored to children's needs, particularly when structured tools such as observation checklists are employed (Ciolan and Florescu, 2023). This indicates that evaluation through observation facilitates specialized support and differentiated education appropriate to children's needs.

The use of multiple methods and techniques is essential during studies aimed at understanding and evaluating children in early childhood (Zembat and Yılmaz, 2022). Combining formal, informal, and alternative methods provides a comprehensive picture, allows for tailored arrangements to support children, and enhances learning through continuous feedback (Doğan, 2022). This serves sustainable development goals. Therefore, it is noteworthy that the preschool teachers in this research rely primarily on informal methods, with no teachers reporting the use of formal methods. The limited use of alternative methods also stands out. Performance-based alternative methods, such as evaluations through games and portfolios (Arslan-Çiftçi, 2022; Çelik, 2022), are designed to identify and support children's unique abilities (Koç, 2023). The absence of formal assessment tools in practice may suggest a lack of expertise, time constraints, or access to relevant resources. Formal tools often require specialized training and, in some cases, one-on-one application, which may not align with teachers' classroom routines. Moreover, formal tools based solely on teacher or family observations are underutilized, likely due to limited awareness or availability. Recent literature introduces formal tools for assessing developmental areas or specific skills (Beaty, 2024; Blessing, 2019; Zembat and Tunçeli, 2022). However, these advancements do not appear to be widely reflected in practice. Providing preschool teachers with relevant resources and training could address this gap.

Table 2 presents examples of in-class guidance activities conducted by preschool teachers participating in the research.

Table 2.
Classroom Guidance Activities Conducted with Children

Classroom Guidance Competence Areas	**Activities Done**		**f**
Adaptation to School and School Environment	School Adaptation	Familiarization and orientation activities	9
		Activities for learning the rules	1
	Preparation for Primary School	Activities to support preparation for primary school	2
Educational Planning and Success Interpersonal Skills	Using Different Methods	Artistic evaluation	1
		Interpretation with pictures	1
		Assessment through play	4
		Through question and answer	1
		Project activities	1
		Using technology in different ways	1
		Dramatizations	2
	Individual and Group Work	Serving as a leader in group activities	1
		Circle activities	2
		Socialization activities	2
	Getting to Know Each Other	Communication, communicating	3
		Conflict problems, activities to address problems when they occur	2
		Expressing one's own ideas and listening to the ideas of peers	2
		Activities to get to know each other	1
	Social Skills	Talking about different characteristics, respecting differences	4
		Social skills activities	1
Understanding and Managing Emotions	Recognizing Emotions	Activities in which children act out their emotions	1
		Understanding and listening to emotions	2
	Managing Emotions	Emotion management activities	1
		Dealing with difficult emotions	2
Career Awareness		Recognizing professions	1
Personal Safety		Asking for help in case of danger - protection	2
		Privacy education and awareness	2
		Activities to recognize the environment	2
		Personal space awareness	1
Self-Awareness		Recognizing interests and talents	1
		Activities to increase self-confidence	3
		Self-recognition, self-development activities	2
		Recognizing their skills	1
		Self-recognition, activities to create self-awareness	3
No implementation		Not available at the moment	1
MoNE Resources		Guidance activities available on the MoNE website	1

The findings in Table 2 reveal that most classroom guidance activities implemented by preschool teachers focus on interpersonal skills (f=19), followed by educational planning and achievement (f=16), and school adaptation (f=12). Upon closer examination, the activities frequently target school adaptation, with fewer efforts aimed at understanding and managing emotions, career awareness, personal safety, and self-awareness. The emphasis on school adaptation aligns with its importance in ensuring children begin and continue school with positive feelings. However, considering that school adaptation typically occurs during the initial weeks, it is notable that throughout the year, teachers predominantly guide children in interpersonal skills while other areas receive relatively less attention.

Table 3 outlines the activities conducted by preschool teachers with parents as part of in-class guidance practices.

Table 3.
In-Class Guidance Activities Conducted with Parents

In-Class Guidance Competency Areas	**Activities Done**	**f**
Interpersonal Skills	Communication	1
	Communication with the child	1
	Activities that increase parent-child interaction	3
Educational Planning and Success	Family involvement	10
	Research homework	1
	Project studies	1
	School-family cooperation	2
	Home visits	1
	Observation of the child	2
	Informative activities about children's developmental characteristics	2
	Seminars, educational guidance events	2
	Event sharing	1
	Parent meetings	1
	Activities to develop children's personal characteristics	1
	Activities to get to know and understand the child	2
Career Awareness	Vocational guidance	1
	Career goals development	1
	Job presentation	1
Emotion-Focused Studies	Duygularını anlamaya ve başa çıkmaya yönelik etkinlikler Activities to understand and cope with emotions	1
	Providing an activity environment for different families to share problems and feelings	1
I don't do any activities		3

Table 3 shows that preschool teachers primarily focus on educational planning and achievement when working with parents. Limited attention is given to areas such as interpersonal skills, career awareness, and emotion-based studies, which involve supporting communication, understanding emotions, and nurturing children's abilities. The limited cooperation between teachers and families in fostering basic life skills, such as emotional competence and communication, is considered a disadvantage. Upon analyzing the details of these activities, the most common approach used was family participation studies (f=10).

The areas in which preschool teachers collaborate with school counselors for in-class guidance activities are presented in Figure 2.

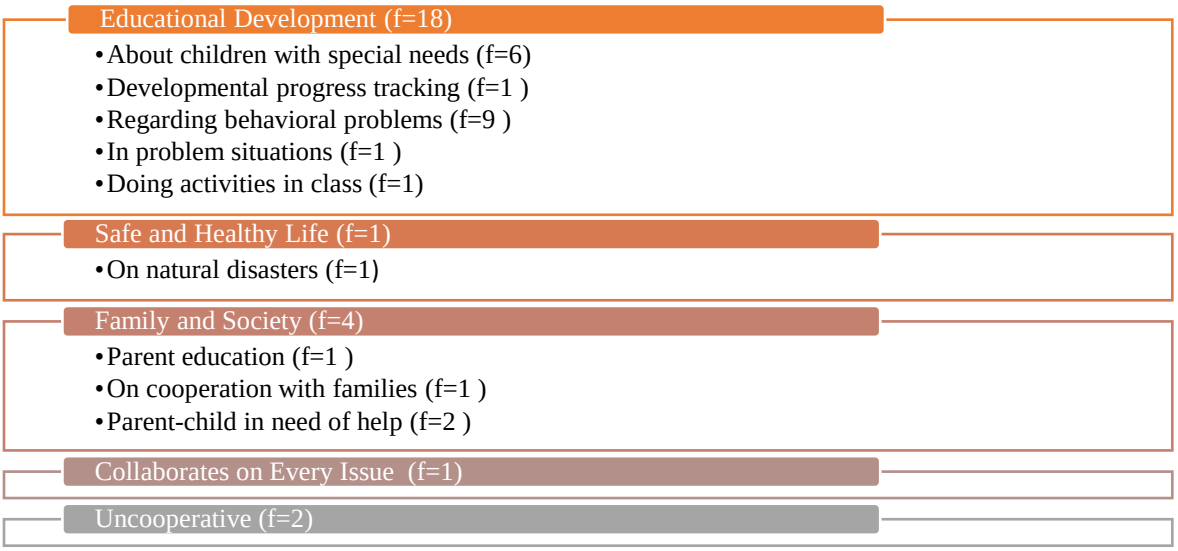

Figure 2. Topics and Areas Where Preschool Teachers Collaborate with School Counselors

Figure 2 highlights that most preschool teachers collaborate with school counselors, particularly regarding behavioral problems and children with special needs. Sample teacher responses include:

"The classroom guidance teacher carries out activities on the subject determined in the guidance meeting." (OOÖ5)
"I work in a preschool within a high school. The counselor has not even visited to work with the children." (OOÖ13)

The topics and areas in which preschool teachers collaborate with school principals for in-class guidance activities are shown in Figure 3.

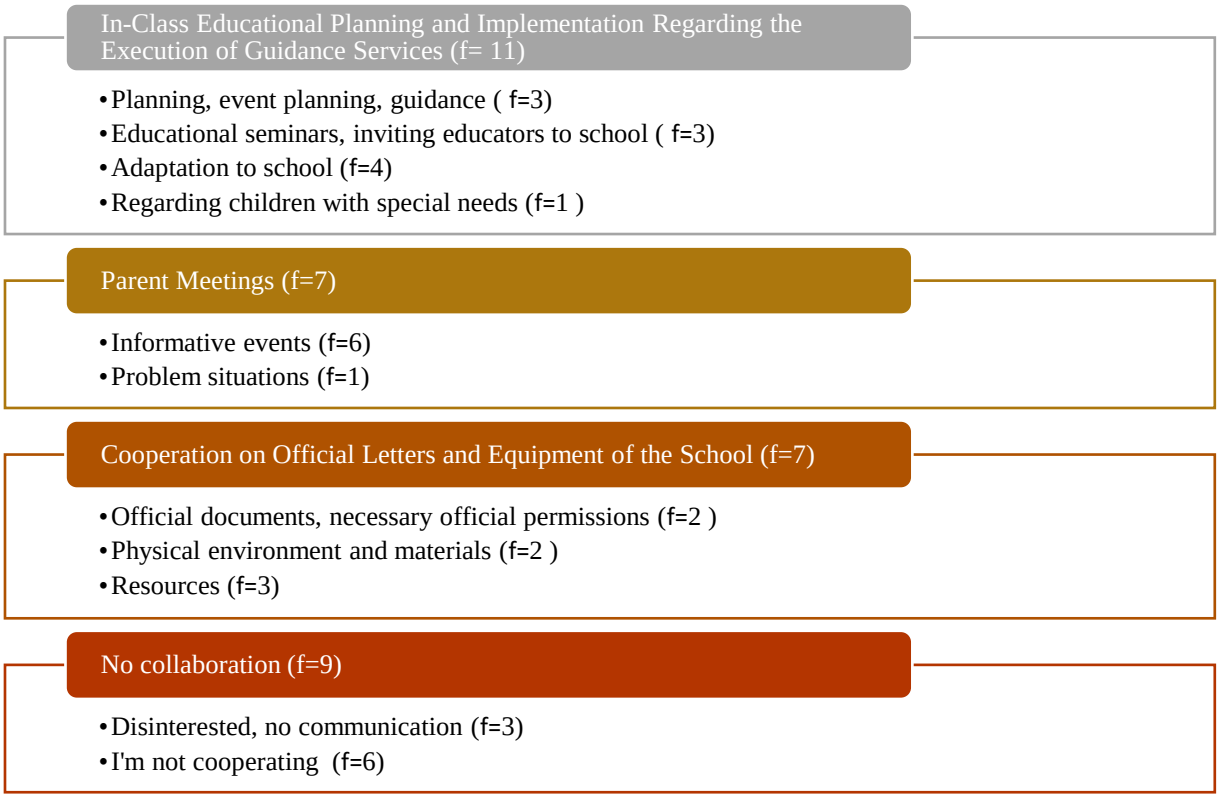

Figure 3. Subjects and Areas of Collaboration with School Principals

According to Figure 3, preschool teachers primarily collaborate with school principals on educational planning and implementation (f=11). Informative activities during parent meetings were also noted (f=6). However, a significant number of teachers (f=6) reported no cooperation at all. One teacher remarked: *"I explain the activities I will do and implement them myself."*(OOÖ21)

Figure 4 presents the problems experienced by preschool teachers while implementing in-class guidance activities.

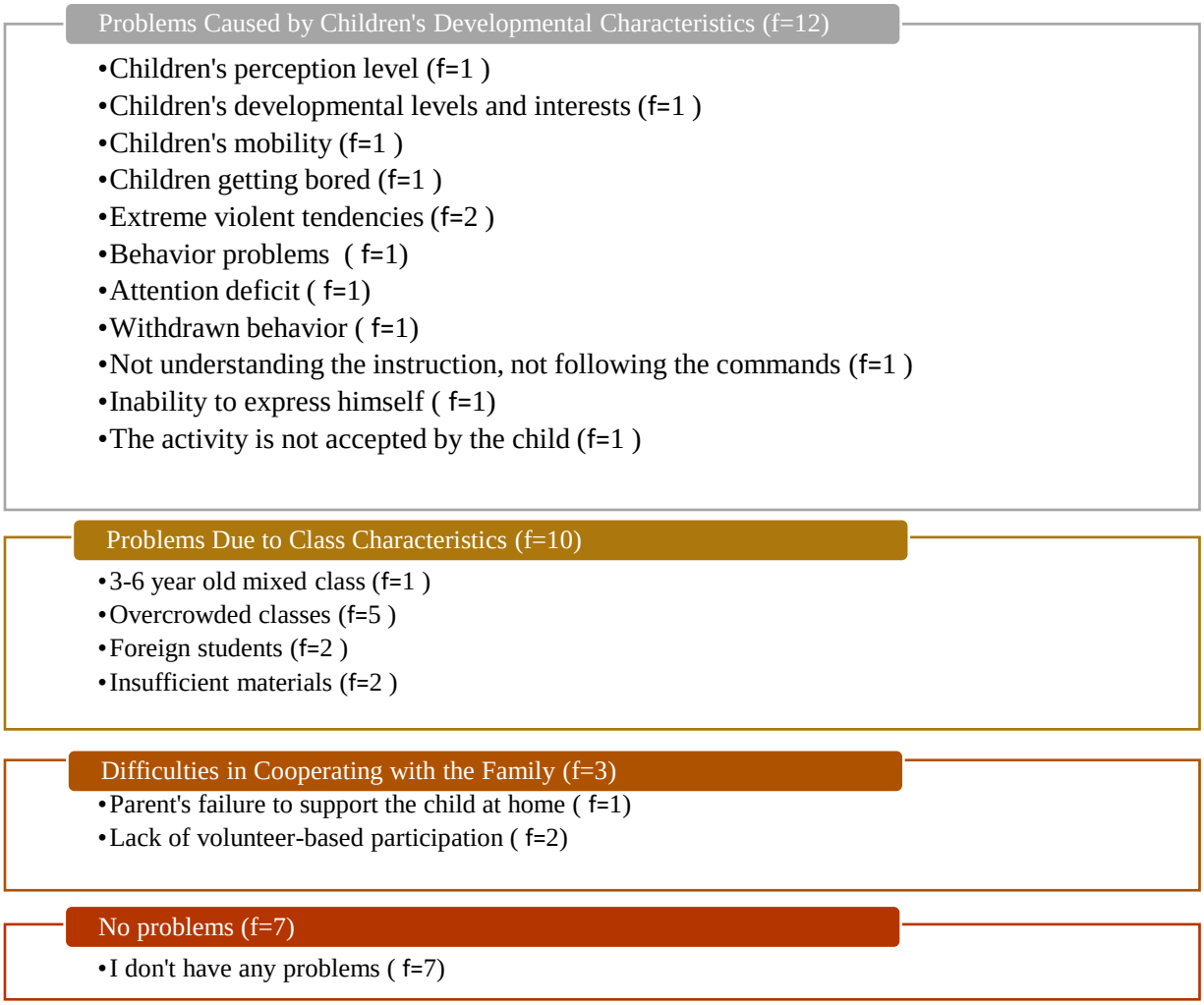

Figure 4. Problems Encountered While Implementing In-Class Guidance Activities

Figure 4 shows that the most commonly reported problems relate to children's developmental characteristics (f=12). Other challenges included behavioral difficulties (e.g., violence and hyperactivity), cognitive issues (e.g., attention span and following instructions), and social-emotional concerns (e.g., boredom, reluctance, and self-expression difficulties). Language development challenges were also noted. These issues may stem from various factors, including temperament, parental attitudes, environmental influences, and technology use. The Covid-19 pandemic, which led to prolonged home isolation, may have exacerbated these challenges. Classroom-related factors, such as overcrowded classes and the In addition to the teachers who reported experiencing the problems mentioned above, some preschool teachers in the study group stated that they did not encounter any issues while carrying out in-class guidance activities. The strategies employed by these teachers have been analyzed and are presented in Figure 5.

Strategies for Development Areas (f=6)

- Providing appropriate guidance to children(f=1)
- Doing activities appropriate to the child's behaviors (f=1)
- Trying to progress regularly and systematically (f=1)
- Calming the children (f= 1)
- Communicating openly with children (f=1)
- Collaborating with the guidance counselor (f=1)

Strategies for Professional Development (f=4)

- Getting information from internet-based applications (f=1)
- Getting ideas from colleagues (f=2)
- Experience (f=1)

Strategies for Communication with Families (f=1)

- Ensuring that parents are fully and accurately informed (f=1)

Figure 5. Strategies Used by Teachers Who Encounter No Problems

Approximately one-quarter of the preschool teachers managed classroom guidance activities effectively. Seeking advice from colleagues was the most commonly mentioned professional development strategy. Figure illustrates the frequency with which preschool teachers benefit from the Classroom Guidance Program. The data regarding the engagement of preschool teachers in the guidance program is illustrated in Figure 6.

Figure 6. Frequency of Teachers Benefiting from the Classroom Guidance Program

As shown in Figure 6, 59% of the preschool teachers occasionally use the Classroom Guidance Program, while 41% consistently benefit from it. Figure 7 details the specific areas where teachers find the program beneficial.

Academic Development (f=23)

- **Adaptation to School and the School Environment**
  Adaptation to school (f=7)
  Getting to know the school (f=1)
  School rules (f=1)
- **Educational Planning and Success**
  Building on achievements (f=3)
  Examples of activities (f=3)
  Educational development (f=2)
  Educational guidance (f=4) Children with special needs (f=4)

In Every Field (f=3)

- **Interpersonal Skills**
  Interpersonal relationships (f=1)
  Personal guidance (f=2)
  Interpersonal awareness (f=1)
  Social development (f=2)
- **Self Awareness**
  Self-acceptance (f=2)
  Respect for personal space (f=1)
  Self-recognition (f=1)
  Self-care (f=1)
  Self Perception (f=1)
- **Understanding and Managing Emotions**
  Social-emotional development (f=5)
  Emotion control (f=1)
  Emotion awareness (f=1)

Figure 7. Areas Where Preschool Teachers Benefit from the Classroom Guidance Program

The program is most valued for supporting academic progress (f=23) and school adjustment (f=7). Activities related to self-awareness, interpersonal relationships, and emotional development were also noted, albeit to a lesser extent. Given the importance of social-emotional development in early childhood, these efforts may be relatively insufficient. The opinions of preschool teachers regarding the Classroom Guidance Program are presented in Figure 8.

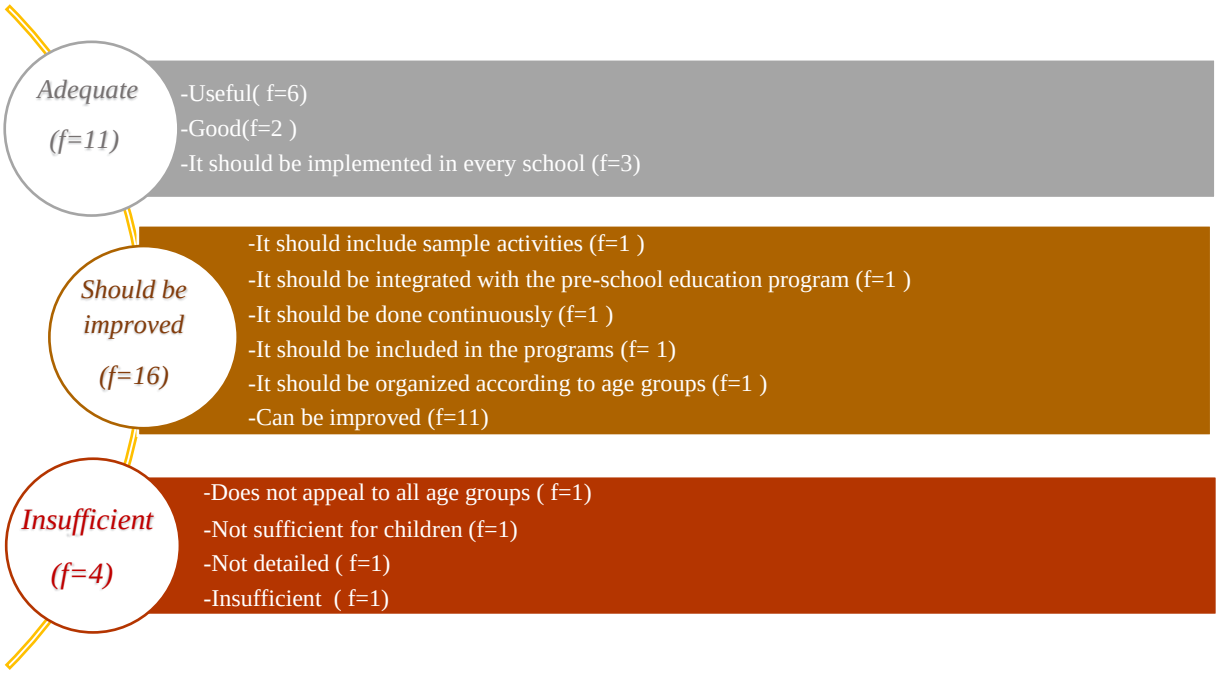

Figure 8. Preschool Teachers' Opinions About the Classroom Guidance Program

The findings show that most preschool teachers describe the Classroom Guidance Program as either satisfactory or needing improvement. While a small number (f=4) find it inadequate, teachers who suggest improvements do not specify areas requiring change. A teacher remarked:

"Practical training for preschool teachers is essential to fully utilize the program, as we currently have limited knowledge of its content, despite its significance similar to the preschool education program." (PT10)

Discussion, Conclusion, and Suggestions

In this study, the opinions of preschool teachers regarding the guidance activities they carry out in the classroom environment were examined, and their responses were evaluated using content analysis. Within the scope of the research, several aspects were addressed: the guidance activities teachers implemented with children in the classroom, their work with parents, the challenges they encountered during guidance activities, and their coping strategies. Additionally, the extent to which preschool teachers benefited from the preschool guidance program in collaboration with school administration and guidance counselors was analyzed, and their opinions about the program were documented.

The results indicate that teachers predominantly prefer informal assessment methods, particularly observation techniques, when evaluating children in classroom guidance activities. Formal evaluation tools were reported as not being used by the participating teachers. Observation has been highlighted as an effective evaluation method for early childhood educators (Stritzel-Rencken, 1996; Turupcu, 2014), and its significance is further emphasized in the Ministry of National Education Preschool Education Program (2013; 2024a; 2024b), which advocates for observation as part of a multifaceted evaluation approach.

Observation enables teachers to assess children's curiosity, engagement, and overall development, which are critical for cognitive and emotional growth (Li, 2023). Regular and structured observation, as

supported by tools like observation rubrics (Florescu & Ciolan, 2023), can help identify children's specific needs and facilitate targeted, differentiated educational practices.

It is widely recognized that the use of various evaluation methods—formal, informal, and alternative—is essential for accurately assessing young children (Zembat & Yılmaz, 2022). Combining these approaches, providing consistent feedback, and tailoring support based on the obtained results contribute significantly to sustainable development (Doğan, 2022). However, a notable finding in the current study is that none of the participating teachers reported using formal methods, and only a small number mentioned alternative methods.

The absence of formal assessment methods raises the question of whether teachers lack knowledge, training, or access to formal tools. Prior studies have suggested that formal tools are often avoided due to unclear scoring and procedural requirements (Demirel, 2010; Yazgünoğlu & Demirel, 2012) and the time-intensive nature of one-on-one implementation. Recent resources, such as publications on formal assessment tools (Beaty, 2024; Blessing, 2019; Zembat & Tunçeli, 2022), highlight their availability, yet their limited use in practice suggests a gap in awareness or training among teachers. Addressing this gap through resource sharing and training opportunities is essential, as integrating formal and informal assessments can yield more comprehensive evaluations (Langston, 2019; NAEYC, 2023). Aligning with the Ministry of National Education Preschool Education Program (2024a; 2024b), it is critical to promote versatility and diversity in assessment methods and provide teachers with the necessary resources and professional development to effectively implement formal methods.

The findings also show that preschool teachers actively participate in guidance programs primarily focused on educational planning, school and environmental adaptation, and interpersonal relationships. These areas align with prior research (Beesley, 2004; Bilgin, 2019; Arslan, 2013), which found that teachers seek support from school counselors for educational planning and relationship-building activities. Collaboration with guidance counselors has been emphasized as particularly valuable in areas where teachers feel less competent (Khansa, 2015). Strengthening such collaborations enhances the effectiveness of guidance activities, benefiting both teachers and children. To further support teachers, practical activity examples from the Classroom Guidance Program(2020) could be integrated into professional development sessions, fostering closer cooperation between teachers and guidance staff. Similarly, increasing the emphasis on guidance activities in pre-service teacher education programs would help address competency gaps.

The study also highlights the significant role of family participation in preschool guidance activities. Teachers frequently included family engagement in their sessions, reflecting its recognized importance in early childhood education. The Family Support Education Guide(OBADER) (MEB, 2013) underscores the benefits of family involvement, a view supported by Gürşimşek (2013), who emphasized its positive impact on children's learning and parental attitudes toward school. However, other studies (Demirel & Yazgünoğlu, 2013) have noted that family participation often falls short of expectations, necessitating diversified strategies to encourage active involvement (ECLKC, 2023; Stefanski, Valli & Jacobson, 2016). While organized activities remain one avenue, fostering greater collaboration with families through alternative guidance methods is essential for more effective engagement.

Collaboration with school counselors, especially regarding behavioral challenges and special needs, emerged as a key theme. Previous research (Öztabak, 2018; Memduhoğlu & Dalçiçek, 2016) has shown that preschool teachers view counselors as problem solvers, particularly in addressing behavioral and developmental challenges. Teachers' involvement in individualized education programs (IEPs) further underscores the importance of collaboration (MEB, 2019). However, the limited availability of school counselors in Turkey remains a challenge. Increasing the number of counselors and promoting collaboration through guidance research centers would enhance support for both teachers and children.

The study also revealed a lack of collaboration between teachers and school principals, with nearly one-third of participants reporting no cooperation. Principals play a crucial role in fostering a collaborative school culture that positively impacts teacher-counselor relationships and overall student success (Yıldız, 2021; Chata & Loesch, 2007; Sanders & Harvey, 2002). Research has shown that effective

collaboration requires strong institutional support (Pérusse, Goodnough & Bouknight, 2007). Implementing models like the Professional Development School (PDS) (Foust & Goslee, 2014) and leveraging social capital theory (Boyland et al., 2019) could strengthen collaboration networks.

A significant portion of teachers reported challenges related to children's developmental characteristics, particularly in social-emotional and cognitive domains. These difficulties may be linked to the COVID-19 pandemic, which has had documented impacts on young children's social-emotional development (Gülay-Ogelman, Erten-Sarıkaya & Güngör, 2022; Opperman et al., 2024). Additionally, inappropriate technology use has been associated with developmental delays (Massaroni et al., 2024; Mustafaoğlu et al., 2018). Addressing these issues requires a broader focus on supporting children's overall development through targeted interventions.

Conversely, some teachers reported no difficulties in implementing guidance activities, attributing their success to the use of strategies aligned with children's developmental characteristics. This finding reflects the importance of integrating developmental principles into teaching practices (Başal, 2005; MEB, 2013; Rubtsov & Yudina, 2010). However, previous studies have highlighted the need for additional training to address teacher-reported challenges, such as parental indifference and perceived inadequacies in guidance practices (Bilgin, 2017; Büyükgöncü, 2013; Stefanski et al., 2016).

The study concludes that preschool teachers benefit from classroom guidance programs, particularly in areas like school adaptation, academic planning, and social-emotional development. These findings reinforce the importance of guidance activities in supporting children's long-term success (Shah et al., 2021). Collaboration among teachers, counselors, administrators, and families remains vital for delivering comprehensive guidance services that address children's educational environments holistically (Gencoğlu et al., 2019; Nasır & Nasır, 2015).

Finally, the study highlights the need to improve the classroom guidance program. While most teachers advocated for improvements, few specified areas for enhancement. Suggestions included integrating the program with preschool education, adapting it for different age groups, and incorporating sample activities into a continuous structure. Despite its limitations—such as the small sample size of 29 volunteer teachers—this study offers valuable recommendations for teachers, researchers, and policymakers to improve guidance practices in preschool education.

Suggestions for teachers:

1) To gain expertise in the use of various evaluation methods, especially formal evaluation, in assessing children's development.

2) To engage in activities that can enhance their professional development in order to increase their self-confidence in carrying out in-class guidance activities.

3) To include practices and methods that support cooperation with families and serve family and community collaboration by diversifying guidance activities beyond family participation.

4) To cooperate with school counselors and go beyond addressing behavioral problems and situations of children with special needs, obtaining opinions on the general development of all children to contribute to the effective realization of their potential.

Suggestions for researchers:

1) It is recommended that the methods frequently preferred by preschool teachers for recognizing and evaluating children should be examined with larger study groups.

2) It is necessary to conduct various training and supportive studies on the subject so that preschool teachers can benefit more from formal evaluation methods within the scope of recognition and evaluation.

3) It is recommended to examine the problem scenarios and suggested solutions in the guidance studies implemented at school and in the classroom with the participation of a larger group of teachers and to diversify the research model by including case studies.

4) In order to improve teachers' abilities to facilitate classroom guidance, it is recommended to organize dissemination training throughout the country, create training materials containing various practical examples, and ensure their effective use.

5) It is of great importance to evaluate and increase the role of school principals in shaping the school atmosphere and interaction network, as they make significant contributions to the social field by collaborating with teachers, guidance counselors, families, and society as a whole.

6) It is important to prepare school guidance action plans and implement plans aimed at increasing cooperation between school principals, guidance counselors, teachers, and families.

7) To develop models that broaden teachers' perspectives on guidance services, including aspects beyond school adaptation, and encourage interdisciplinary collaboration.

8) It is recommended to carry out in-service training programs to ensure that teachers can use the classroom guidance program effectively in all guidance dimensions.

9) Presenting concrete examples and practices regarding regulations aimed at improving family and social integration in the work of preschool education teachers.

Recommendations for policymakers:

1) Recognizing the important role of school principals in strengthening the school climate and relationships between students, teachers, and society, interventions that will support their efforts in this direction need to be integrated.

2) By considering schools within a learning ecosystem, education programs and guidance programs should be harmonized to create structures that take into account the individual differences of children and support them in line with their abilities.

3) Increasing the number of counselors working in the provinces and decreasing the number of children per counselor working in schools; it is necessary to support counselors' collaborative work with children, families, and all teachers.

4) It would be useful to organize in-service and pre-service trainings to increase the competencies of preschool educators in classroom guidance practices.

5) Expanding the scope and details of guidance studies in line with the understanding of strengthening the infrastructure of preschool education institutions will make a significant contribution to their relations with family and society throughout the preschool program and guidance activities.

Acknowledgment

Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

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Data Availability Statement: Data generated or analyzed during this study should be available from the authors on request.

Conflict of Interest: We declare that there is no conflict of interest between the authors, that all authors contribute to the study and that all the responsibility belongs to the article authors in case of all ethicalviolations

References

Akgün, E. (2010). Okul öncesindeki görünümlerin bakış açısıyla anasınıflarındaki bakış açısının değerlendirilmesi. *İlköğretim Çevrimiçi , 9* (2), 474-482.

Aliyev, R., Ergüner-Tekinalp, B., Ülker, R., & Shine- Edizer, F. (2012). Türkiye'de erken çocukluk eğitiminde yeni psikolojik danışmanlık ve rehberlik hizmetlerine yönelik okul danışmanları ve müdürlerinin algıları . *Eğitim Bilimleri: Teori ve Uygulama - Özel Sayı, Sonbahar* , 3083-3098.

Arslan, K. E. (2013). *Okul öncesi eğitimin etkili politikalarının gerçekleştirilmesinde eğitim kapsamının belirlenmesi* (Yayımlanmamış Yüksek Lisans Tezi). Selçuk Üniversitesi, Konya.

Arslan-Çiftçi, H. (2022). Çocuğu tanıma ve değerlendirmede oyunun rolü. In R. Zembat & H. İ. Tunçeli (Eds.), *Çocuğu tanıma ve değerlendirme* (ss. 205-232). Nobel Yayıncılık.

Beaty, J. J. (2024). *Observation and assessment in early childhood* (3rd ed., Çev. Ed. M. Boz). Anı Publishing.

Beesley, D. (2004). Teachers'perceptions of school counselor effectiveness: collaborating for student success. *Education, 125*(2).

Bilgin, H. (2019). Okul öncesi eğitimde aile ile iletişim ve ailelere rehberlik. Gülden Uyanık Balat (Ed.), *Okul Öncesi Eğitime Giriş* içinde, Ankara: Pegem Akademi.

Boyland, L. G., Geesa, R. L., Lowery, K. P., Quick, M. M., Mayes, R. D., Kim, J., McDonald, K. M. (2019). Collaborative principal-school counselor preparation: National standards alignment to improve training between principals and school counselors. *International Journal of Educational Leadership Preparation, 14*(1), 188-205.

Büyükgöncü, N. (2013). *Okul öncesi eğitim sürecinde uygulanan bireysel tanıma tekniklerinin öğretmenin bakış açısının değerlendirilmesi* (Yayınlanmamış Yüksek Lisans Tezi). Erciyes Üniversitesi, Kayseri.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2020). *Bilimsel araştırma yöntemleri (28. Baskı)* . Ankara: Pegem Yayınları.

Chata, C. C., & Loesch, L. C. (2007). Future school principals' views of the roles of professional school counselors. *Professional School Counseling, 11*(1).

Chess, S., & Thomas, A. (2012). Goodness of Fit: A Special Developmental Concept and its Clinical Applications. *Goodness of Fit–Clinical Applications from Infancy through Adulthood*, 3-9.

Ciolan, L. E., & Florescu, D. M. (2023). Training of early childhood teachers to develop socio-emotional skills in pre-schoolers. *Revista Romaneasca pentru Educatie Multidimensionala, 15*(1), 564-574.

Creswell, J. W. (2012). *Nitel araştırma yöntemleri* (M. Bütün & S. B. Demir, Trans.). Siyasal Kitabevi.

Çelik, B. (2022). Portfolyo. Ed. R. Zembat ve H. İ. Tunçeli. *Çocuğu tanıma ve değerlendirme* içinde s. 135-165, Bölüm 7. Nobel.

Çevik, G. B. (2017). Examining pre-school teachers' and parents' views on counseling and guidance services in pre-school. Education. *International Journal of Evaluation and Research in Education, 6*(3), 207-215.

Çitak, Ş., & Birol, Ü. Z. N. (2019). Okul öncesi kurumlarından psikolojik danışma ve rehberlik servislerinin kaldırılmasına ilişkin yönetici ve öğretmen algılarının incelenmesi. *turan: Stratejik Arastirmalar Merkezi, 11*(44), 255-264.

Demirel, M. (2010). İlköğretim ve ortaöğretim kurumlan sınıflarının dağılımının değerlendirilmesi . *Eğitim ve Bilim, 35* (156), 45-61.

Demirel, M., & Yazgünoğlu, S. (2013). İlkokullarda sınıf rehberliği etkinliklerinin değerlendirilmesi. *Procedia - Sosyal ve Davranış Bilimleri 93,* 1598 – 1602.

Dilek, H., & Talu, E. (2021). Okul öncesi rehberlik hizmetlerinin değerlendirilmesi. *Erken Çocukluk Çalışmaları Dergisi, 5*(2), 384-409.

Doğan, H. (2022). Erken çocukluk döneminde değerlendirme döngüsü, çocuğu tanıma ve değerlendirme teknikleri. Ed. R. Zembat ve H. İ. Tunçeli. *Çocuğu tanıma ve değerlendirme* içinde s. 37-56, Bölüm 2. Nobel.

Dursun, B. (2023). *Okul Öncesi Öğretmenlerinin Rehberlik Yeterlilikleri İle Çocukların Duygularına Verdikleri Tepkiler ve Öğretmenlik Tutumları Arasındaki İlişkinin İncelenmesi* (Yayınlanmamış Yüksek Lisans Tezi), Marmara Universitesi, İstanbul.

Eurydice. (2023). *Poland - Guidance and counselling in early childhood and school education*. Retrieved January 4, 2024, from https://eurydice.eacea.ec.europa.eu/national-education-systems/poland/guidance-and-counselling-early-childhood-and-school-education

Forget-Dubois, N., Dionne, G., Lemelin, J. P., PErusse, D., Tremblay, R. E., & Boivin, M. (2009). Early child language mediates the relation between home environment and school readiness. *Child development*, *80*(3), 736-749.

Foust, G. E., & Goslee, P. A. (2014). Expanding the professional development school model: developing collaborative partnerships with school counselors. *School-University Partnerships*, *7*(1), 101-109.

Gencoğlu, C., Demirtaş-Zorbaz, S., Demircioğlu, H., & Ekin, S. (2019). Erken çocukluk eğitiminde psikolojik danışmanlık ve rehberlik hizmetleri. *Eğitim Politika Analizi ve Stratejik Araştırmalar, 14* (1), 6-23.

Gibbons, M. M., Diambra, J. F., & Buchanan, D. K. (2010). School counselor perceptions and attitudes about collaboration. *Journal of School Counseling*, *8*(34).

Gülay-Ogelman, H., Erten-Sarıkaya, H., & Güngör, H. (2022). COVID-19 sürecinde okul öncesi çocukların sosyal ve duygusal yeterliliklerinin değerlendirilmesi. *İstanbul Sabahttin Zaim Üniversitesi Eğitim Dergisi, 4*(8):57-71. Doi: 0.46423/izujed.1087563

Güler, M., & Çapri, B. (2019). Öğretmenlerin Okul Öncesi Rehberlik Programına İlişkin Görüşleri= Öğretmenlerin okul öncesi rehberlik programına ilişkin başlayacak. *Pegem Eğitim ve Öğretim Dergisi, 9* (3), 521-546.

Gürbüz, F. B., & Özer, N. (2023). Psikolojik danışman ve rehber öğretmenlerin anasınıflarında uygulanan rehberlik hizmetlerine ilişkin görüşleri. *Erken Çocukluk Çalışmaları Dergisi*, *7*(2), 125-142.

Gürşimşek, İ. (2013). Okul öncesi eğitime aile katılımı ve psikososyal gelişim. *Kuram ve Uygulamada Eğitim Bilimleri , 3* (1), 125-144.

Hanifa, D. S., & Lestari, T. (2024). Nurturing child personality: The crucial role of parental influence. *Educatione: Journal of Education Research and Review*, 15-20.

Hatunoğlu, A., & Hatunoğlu, Y. (2006). Okullarda verilen gözenekli sorunlu alanlar. *Kastamonu Eğitim Dergisi , 14* (1), 333-338.

Head Start-Erken Çocukluk Öğrenme ve Bilgi Merkezi, ECLKC, (2023). Ailelerle Ortaklıklar Kurma Serisi. Erişim tarihi 03.12.2023 erişim adresi: https://eclkc.ohs.acf.hhs.gov/family-engagement/article/ bina-ortaklıkları-aileler-seri

İlgar, Ş., & Gazioğlu, İ. (2010). Eğitsel rehberlikte bazı çalışma alanları.Ş. İlgar ve İşmen Gazioğlu, E.(Eds.). *Öğretmen ve Öğretmen Adayları Rehberlik İçin, Pegem, Ankara* .

Kabi, K. (2022). Early childhood education: psychological counselling and guidance services. *Global Science Research Journals*, *6* (2), 1-2.

Kanak, M., Ersoy, M., & Yerliyurt, N. S. (2018). Okul öncesinde rehberlik hizmetlerinin gerekliliğinin rehber öğretmen görüşleri doğrultusunda değerlendirilmesi. *EKEV akademi dergisi*, (76), 187-208.

Karagüven, H. (2001). Endüstri meslek liselerinde rehberlik servislerinin işleyişinin incelenmesi ve değişiklikleri belirleme çalışması. *VI. Ulusal Psikolojik Danışma ve Rehberlik Kongresi.* Ankara: ODTÜ Eğitim Fakültesi.

Karasar, N. (2009). *Bilimsel araştırma yöntemi: Kavramlar-ilkeler-teknikler*. Ankara: Nobel Yayın Dağıtımı.

Kartika, S., Munira, A., & Rahmalina, D. (2023). Pembentukan kepribadian pada anak dengan temperamen diri dan pola asuh orang tua. *Fonologi: Jurnal Ilmuan Bahasa dan Sastra Inggris*, 1(2), 38-42.

Katz, S., Earl, L., & Olson, D. (2001). The paradox of classroom assessment: A challenge for the 21st century. *McGill Journal of Education/Revue des sciences de l'education de McGill*, *36*(001).

Khansa, R. (2015). Teachers' perceptions toward school counselors in selected private schools in Lebanon. *Procedia-Social and Behavioral Sciences*, *185*, 381-387.

Kılıçoğlu, EA (2013). *Okul öncesi eğitim süreçlerinin etkili rehberlik uygulamalarının gerçekleştirilmesinde eğitim gereksinimlerinin belirlenmesi.* Yayımlanmamış Yüksek Lisans Tezi, Selçuk Üniversitesi, Konya.

Koç, A. (2023). Eğitimde alternatif değerlendirme yöntemleri. Ed. M. K. Aydın, M. Kuş. *Eğitimde Değerlendirme* içinde s. 129-160, Bölüm 7. Vizetek Yayınları.

Kriener, N. A. (2000). Engaging preschoolers in the school counseling program: Classroom suggestions for counselors. *Graduate Research Papers*, 1040. https://scholarworks.uni.edu/grp/1040

Kutlu, M. (2002). Üniversitenin psikolojik danışma ve rehberlik hizmetlerinden Beklentileri. *Eğitim ve Bilim Dergisi* , 27 (123), 22-30.

Langston, A. (2019). Evaluating early years practice in your school. A practical tool for reflective teaching. Bloomsbury Publishing. ISBN 9781472959164

Massaroni, V., Delle-Donne, V., Marra, C., Arcangeli, V., & Chieffo, D. P. R. (2024). The relationship between language and technology: How screen time affects language development in early life—a systematic review. *Brain Sciences, 14*(1), 27. https://doi.org/10.3390/brainsci14010027

Miles, M. B. (1994). Qualitative data analysis: An expanded sourcebook. *Thousand Oaks*.

Millî Eğitim Bakanlığı [MEB], (2012). *Okul öncesi eğitim rehberlik programı* . Talim ve Terbiye Kurulu Başkanlığı, Ankara.

Millî Eğitim Bakanlığı [MEB], (2013. *Okul öncesi eğitim programı* (36-72 aylık çocuklar için). Ankara.

Milli Eğitim Bakanlığı.[MEB], (2019). *Özel Eğitim Kurumları Yönetmeliği.* 30879 Sayılı Resmi Gazete. Erişim tarihi 29.11.2023 erişim adresi: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.mevzuat.gov.tr/File/GeneratePdf?mevzuatNo=16154&mevzuatTur=KurumVeKurulusYonetmeligi&mevzuatTertip=5

Milli Eğitim Bakanlığı [MEB]. (2020). *Sınıf Rehberlik Programı,* Ankara..

Milli Eğitim Bakanlığı [MEB]. (2024a). *Okul öncesi eğitim programı.* Ankara. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://tegm.meb.gov.tr/dosya/okuloncesi/guncellenenokuloncesiegitimprogrami.pdf

Milli Eğitim Bakanlığı [MEB]. (2024b). T*ürkiye yüzyılı maarif modeli okul öncesi eğitim programı*. Ankara. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://tegm.meb.gov.tr/meb_iys_dosyalar/2024_09/20104013_2024programokuloncesionayli.pdf

Memduhoğlu, H. B., & Dalçiçek, E. (2016). Öğretmenlerin sadakat hizmetine yönelik metaforik algıları. *Akademik Sosyal Bilimler Araştırmaları Dergisi , (47)*, 137-148.

Mustafaoğlu, R., Zirek, E., Yasacı, Z., & Razak-Özdinçler, A. (2018). The negative effects of digital technology usage on children's development and health. *Addicta: The Turkish Journal on Addictions, 5*(2):13-21.

NAEYC (2023). DAP: Çocukların Gelişimini ve Öğrenmesini Gözlemleme, Belgeleme ve Değerlendirme. Erişim tarihi 07.12.2023 erişim adresi: https://www.naeyc.org/resources/position-statements/dap/assessing-development

Nasir, A., & Nasir, L. (2015). Counseling on early childhood concerns: sleep issues, thumb-sucking, picky eating, school readiness, and oral health. *American family physician*, *92*(4), 274-278.

Oppermann, E., Blaurock, S., Zander, L., & Anders, Y. (2024). Children's social-emotional development during the covid-19 pandemic: protective effects of the quality of children's home and preschool learning environments. *Early Education and Development*, *35*(7), 1432–1460. https://doi.org/10.1080/10409289.2024.2360877

Öztabak, M. Ü. (2018). Okul öncesi öğretmenlerinin okul danışmanına ilişkin görüşlerine ilişkin algıların incelenmesi. *Eğitim ve Öğretim Çalışmaları Dergisi* , 6(6), 13-24.

Peker, M. (2020). Okul Öncesinde Görev Yapan Yöneticilerin ve Öğretmenlerin Rehber Öğretmenlerin Görev ve Sorumluluklarına Dair Algılarının İncelenmesi. Yayımlanmamış Yüksek Lisans Tezi). Pamukkale Üniversitesi Eğitim Bilimleri Enstitüsü, Denizli.

Perusse, R., Goodnough, G. E., & Bouknight, T. (2007). Counselor education and educational administration: an exploratory survey of collaboration. *Journal of School Counseling*, *5*(24).

Perusse, R., Goodnough, G. E., Donegan, J., & Jones, C. (2004). Perceptions of school counselors and school principals about the national standards for school counseling programs and the transforming school counseling initiative. *Professional School Counseling*, 152-161.

Pişkin, M. (1989). *Orta Dereceli Okullarda Görevli Yönetici, Öğretmen ve Danışmanları İdeal ve Gerçek Danışmanlık Görev Algıları.* Yayınlanmamış Yüksek Lisans Tezi. Ankara: Ankara Üniversitesi, Sosyal Bilimler Enstitüsü.

Polatlar, D., & Öztabak, M. Ü. (2022). Okul öncesi eğitim kurumlarındaki rehberlik ve psikolojik danışma çalışmalarının değerlendirilmesi. *Marmara Üniversitesi Atatürk Eğitim Fakültesi Eğitim Bilimleri Dergisi,* 55(55), 219-242. https://doi.org/10.15285/maruaebd.1012577

Rodriguez-Monge, M., Isabela, I.P., & Chiappelli, F. (2023). CoViD-19 effects on social-emotional development: impact of early intervention. *Bioinformation, 19*(9):889-892.

Saglam, M., Karlıdag, I. O., & Kokrmaz, R.B. (2021). Preschool Teachers' Views on Guidance and Psychological Counseling Services in Early Childhood Education. *Education Quarterly Reviews*, *4*(4), 124-132.

Sanders, M. G., & Harvey, A. (2002). Beyond the school walls: A case study of principal leadership for school-community collaboration. *Teachers college record*, *104*(7), 1345-1368.

Shah, R., Brown, G. T. L., Keegan, P., Harding, J. E., McKinlay, C. J. D., & CHYLD Study Group. (2021). School readiness screening and educational achievement at 9–10 years of age. *Journal of Paediatrics and Child Health*, *57*(12), 1929-1935.

Sibley, D. C. (2022). Mood and anxiety disorders in children and youth: the role of parenting and child temperament and implications for early identification and prevention. *In Mental Health Assessment, Prevention, and Intervention: Promoting Child and Youth Well-Being* (pp. 213-246). Cham: Springer International Publishing.

Stefanski, A., Valli, L., & Jacobson, R. (2016). Katılım ve etkileşimin ötesinde: okul-toplum ortaklıklarında ailenin rolü. *Okul Topluluğu Dergisi, 26* (2): 135-160.

Stevenson, H. W., & Newman, R. S. (1986). Long-term prediction of achievement and attitudes in mathematics and reading. *Child development*, 646-659.

Stone, C. B., & Dahir, C. A. (2016). *The transformed school counselor*. Cengage Learning.

Stritzel-Rencken, K. (1996). Gözlem: Değerlendirmedeki birincil araç. *Çocuk Bakımı Bilgi Değişimi (1)*50-52.

Swider-Cios, E., Vermeij, A., & Sitskoorn, M. M. (2023). Young children and screen-based media: The impact on cognitive and socioemotional development and the importance of parental mediation. *Cognitive Development, 66*, https://doi.org/10.1016/j.cogdev.2023.101319.

Tekin, G. (2012). Erken çocukluk eğitiminde danışmanlık ve rehberlik hizmetleri: Türkiye, Malatya'daki kamu okul öncesi kurumları örneği. *ABD-Çin Eğitim İncelemesi (10),* 875-880.

Temiz, Z. (2017). Türkiye'de okul öncesi eğitimdeki rehberlik ve denetim süreci. *Turkish Online Journal of Qualitative Inquiry*, *8*(3), 350-371.

Turupcu, A. (2014). *Erken çocukluk eğitiminde bir değerlendirme aracı olarak gözlem: Öğretmen görüşleri ve uygulamalarına ilişkin fenomenolojik bir vaka çalışması* . Yüksek Lisans Tezi. Orta Doğu Teknik Üniversitesi.

Unicef (2022). Okullarda ve öğrenme ortamlarında ruh sağlığını ve psikososyal refahı teşvik etmek ve korumak için beş temel sütun. /https://www.unicef.org/media/126821/file/Promoting%20and%20protecting%20mental%20health%20in%20schools%20and%20learning%20environments.pdf

Yazgünoğlu, S. ve Demirel, M. (2012). Okul ve sınıf rehber davranışlarının ilköğretim ve ortaöğretim programlarının sınıfların programlarının gerçekleştirilmesi sağlanır. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, Özel sayı (2),* 244-255.

Wu, S. (2024). Research on the formation of children's personality. *Journal of Education and Educaional Research, 9* (1), 246-250.

Yeşilyaprak, B. (2010). Türkiye'de mesleki rehberlik ve kariyer danışmanlık hizmetleri: güncel durum ve öngörüler. *Kariyer Psikolojik Danışmanlığı Dergisi* , *2* (2), 73-102.

Yıldırım, A. ve Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri.* (9. Baskı). Ankara: Seçkin Yayıncılık.

Yıldız, NG (2021). Okul topluluğunda işbirlikçi liderlik: okul danışmanları ve müdürler dilsel olarak çeşitli öğrenciler için güçlerini birleştiriyor. *Yaşam Boyu Eğitim ve Liderlik Dergisi, 7* (2):14-26. Doi: 10.25233/ijlel.909564

Zembat, R., & Tunçeli, H. İ. (2022). *Çocuğu tanıma ve değerlendirme.* Nobel.

Zembat, R., & Yılmaz, H. (2022). Erken çocukluk döneminde çocuğu tanıma ve değerlendirmenin önemi. Ed. R. Zembat ve H. İ. Tunçeli. *Çocuğu tanıma ve değerlendirme* içinde s. 1-36, Bölüm 1. Nobel.

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The Mediating Role of Mental Well-Being Between Psychological Resilience, Life Satisfaction and Emotional Intelligence

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Abstract

Mental well-being holds significance throughout all phases of life, spanning from early years and adolescence to adulthood. The purpose of this research was to investigate the potential mediating effect of mental well-being on the relationship between emotional intelligence, life satisfaction, and psychological resilience, which are all dependent variables. The research involved 317 university students who volunteered, with a majority of 303 being female and 14 male. Results revealed that mental well-being acts as a complete mediator in the link between emotional intelligence and life satisfaction, while it partially mediates the connection between emotional intelligence and psychological resilience. The model suggests that individuals, regardless of their level of emotional intelligence, experience greater life satisfaction and psychological resilience when mental well-being is high. It's expected that those with enhanced psychological resilience and life satisfaction, particularly those with a certain level of emotional intelligence, will see a positive impact on their life trajectory when their mental health is supported and strengthened.

Keywords: Mental well-being; emotional intelligence, life satisfaction, psychological resilience.

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Introduction

Positive emotions transcend mere fleeting happiness; they offer fresh perspectives, enhanced problem-solving abilities, and heightened creativity. Throughout history, humanity has strived to attain the positive emotions and sensations associated with this state of mind. The scientific community's efforts in this realm are undeniable. Therefore, research findings shed light on individuals' psychological well-being in a holistic sense (Tay et al., 2013). Seligman (2011) underscores the significance of positive relationships, leading a purpose-driven life, and cultivating a strong commitment to life in his model that explicates the concept of well-being, closely intertwined with positive psychology. In discussions on well-being, the notion of mental well-being encompasses emotional, psychological, and social dimensions (Westerhof & Keyes, 2010).

Emotional Intelligence

Emotions play a crucial role in well-being and the experience of feeling well. Individuals demonstrate the concept of emotional intelligence by perceiving, utilizing, and controlling emotions (Petrides & Furnham, 2003). In the definition of emotional intelligence, Cherniss et al. (2006) characterizes it as the capacity of humans to accurately comprehend and articulate their own emotions while also comprehending the emotions of others and providing suitable responses to them. Research examining the relationship between emotional intelligence and well-being has revealed that individuals with low emotional intelligence experience both physical and mental dissatisfaction (Villanueva et al., 2022). Furthermore, a longitudinal study by Shamshad (2022) demonstrated that emotional intelligence predicts well-being in the context of transformational leadership and self-efficacy, with a serial mediation effect. Emotional intelligence closely links to psychological resilience. Zheng (2021) conducted a longitudinal study, affirming a positive association between increased emotional intelligence and enhanced psychological resilience. In their study involving university students, Sarrionandia et al. (2018) identified that psychological resilience plays a mediating role in the connection between national emotional intelligence and the reduction of stress.

Psychological Resilience

Psychological resilience refers to an individual's capacity to adapt to adversity, bounce back from stressful experiences, and maintain or regain a sense of well-being (Southwick et al., 2014). This construct is closely linked to life satisfaction, emotional intelligence, and mental well-being, all of which play a pivotal role in enhancing resilience (Gao et al., 2017; Ramos-Díaz et al., 2019). While emotional intelligence and psychological resilience have been extensively studied, life satisfaction is also a commonly encountered concept. Ramos-Diaz et al. (2019) discovered that emotional intelligence has a positive impact on life satisfaction, particularly when mediated by psychological resilience. A two-year longitudinal study found that emotional intelligence was positively correlated with life happiness (Sánchez-Álvarez et al., 2015). Together, these interrelated factors may enhance psychological resilience, enabling individuals to not only withstand but also thrive despite life’s inevitable challenges, ultimately leading to greater life satisfaction and psychological growth.

Life Satisfaction

Life satisfaction, often defined as the cognitive assessment of one’s life as a whole, is a critical component of overall well-being (Diener et al., 2013). It is often considered a key indicator of subjective well-being, which also includes emotional and psychological dimensions (Schimmack et al., 2002). The longitudinal study carried out by Wang et al. (2023) showcased a positive relationship between emotional intelligence and life satisfaction, indicating that heightened emotional intelligence contributes to increased satisfaction with life. The longitudinal research conducted on the association between life satisfaction and psychological resilience indicated favorable correlations between psychological resilience and life satisfaction (Kjeldstadli et al.,2006; Zhang et al.,2023). Understanding the determinants of life satisfaction is crucial for developing interventions aimed at improving individual well-being and fostering healthier, more fulfilling lives.

The mediating Role of Mental Well-Being

Mental well-being has increasingly been recognized as a crucial mediating factor in the relationship between various life stressors and psychological outcomes. In the context of psychological research, mental well-being is often conceptualized as a dynamic state that encompasses emotional, psychological, and social dimensions, influencing an individual's ability to cope with adversity. As a mediating variable, mental well-being can explain how and why specific stressors, such as traumatic events or chronic stress, lead to positive or negative outcomes (Teh et al., 2015). Tekkurşun Demir et al. (2018) define mental well-being as the state of being mentally healthy. Furthermore, in the comprehensive definition, it encompasses the ability to recognize and utilize one's abilities, foster positive connections with others, lead a fulfilling and meaningful existence, make valuable contributions to society, experience happiness, derive contentment, and attain inner tranquility. Additionally, mental well-being includes emotions such as serenity, joy, self-assurance, and dedication to society, which are regarded as constituents of mental well-being (Demirtaş & Baydemir, 2019). Research findings indicate that individuals with high levels of mental well-being typically exhibit positive physical and psychological health outcomes. In a study by Keyes et al. (2010) focusing on refugee and migrant students, the relationship between school culture, school commitment, and school support, and the mental well-being of these students was explored. Particularly, the study delved into the role of psychological resilience as a potential mediator in this relationship. Psychological resilience denotes an individual's capacity to adapt and thrive despite encountering significant adversity and substantial challenges throughout life (Masten, 2001). Khawaja et al. (2017) discovered that as young adults' psychological resilience increases, their level of mental well-being also rises.Furthermore, a study conducted by Roulston et. al. (2018) determined that a six-week mindfulness training program for university students resulted in enhanced mental well-being and higher psychological resilience. The studies have identified positive correlations between mental well-being and psychological resilience (Duman et al., 2020; Khawaja et al., 2017; Roulston et. al., 2018).

The Present Study

Researching the mediating role of mental well-being in the relationship between emotional intelligence, life satisfaction, and resilience is crucial for understanding the intricate connections between these psychological constructs. Studies have shown that emotional intelligence plays a significant role in influencing life satisfaction and mental well-being (Liu et al., 2013). Additionally, resilience has been identified as a key factor in promoting positive mental health outcomes, such as reducing depression and anxiety, and enhancing overall well-being (Muniandy et al., 2021). Furthermore, the mediating effects of resilience and subjective well-being have been highlighted in mitigating the impact of stressors, such as the COVID-19 pandemic, on mental health (Veronese et al., 2021). By exploring how these factors interact and influence each other, researchers can provide valuable insights into developing interventions that enhance resilience and promote mental well-being, especially in challenging circumstances like the current global health crisis. Understanding the importance of researching the mediating role of mental well-being in the context of emotional intelligence, life satisfaction, and resilience is essential for informing interventions that can effectively support individuals' psychological health. Studies have indicated that resilience interventions have the potential to improve well-being and reduce the prevalence of mental disorders, underscoring the significance of resilience in mental health promotion (Ferreira et al., 2021). By investigating these relationships, researchers can identify strategies to enhance resilience, coping mechanisms, and emotional intelligence, ultimately contributing to the development of targeted interventions that promote mental well-being and overall psychological health. Hence, it's crucial to explore how mental well-being may act as a mediator in the connection between emotional intelligence, life satisfaction, and psychological resilience. Upon reviewing the literature, there is a lack of comprehensive studies that address all of these ideas simultaneously. The research holds significance as it represents a novel investigation at present. The curent study aims to investigate the role of mental well-being as a mediator between emotional intelligence and both life satisfaction and psychological resilience. In alignment with the primary aim of this study, the research hypotheses are outlined as follows:

H_1: there is a significant positive relationship between emotional intelligence and resilience.

H_2: mental well-being mediates the relationship between emotional intelligence and resilience.

H_3: mental well-being mediates the relationship between emotional intelligence and life satisfaction

Method

Participants and Procedure

In the present study, participants were reached through convenience sampling. Convenience sampling is a nonprobability sampling method that involves selecting members from a target population based on practical criteria like accessibility, proximity, availability, or willingness to participate (Etikan et al., 2016). The study engaged participants through both online and face-to-face. Prior to their involvement, participants received detailed information about the study. Data collection through online channels was publicized on various social media platforms such as Twitter, Instagram, etc. A total of 317 participants willingly took part in the study. The participants' ages ranged from 17 to 23 years, with a mean age of 19.71 (*SD*=1.31). Among the participants, 303 (95.6%) were female, while 14 (4.4%) were male.

Measures

Emotional Intelligence Trait Scale-Short Form

Petrides and Furnham (2001) originally developed the scale, which was later adapted to Turkish by Deniz et al. (2013). The survey consists of a total of 20 items, with each item rated on a 7-point Likert scale. In the adaptation study of the scale, it was discovered that both the items and subscales of the original and the Turkish version remained consistent.There are a total of four sub-dimensions on the scale. The sub-dimensions encompassed in this context are well-being, self-control, sociability, and emotionality. The scale allows for a maximum score of 140 and a minimum score of 20. Elevated scores indicate a correspondingly elevated level of emotional intelligence. The well-being factor had a reliability value of.72, self-control had a reliability coefficient of .70, and emotionality had a reliability coefficient of.66, sociability had a reliability coefficient of .70, and the overall scale had a reliability coefficient of .81. The analysis in this study showed that the scale had a reliability coefficient of .84.

Brief psychological resilience scale:

The scale originally developed by Smith et al. (2008) was adapted into Turkish by Doğan et al. (2015). It comprises 6 items designed to evaluate psychological resilience and utilizes a 5-point Likert scale. The scale is unidimensional. On the scale, the 'Strongly disagree' choice is assigned a value of 1, while the 'Strongly agree' option is assigned a score of 5. The scale yields a cumulative score of 30 points. Increased scores correlate with elevated levels of psychological resilience. In the Turkish adaptation of the study, Cronbach's alpha reliability was calculated, resulting in a value of .81. In the current study, the reliability coefficient was re-evaluated and also found to be .81.

Life satisfaction scale:

The life satisfaction scale, originally developed by Diener et al. (1985), is a single-dimensional instrument consisting of 5 items rated on a 5-point Likert-type scale. This scale was adapted into Turkish by Dağlı and Baysal (2016), yielding a total score of 25 points, with higher scores indicating greater life satisfaction. The Turkish adaptation demonstrated a Cronbach's alpha reliability coefficient of .88. In the current study, the reliability coefficient was re-evaluated and found to be .84.

Warwick-Edinburgh Mental Well-Being Scale Short Form:

The scale utilized to assess individuals' mental well-being was developed by Tennant et al. (2007). It operates on a 5-point Likert-type scale (1= Never 5 = Always) consisting of 7 items. Individuals are asked to fill it out according to their experiences in the last two weeks. Higher scores indicate higher mental well-being. It was adapted into Turkish by Demirtaş and Baydemir (2019). It is a one-dimensional scale. In the Turkish adaptation, Cronbach's alpha reliability was calculated as .84. For this study, the reliability coefficient was checked again and found to be .84.

Data Analysis

In the analysis section of the study, both the SPSS 26 package program and the AMOS program were utilized. Initially, an assessment was made to determine whether variables such as emotional intelligence, mental well-being, life satisfaction, and psychological resilience exhibited normal distribution. Following this, reliability analysis was conducted. Subsequently, descriptive statistics of the variables were examined.Correlation analysis was conducted to examine the relationships between the variables, and structural equation modeling (SEM) was initiated based on the significance levels determined from the correlation results. Amos program was used for structural equation modeling and it was used to measure more parameters. In the first stage, latent variables of the variables were created and the measurement model was tested by looking at the relationship between these latent variables (Kline, 2023).

According to Hu and Bentler (1999), the goodness of fit recommendations of SEM results were taken into consideration. In this context, chi-square, GFI, CFI, NFI, TLI, and SRMR values were taken as a basis. In terms of values, the chi-square test is expected to be less than 5, GFI, CFI, NFI, and TLI, values are expected to be greater than .90 and the SRMR value is expected to be less than .08 (Hu & Bentler, 1999; Tabachnick et al., 2013). Since the measurement fit values were found to be sufficient, the second measurement part was started. In addition, to determine which SEM model is the best, firstly the significance level and then the AIC and ECVI values together with the chi-square difference test were examined. Whichever model has small AIC and ECVI values, that model was preferred (Browne & Cudeck, 1992).

To support the study, bootstrapping was used to strengthen the significance of the mediation test (Preacher & Hayes, 2008). With the bootstrapping process, the number of samples was increased to 5000 and a confidence interval was created with the bootstrap value. The lack of zero within this confidence interval suggests that the mediation is statistically significant.

Findings

Descriptive statistics and correlation analyses are included in this section. Subsequently, the results of the measurement model and the structural model are presented. In the last stage, the results of the bootstrapping process are presented.

Table 1.

Descriptive statistics and correlations between variables (N=303)

Variable	N	Mean	SD	Skewness	Kurtosis	1	2	3	4
1.Emotional intelligence	317	92.35	16.96	.050	.137	-			
2.Mental well-being	317	24.76	5.25	-.127	-.153	.76**	-		
3. Resilience	317	18.00	4.78	.155	.412	.56**	.44**	-	
4.Life satisfaction	317	14.96	4.33	-.086	-.055	.47**	.60**	.27**	-

**p<.001

According to Finney and DiStefano (2006), the variables should be within the normality criteria of ±2 for skewness and ±7 for kurtosis. In Table 1, Skewnees are between (-.127 and .155) and Kurtosis is between (-.153 and .412), which shows a normal distribution.

When the relationships between variables are analyzed in Table-1, there are significant positive relationships between emotional intelligence and life satisfaction (r= .47, p<.001), emotional intelligence and psychological resilience (r= .56, p<.001), emotional intelligence and mental well-being (r= .76, p<.001), mental well-being and psychological resilience (r= .44, p<.001), mental well-being and life satisfaction (r= .60, p<.001), psychological resilience and life satisfaction (r= .27, p<.001).

Considering the measurement model of emotional intelligence, mental well-being, psychological resilience, and life satisfaction variables, there are 4 latent variables and 11 observed variables. According to the measurement results, x^2/df= 4.61, GFI .908, CFI .926, NFI .960, TLI .893, RFI .867,

IFI .927, SRMR .032. Factor loadings ranged between .48 and .94. It is plausible to assert that the observed variables effectively represent the latent variables in a meaningful manner.

In the post-measurement structural model, different models of mental well-being among university students' emotional intelligence, psychological resilience, and life satisfaction were tested. Firstly, the full mediator and partial mediator roles for both dependent variables were examined, and in addition, the partial mediator role for life satisfaction and the full mediator role for psychological resilience were tested. However, all of these paths were found to be insignificant. Since they were found to be insignificant, the model with the best-fit index was determined as the full mediating role of mental well-being between emotional intelligence and life satisfaction and the partial mediating role of mental well-being between emotional intelligence and psychological resilience. Considering the fit indices, x^2/df= 4.41, GFI= .906, CFI= .926, NFI= .907, TLI= .899, RFI= .873, IFI= .927, SRMR .06 fit values are at the expected level. The model in which life satisfaction is a full mediator and psychological resilience is a partial mediator shows that it is the best model. The model's path coefficients are depicted in Figure 1.

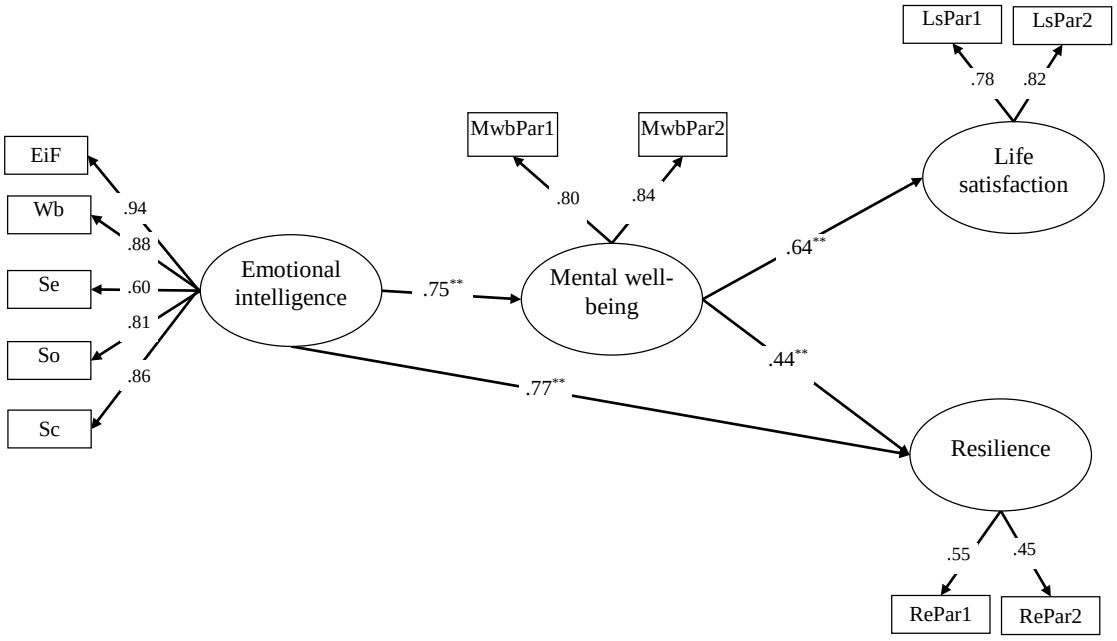

Figure 1. Standardized factor loading for the fully mediated structural model. *Note.* N = 317; ** p < .001; EIF emotional intelligence total; Wb well being; Se sensuality; So sociability; Sc self control; *MwbPar* parcels of mental well being; *LsPar* parcels of life satisfaction; *RePar* parcels of resilience

Discussion, Conclusion, and Suggestions

In short, mental well-being refers to being in good mental health (Tekkurşun Demir et al., 2018). In addition, it has been conceptualized as the capacity to contribute to society, lead a meaningful life, experience happiness, cope with the situations faced in life, and take responsibility (Demirtaş & Baydemir, 2019). The study was conducted to measure the mediating effect of mental well-being between emotional intelligence, life satisfaction, and psychological resilience. As a result of the analysis of the collected data, it was found that there was a full mediating effect of mental well-being between emotional intelligence and life satisfaction and a partial mediating effect of mental well-being between emotional intelligence and psychological resilience. The results are discussed below within the scope of the hypotheses.

Initially, upon investigating the mediating role of mental well-being between emotional intelligence and life satisfaction, it was found that a complete mediating relationship was present.Thus, when the mental well-being of individuals with high emotional intelligence levels increases, their life satisfaction also increases, and when the mental well-being of individuals with low emotional intelligence levels increases, their life satisfaction also increases. In addition, if mental well-being is low, life satisfaction is also low. Research by Sammer and Majeed, (2022) has shown that emotional intelligence positively influences life satisfaction and is a significant predictor of life satisfaction across different populations. Similarly, Carmeli et al. (2009) demonstrated a positive association between emotional intelligence and psychological well-being components, including life satisfaction. Also, previous studies have found positive correlations between mental well-being and life satisfaction. For instance, Gale et al. (2013) observed that an improvement in mental well-being leads to increased life satisfaction. Additionally, in a two-year longitudinal study, Sánchez-Álvarez et al. (2015) found that emotional intelligence was positively associated with higher levels of life satisfaction.These findings suggest that mental well-being plays a crucial role in enhancing the impact of emotional intelligence on life satisfaction. Understanding this interplay is vital for developing interventions to promote overall well-being and satisfaction, especially in high-stress environments like healthcare settings or during challenging times such as the COVID-19 pandemic.

The other hypothesis is that mental well-being has a partial mediating role between emotional intelligence and psychological resilience. It was concluded that when the mental well-being of individuals with high emotional intelligence levels increases, their psychological resilience increases, and when the mental well-being of individuals with low emotional intelligence levels increases, their psychological resilience increases. Consistent with the outcomes of the present research, a recent study conducted by Ime (2023) reveals positive associations among psychological resilience, emotional flexibility, and mental well-being. Additionally, Yıldırım (2019) found that resilience partially mediates the relationship between stress and life satisfaction. These findings suggest that mental well-being acts as a bridge between emotional intelligence and resilience, influencing how individuals navigate stressors and maintain psychological health. This interconnectedness underscores the importance of considering mental well-being as a key factor in understanding the relationship between emotional intelligence and resilience, emphasizing the need for interventions that promote mental well-being to enhance overall psychological resilience.

In addition, in case of low mental well-being, there is a low psychological resilience. The positive correlation between mental well-being and psychological resilience is well-supported by various studies. This correlation suggests that mental well-being plays a crucial role in fostering resilience, potentially acting as a protective factor against stressors and contributing to individuals' ability to adapt positively to adversity.Research consistently shows that higher levels of mental well-being are associated with greater psychological resilience, indicating that individuals with better mental health are more likely to exhibit resilience in the face of challenges (Zhang et al., 2023). Also, in the literature review, it was concluded that people with high mental well-being have very good physical and psychological health and strong life qualities (Keyes et al., 2010). In addition, it was concluded that mindfulness training for university students for six weeks increased mental well-being and also increased their psychological resilience (Roulston et al., 2018). By recognizing the link between mental well-being and psychological resilience, interventions can be designed to enhance both aspects concurrently, thereby fostering a more comprehensive approach to promoting individuals' mental health and well-being. Overall, the positive correlation between mental well-being and psychological resilience underscores the importance of addressing both factors in mental health promotion efforts to support individuals in building resilience and maintaining positive mental health outcomes.

The study findings suggest a significant relationship between emotional intelligence and various aspects of well-being, such as life satisfaction and psychological resilience. The results indicate that mental well-being fully mediates the relationship between emotional intelligence and life satisfaction, emphasizing the influence of individuals' mental states on their overall satisfaction with life. Moreover, mental well-being partially mediates the relationship between emotional intelligence and psychological resilience, highlighting the role of emotional intelligence in individuals' ability to cope with challenges and recover from adversity. These findings underscore the complex interplay between emotional

intelligence, mental well-being, and different facets of overall well-being, emphasizing the importance of emotional factors in understanding individuals' satisfaction with life and resilience to stressors. Understanding the mediating effects of mental well-being between emotional intelligence and various well-being indicators can have significant implications for interventions aimed at enhancing individuals' overall well-being. By acknowledging mental well-being as a mediator, interventions can target both emotional intelligence and mental well-being to enhance outcomes like life satisfaction and psychological resilience. This study contributes to the existing literature emphasizing the role of emotional intelligence in promoting well-being and resilience, elucidating the mechanisms through which emotional intelligence influences individuals' overall satisfaction with life and ability to navigate challenges effectively. Ultimately, these findings highlight the importance of considering emotional factors in interventions and programs designed to improve individuals' well-being and resilience in diverse contexts.

Although the study explains the relationship between emotional intelligence, life satisfaction psychological resilience, and mental well-being, it should be noted that there are some limitations. First of all, the generalisability of the sample and sample size is limited. The majority of participants are girls include potential gender bias in the findings, as the results may not be generalizable to a more diverse population. Therefore, its generalisability can be increased with students from different cultures and different large samples. Secondly, the mediating variable could have been the case of looking at different concepts other than the concept of mental well-being. The study is limited to the mediating effect of the mentioned concept between emotional intelligence, life satisfaction, and psychological resilience. Thirdly, the participants participated according to their own ideas about data collection. Different collection methods can be used. Finally, our research is a cross-sectional study. Cross-sectional studies are insufficient in terms of causality. For this, causality can be emphasized in longitudinal studies.

Acknowledgment

Ethics statement: The researchers declare that they carried out the study by adhering to the ethical rules that must be followed in human experiments as stated in the Helsinki Declaration of 1975. Before the administration of measures, participants were informed about the aim of the study by the authors. Participants were asked whether they were volunteers to participate in the study. Then the measures were administered to the only volunteer students. Before completing the measures informed consent was obtained by all participants.

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References

Browne, M. W., & Cudeck, R. (1992). Alternative ways of assessing model fit. *Sociological Methods & Research, 21*(2), 230-258. https://doi.org/10.1177/0049124192021002005

Carmeli, A., Yitzhak-Halevy, M., & Weisberg, J. (2009). The relationship between emotional intelligence and psychological wellbeing. *Journal of Managerial Psychology, 24*(1), 66-78. https://doi.org/10.1108/02683940910922546

Cherniss, C., Extein, M., Goleman, D., & Weissberg, R. P. (2006). Emotional intelligence: what does the research really indicate?. *Educational Psychologist, 41*(4), 239-245. https://doi.org/10.1207/s15326985ep4104_4

Dağlı, A., & Baysal, N. (2016). Yaşam doyumu ölçeğinin Türkçe'ye uyarlanmasi: geçerlik ve güvenirlik çalişmasi. *Elektronik Sosyal Bilimler Dergisi, 15*(59),1250-1262. https://doi.org/10.17755/esosder.263229

Demirtaş, A. S., & Baytemir, K. (2019). Warwick-edinburgh mental iyi oluş ölçeği kısa formu'nun Türkçe'ye uyarlanmasi: geçerlik ve güvenirlik çalişmasi. *Elektronik Sosyal Bilimler Dergisi, 18*(70), 689-701. https://doi.org/10.17755/esosder.432708

Deniz, M. E., Özer, E. ve Işık, E. (2013). Duygusal zeka özelliği ölçeği–kısa formu: Geçerlik ve güvenirlik çalışması. *Eğitim ve Bilim, 38*(169), 407-419.

Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment, 49*(1), 71-75. https://doi.org/10.1207/s15327752jpa4901_13

Diener, E., Inglehart, R., & Tay, L. (2013). Theory and validity of life satisfaction scales. *Social Indicators Research, 112*, 497-527. https://doi.org/10.1007/s11205-012-0076-y

Doğan, T. (2015). Kısa psikolojik sağlamlık ölçeği'nin Türkçe uyarlaması: Geçerlik ve güvenirlik çalışması. *The Journal of Happiness & Well-Being, 3*(1), 93-102.

Duman, N., Göksu, P., Köroğlu, C., & Talay, A. (2020). Üniversite öğrencilerinde mental iyi oluş ile psikolojik dayanıklılık ilişkisi. *Yaşam Becerileri Psikoloji Dergisi, 4*(7), 9-17. https://doi.org/10.31461/ybpd.668737

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1-4. doi:10.11648/j.ajtas.20160501.11

Ferreira, M., Marques, A., & Gomes, P. V. (2021). Individual resilience interventions: A systematic review in adult population samples over the last decade. *International Journal of Environmental Research and Public Health, 18*(14), 7564. https://doi.org/10.3390/ ijerph18147564

Gale, C. R., Booth, T., Mõttus, R., Kuh, D., & Deary, I. J. (2013). Neuroticism and Extraversion in youth predict mental wellbeing and life satisfaction 40 years later. *Journal of Research in Personality, 47*(6), 687-697. https://doi.org/10.1016/j.jrp.2013.06.005

Gao, T., Ding, X., Chai, J., Zhang, Z., Zhang, H., Kong, Y., & Mei, S. (2017). The influence of resilience on mental health: The role of general well-being. *International Journal of Nursing Practice, 23*(3), e12535. https://doi.org/10.1111/ijn.12535

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080 /10705519909540118.

İme, Y. (2023). Adaptation of Short Warwick-Edinburgh Mental Well-being Scale: Its Relationship with Loneliness, Emotional Flexibility and Resilience Among Adolescents. *Polish Psychological Bulletin,54*(3),201-206. DOI: 10.24425/ppb.2023. 148052

Kline, R. B. (2023). *Principles and practice of structural equation modeling*. Guilford publications.

Keyes, C. L., Dhingra, S. S., & Simoes, E. J. (2010). Change in level of positive mental health as a predictor of future risk of mental illness. *American Journal of Public Health, 100*(12), 2366-2371.

Khawaja, N. G., Ibrahim, O., & Schweitzer, R. D. (2017). Mental wellbeing of students from refugee and migrant backgrounds: The mediating role of resilience. *School Mental Health, 9*, 284-293. https://doi.org/10.1007/s12310-017-9215-6

Kjeldstadli, K., Tyssen, R., Finset, A., Hem, E., Gude, T., Gronvold, N. T., ... & Vaglum, P. (2006). Life satisfaction and resilience in medical school–a six-year longitudinal, nationwide and comparative study. *BMC Medical Education*, *6*, 1-8. https://doi.org/10.1186/1472-6920-6-48

Liu, Y., Wang, Z., & Lü, W. (2013). Resilience and affect balance as mediators between trait emotional intelligence and life satisfaction. *Personality and Individual differences*, *54*(7), 850-855. https://doi.org/10.1016/j.paid.2012.12.010

Masten, A. S. (2001). Ordinary magic: Resilience processes in development. *American Psychologist, 56*(3), 227–238. https://doi.org/10.1037/0003-066X.56.3.227

Muniandy, M., Richdale, A. L., Arnold, S. R., Trollor, J. N., & Lawson, L. P. (2021). Inter-relationships between trait resilience, coping strategies, and mental health outcomes in autistic adults. *Autism Research*, *14*(10), 2156-2168. https://doi.org/10.1002/aur.2564

Petrides, K. V., & Furnham, A. (2001). Trait emotional intelligence: Psychometric investigation with reference to established trait taxonomies. *European journal of personality*, *15*(6), 425-448. https://doi.org/10.1002/per.416

Petrides, K., and Furnham, A.(2003). Trait Emotional Intelligence: Behavioural Validation in Two Studies of Emotion Recognition and Reactivity to Mood Induction. *European Journal of Personality*, *17*, 39–57. https://doi.org/10.1002/per.466

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*(3), 879-891. https://doi.org/10.3758/BRM.40.3.879

Ramos-Díaz, E., Rodríguez-Fernández, A., Axpe, I., & Ferrara, M. (2019). Perceived emotional intelligence and life satisfaction among adolescent students: The mediating role of resilience. *Journal of Happiness Studies*, *20*(8), 2489-2506. https://doi.org/10.1007/s10902-018-0058-0

Roulston, A., Montgomery, L., Campbell, A., & Davidson, G. (2018). Exploring the impact of mindfulnesss on mental wellbeing, stress and resilience of undergraduate social work students. *Social Work Education*, *37*(2), 157-172. https://doi.org/10.1080/02615479.2017.1388776

Sammer, A., & Majeed, S. (2022). Emotional intelligence and self efficacy as predictors of life satisfaction among doctors working in emergency department. *Journal of Development and Social Sciences*, *3*(2), 1208-1219. https://doi.org/10.47205/jdss.2022(3-II)107

Sánchez-Álvarez, N., Extremera, N., & Fernandez-Berrocal, P. (2015). Maintaining life satisfaction in adolescence: Affective mediators of the influence of perceived emotional intelligence on overall life satisfaction judgments in a two-year longitudinal study. *Frontiers in Psychology*, *6*, 1892.https://doi.org/10.3389/fpsyg.2015.01892

Sarrionandia, A., Ramos-Díaz, E., & Fernández-Lasarte, O. (2018). Resilience as a mediator of emotional intelligence and perceived stress: A cross-country study. *Frontiers in Psychology, 9*, 2653.https://doi.org/10.3389/fpsyg.2018.02653

Schimmack, U., Radhakrishnan, P., Oishi, S., Dzokoto, V., & Ahadi, S. (2002). Culture, personality, and subjective well-being: integrating process models of life satisfaction. *Journal of Personality and Social Psychology*, *82*(4), 582-593.

Seligman, M. E. (2011). *Flourish: A visionary new understanding of happiness and well-being*. Simon and Schuster.

Shamshad, I., & Naqi Khan, M. K. (2022). Emotional intelligence, transformational leadership, self-efficacy for well-being: A longitudinal study using sequential mediation. *Journal of Public Affairs*, *22*(3), e2506. https://doi.org/10.1002/pa.2506

Smith, B. W., Dalen, J., Wiggins, K., Tooley, E., Christopher, P., & Bernard, J. (2008). The brief resilience scale: assessing the ability to bounce back. *International Journal of Behavioral Medicine*, *15*, 194-200. https://doi.org/10.1080/10705500802222972

Southwick, S. M., Bonanno, G. A., Masten, A. S., Panter-Brick, C., & Yehuda, R. (2014). Resilience definitions, theory, and challenges: interdisciplinary perspectives. *European Journal of Psychotraumatology*, *5*(1), 25338. https://doi.org/10.3402/ejpt.v5.25338

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2013). *Using multivariate statistics* (Vol. 6). Pearson.

Tay, L., & Kuykendall, L. (2013). Promoting happiness: The malleability of individual and societal subjective wellbeing. *International Journal of Psychology*, *48*(3), 159-176. https://doi.org/10.1080/00207594.2013.779379

Teh, H. C., Archer, J. A., Chang, W., & Chen, S. A. (2015). Mental well-being mediates the relationship between perceived stress and perceived health. *Stress and Health, 31*(1), 71-77. https://doi.org/10.1002/smi.2510

Tekkurşun Demir, G., Namlı, S., Hazar, Z., Türkeli, A., Cicioğlu, İ. (2018). Bireysel ve takım sporcularının karar verme stilleri ve mental iyi oluş düzeyleri. *CBÜ Beden Eğitimi ve Spor Bilimleri Dergisi, 13*(1), 176-191.

Tennant, R., Hiller, L., Fishwick, R., Platt, S., Joseph, S., Weich, S., ... & Stewart-Brown, S. (2007). The Warwick-Edinburgh mental well-being scale (WEMWBS): development and UK validation. *Health and Quality of life Outcomes, 5,* 1-13. https://doi.org/10.1186/1477-7525-5-63

Veronese, G., Mahamid, F., Bdier, D., & Pancake, R. (2021). Stress of COVID-19 and mental health outcomes in Palestine: the mediating role of well-being and resilience. *Health Psychology Report, 9*(4), 398-410.https://doi.org/10.5114/hpr.2021.104490

Villanueva, L., Prado-Gascó, V., & Montoya-Castilla, I. (2022). Longitudinal analysis of subjective well-being in preadolescents: The role of emotional intelligence, self-esteem and perceived stress. *Journal of Health Psychology, 27*(2), 278-291. https://doi.org/10.1177/1359105320951605

Wang, X., Lu, X., Hu, T., Xue, S., Xu, W., & Tang, W. (2023). Optimism and friendship quality as mediators between trait emotional intelligence and life satisfaction in Chinese adolescents: A two-wave longitudinal study. *Current Psychology*, *42*(34), 29918-29927. https://doi.org/10.1007/s12144-022-03931-0

Westerhof, G. J. ve Keyes, C. L. M. (2010). Mental illness and mental health: The two continua model across the lifespan. *Journal of Adult Development, 17,* 110-119. https://doi.org/10.1007/s10804-009-9082-y

Yıldırım, M. (2019). Mediating role of resilience in the relationships between fear of happiness and affect balance, satisfaction with life, and flourishing. *Europe's Journal of Psychology*, *15*(2), 183. doi: 10.5964/ejop.v15i2.1640

Zheng, Y., Cai, D., Zhao, J. L., Yang, C., Xia, T., & Xu, Z. (2021). Bidirectional relationship between emotional intelligence and perceptions of resilience in young adolescents: a twenty-month longitudinal study. *In Child & Youth Care Forum 50*, 363-377. https://doi.org/10.1007/s10566-020-09578-x

Zhang, R., Wang, L. X., Datu, J. A. D., Liang, Y., Dou, K., Nie, Y. G., & Li, J. B. (2023). High Qualities of Relationships with Parents and Teachers Contribute to the Development of Adolescent Life Satisfaction Through Resilience: A Three-Wave Prospective Longitudinal Study. *Journal of Happiness Studies*, *24*(4), 1339-1365. https://doi.org/10.1007/s10902-023-00647-1

e-Kafkas Journal of Educational Research e-KJER Research Article

The Effect of Intelligence Games on 6th and 7th Grade Students' Critical Thinking Skills, and Student Opinions on Their Science Course Achievement[1]

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Abstract

The purpose of this study was to evaluate the critical thinking abilities of sixth and seventh grade students who participated in an intelligence games course as well as their perceptions of their performance in a science course. The sample of the study consisted of 16 students at 6th and 7th grade level studying in Ardahan. A mixed research model using quantitative and qualitative data was preferred in the study. In order to collect quantitative data, a single-group pre-test, post-test experimental design was used, and the critical thinking skills test and demographic characteristics form were used as scales. For qualitative data, a case study was conducted and a semi-structured interview form was applied. Critical thinking skills test data were analyzed by dependent sample t-test and the effect of father and mother education level on critical thinking skills was analyzed by ANOVA test. The semi-structured interview form was analyzed by content analysis. Due to the Covid-19 pandemic, the study was conducted as a "Live Lesson" over the Education Information Network (EBA) for 10 weeks as 1 class hour per week. For the activities in the course, the book "Teaching Material for Teachers of Secondary and Imam Hatip Secondary Schools Grades 5, 6, 7 and 8" and smart device applications of strategy games were used. As a result of the research, A small change in favor of the post-test was detected between the pre-test and post-test averages of the critical thinking skills test. Additionally, there was no correlation between the students' critical thinking abilities and their parents' educational levels among those who took the intelligence games course ($p>0.05$). The students claimed that intelligence games would benefit the science course in their interviews and that they enjoyed the intelligence games course. They also claimed that playing intelligence games helped them develop their cognitive abilities, including attention and memory.

Keywords: Intelligence games, critical thinking, science, middle school students, mixed design

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Introduction

Intelligence games have always been popular because they enable one to make quick, precise, and original decisions in the face of challenges and to renew the individual himself (Devecioğlu & Karadağ, 2014). The game of ur found in the tomb of the Sumerian king of Ur in 4 thousand BC, the game of go, which has a history of 4 thousand years in East Asia, especially in Japan, Korea and China, mangala played in Anatolia (MEB, 2013; MEB, 2016; Öner & Dindar, 2018), chaturanga, which was played in India in the 6th century and is the ancestor of chess, and chess played since the 1600s (Davidson, 1949) demonstrate that intelligence games have existed in people's lives since ancient times.

Today, the contributions of intelligence games to human life have been understood and some of them such as strategy games, geometric-mechanical games, reasoning-operation games, verbal games, and memory games are included in the curriculum (MoNE, 2013). The reason for this situation is that individuals need to have many skills such as creative and critical thinking, collaborative work, problem solving, efficient communication, being open to changes and using technology in a beneficial way in order to be successful in business and education life (Eryılmaz & Uluyol, 2015). In order to provide students with these 21st century skills, an elective "Intelligence Games Course" was started to be implemented gradually starting from the 5th and 6th grades of secondary schools in the 2013-2014 academic year. With the elective intelligence games course, it is aimed for students to recognize and develop their own intelligence capacities, find unique and quick solutions to problems, think systematically, work individually and in teams, and develop a positive attitude towards problem solving (MoNE, 2013). In the implementation of the course, step-by-step teaching that goes from easy to difficult, near to far, simple to complex, known to unknown, shows a progressive relationship and gives the student the right to choose is preferred (MoNE, 2013). In order to provide a flexible structure to the intelligence games course and to enable the teacher to group the course according to student levels, the achievements of these games were classified according to different difficulty levels as D1, D2, D3 (levels) in the curriculum (Devecioğlu & Karadağ, 2014). In the measurement and evaluation of the course, checklists, graded scoring forms, observation, self-evaluation, and group evaluation tools are used to evaluate the student's skill acquisition process (MoNE, 2013).

Critical thinking, which is one of the requirements of the age that can be taught to students through intelligence games, has recently been one of the most discussed and researched topics (Güven & Kürüm, 2004). In the process of critical thinking, different mental processes occur, such as distinguishing and controlling variables, recognizing gaps in knowledge, recognizing the necessity of explanatory definitions, evaluating how strong the justifications are on the way to the conclusion, making inferences from the findings, making decisions according to rational criteria, and reading for understanding (Education Reform Initiative, 2008). All these skills and competencies are characteristics that every individual should have today (Güven & Kürüm, 2004) and these characteristics can only be acquired through education (Şenşekerci & Bilgin, 2008). In order to gain critical thinking skills, students should start to be trained in these aspects at an early age (Kurnaz, 2019).

Critical thinking skills have also been included in the achievements of the "Science Curriculum" organized by the Ministry of National Education in 2018. It is stated in the curriculum that today's individuals should be able to produce and use knowledge, solve problems, think critically, be entrepreneurial and determined, have high communication skills, have empathy, and contribute to the society and culture they live in (MoNE, 2018). Intelligence games can be one of these applications. These games can contribute to students' academic achievement as well as critical thinking skills. In this sense, Demirel (2015) determined an increase in students' academic achievement thanks to intelligence games; Baki (2018) determined an increase in students' self-efficacy towards academic effort by using these games.

In summary, it is stated in the literature that critical thinking skills are a skill required by our age and that this skill can be acquired by students through intelligence games. From this perspective, this study aims to examine the relationship between intelligence games and critical thinking skills and to investigate the effect of these games on success in science classes. In addition, the study also investigated the effect of the mother and father education levels of students taking intelligence games courses on critical thinking skills. In line with the purpose of the study, a study was conducted on the problem of

"Do intelligence games have an effect on the critical thinking skills of 6th and 7th grade students and their success in science classes?" The sub-problems of the study are as follows.

1. What is the level of effect of the intelligence games course on the critical thinking skills of 6th and 7th grade students?
2. Does the mother's education level of 6th and 7th grade students taking intelligence games course affect their critical thinking skills?
3. Does the father's education level of 6th and 7th grade students taking intelligence games course affect their critical thinking skills?
4. What are the opinions of 6th and 7th grade students who take intelligence games course about their success in science class?

Method

Research Model

This research was conducted with a mixed research model in which both methods were used together in order to make situations that could not be explained by quantitative or qualitative methods alone more understandable. Thus, the need to choose one of these two models was eliminated and both qualitative and quantitative data related to the same basic phenomena could be examined (Kıral and Kıral, 2011). Because the reason for choosing the mixed research model is to find solutions to problems that cannot be explained by the quantitative research model that evaluates events with results (scores and numbers) and the qualitative research model that conducts process-oriented research alone (Büyüköztürk et al., 2019).

A single-group pretest-posttest experimental design was used to collect quantitative data, and a case study design that allows a holistic approach that allows for an in-depth examination of the situation was used to collect qualitative data, and semi-structured interviews were conducted with students.

Study Group

Since this study was conducted during the period when the Covid-19 pandemic, the appropriate sampling method was preferred in determining the study group. The aim of the appropriate sampling method is to minimize the loss of time, money and labor (Büyüköztürk et al., 2019). It was carried out through distance education via the Education Information Network (EBA) and the study group was formed with students who did not have problems using smart device and internet in order not to disrupt the process. The study was conducted with 16 students studying in the 6th and 7th grades of Kazım Karabekir Regional Boarding Secondary School in the Central District of Ardahan Province in the 2020-2021 academic year.

Data Collection Instruments

The data of the study were collected through critical thinking skills test, demographic information form and semi-structured interview form.

Critical Thinking Skills Test: In order to collect the quantitative data of the study, the "Critical Thinking Skills Test" developed by Eğmir and Ocak (2016) was applied. In the analyses made on the final version of the test consisting of 25 questions, the KR-20 and KR-21 values for the whole test were found to be 0.61 and 0.63, respectively. In addition, the difficulty index for the whole test was found to be 0.37 and the discrimination index was found to be 0.32. Thus, it can be said that the test is a test with a medium difficulty and a very good level of discrimination.

Demographic Information Form: It was created in line with expert opinions.

Semi-structured Interview Questions Form: The item pool, which was created by using literature to determine the effect of intelligence games on science lessons, was presented to 3 field experts for their opinions. The form was finalized by making necessary corrections and additions in line with the opinions of the field experts. In qualitative research, credibility, transferability, verifiability and reliability are examined in order to ensure internal and external validity and reliability. In addition, the statements of the participants of the study, especially the data

obtained from the interviews, were given in the form of direct quotes, thus trying to increase internal validity. A trustworthy environment was created during the interviews, the names of the participants were not used in the study and code names were given to the participants.

Implementation

For the implementation of the study, a 10-week course on intelligence games was planned for 1 class hour per week and the lessons were conducted as live lessons through EBA. While teaching the lessons, the curriculum of the course (2013) and the activities of "Secondary School and Imam Hatip Secondary School Intelligence Games Teaching Material for 5th, 6th, 7th and 8th Grades and Teachers (2016)" were used. Before the lessons started, the "Critical Thinking Skills Test" was applied on the digital platform as a pre-test. Students solved the test projected on the screen via EBA live lesson and sent their answers to the researcher by creating an answer sheet. While solving the test, the students' voices were muted, their images were kept on and they were asked to finish the test within a certain period of time.

In the process of the lessons, first of all, the activities related to intelligence games were projected on the screen, the rules of the activities were explained by the researcher and the students were shown how to play. In the next stage, the students were assigned as "hosts", i.e. "administrators", and they were allowed to play the activities by showing them on their smart devices to the other students participating in the lesson. In this process, the moves made by the students who lost or won the game were discussed and the game was evaluated. In cases where the duration of the class was not sufficient, the activities were sent to the students with the help of smart devices and they were allowed to complete the activities at home. Some strategy games were played through smart device applications. Students downloaded the applications of mangala, pentago and reversi games to their smart devices and played them by projecting them on the screen during the live lesson. While choosing these applications, care was taken to ensure that they did not contain inappropriate advertisements and promotions.

At the end of the 10-week period, the "Critical Thinking Skills Test" was applied as a post-test with EBA live lesson as in the pre-test and interviews were conducted. In the interviews, it was tried to determine the relationship established between intelligence games and science course by the students. Demographic characteristics form was also applied as a post-test.

Analysis of the Data

In order to examine the effect of intelligence games activities on students' critical thinking skills, the pre-test and post-test data of the experimental group (N experimental group = 16) were analyzed by performing a "dependent sample t-test" after it was determined that they showed a normal distribution. The Shapiro-Wilk value of the "Difference Score" (Yıldırım, 2016) obtained from the difference between the pre-test and post-test scores of the "Critical Thinking Skills Test" of the experimental group students is greater than 0.05 ($p>0.05$). Since the skewness coefficient obtained from the data divided by its standard error is between +1.96 and -1.96 at a significance level of 5%, the data is interpreted as being close to normal. In addition, for the normal distribution test, the fact that the mean value and median value of the data are close to each other is accepted as an indicator that the data set has a normal distribution. In the literature, it is stated that if the number of subjects is $n>10$, the groups should show a normal distribution in order to apply a parametric test. In order to collect the quantitative data of the study, the "Critical Thinking Skills Test" developed by Eğmir and Ocak (2016) was applied. In the analyses made on the final version of the test consisting of 25 questions, the KR-20 and KR-21 values for the whole test were found to be 0.61 and 0.63, respectively. In addition, the difficulty index for the whole test was found to be 0.37 and the discrimination index was found to be 0.32. Thus, it can be said that the test is a test with a medium difficulty and a very good level of discrimination.

The data obtained with the Critical Thinking Skills Test was analyzed with the dependent sample t-test in the SPSS program; the effect of the mother and father education status of the students taking the intelligence games course on the critical thinking skills was analyzed with the one-way variance analysis, ANOVA, to see the intra-group and inter-group variations. In the analysis of interview data, which is the qualitative dimension of the research, content analysis was preferred. In this study, the data obtained from the open-ended questions directed to the students were classified based on themes and codes with content analysis, and their detailed opinions on intelligence games were tried to be revealed.

Content analysis is one of the indispensable methods of social sciences (Metin & Ünal, 2022) and is used to provide an objective, measurable and verifiable explanation of open-ended content (Fiske, 1996). The reliability of the content analysis was calculated with the formula [Reliability = Consensus / (Consensus + Disagreement) x 100] developed by Miles and Huberman (1994). Values above 70% were considered reliable. A final consensus was reached in the categories where the researchers had disagreements. The credibility of the study was ensured by consulting two separate experts from the field of science education. In categories where the researchers had disagreements, expert opinions were again consulted and a final consensus was reached. For the transferability of the study, the detailed presentation of the findings with themes and codes supported this purpose. Showing the themes and codes to the experts and reaching a consensus both ensured the consistency of the study and supported its transferability. The researchers remained impartial in the study and did not engage in any guiding behavior.

Results and Interpretation

Within the scope of the study, the effects of intelligence games activities on critical thinking skills and science course, and the effects of mother and father education levels on critical thinking skills were investigated. In addition, students' opinions on whether intelligence games contribute to success in the science course, if so, in which subjects with which features they increase success, whether intelligence games are necessary to be successful in the science course, and whether they want to have intelligence games in the science course were examined.

The Effect of Intelligence Games Activities on Critical Thinking Skills

When the effect of intelligence games activities on students' critical thinking skills were examined, the pre-test and post-test data of the experimental group showed a normal distribution and were analyzed with the dependent sample t-test. Descriptive statistics results are presented in Table 1.

Table 1.

Critical Thinking Skills Test Pre-Test and Post-Test Scores of the Experimental Group

Group	Test	N	$\bar{x}$	ss	Min	Max	sd	t	p
Experiment	Pre-test test	16	15.87	4.84	5	22	15	-1.56	0.13
	Post-test	16	17.37	4.04	8	22			

As seen in Table 1, the mean scores of the experimental group students in the critical thinking test were 15.87 ($\bar{x}$ pre-test=15.87) before taking the intelligence games course and 17.37 ($\bar{x}$ post-test =17.37) after the intelligence games course. The p value was greater than 0.05 (p=0.13) and this result shows that there is no significant relationship between intelligence games and critical thinking skills (p>0.05).

The Effect of Demographic Characteristics of The Students Taking Intelligence Games Course on Critical Thinking Skills

Demographic data of the students who took the intelligence games course is given in the table below

Table 2.

Demographic Data of Students

Demographic Data		f	%
Gender	Girl	14	87.5
	Boy	2	12.5
Mother's Education Level	Elementary	7	43.8
	High School	5	31.3
	University	3	18.8
	Post-graduate	0	0
	None	1	6.3

Table 2 Continuing

Father's Education Level	Elementary	5	31.3
	High School	5	31.3
	University	6	37.5
	Post-graduate	0	0
	None	0	0
Liking Science Class	Likes	16	100
	Don't Like	0	0

The variables of gender and liking science class among the data collected with the demographic characteristics information form were not subjected to analysis since they did not show significant differences as can be seen in the table. The results of the analysis according to mother and father education levels are given below.

The Effect of Mother's Education Level of The Students Taking Intelligence Games Course on Critical Thinking Skills

The critical thinking test values of the experimental group students according to their mother's education level are given in Table 3, and the results of the ANOVA test for the effect of mother's education level on their critical thinking skills are given in Table 4.

Table 3.

Critical Thinking Scale Posttest Scores According to Mother's Education Level

Mother's Education Level	Critical Thinking Skill Test		
	N	x̄	SS
Elementary	7	15.28	4.88
High School	5	17.8	2.38
University	3	20.33	2.08
None	1	21.00	.

According to Table 3, the critical thinking skill test averages of the students who took the intelligence games course were 15.28 (x̄=15.28) for 7 students whose mothers graduated from primary school, 17.8 (x̄=17.80) for 5 students who graduated from high school, 20.33 (x̄=20.33) for 3 students who graduated from university, and 21 (x̄=21) for 1 student who did not graduate from any school.

Table 4.

Anova Test Results for the Effect of Mother's Education Status on Critical Thinking Skills of The Students Taking Intelligence Games Lessons

Source of Variance	Sum of Squares	sd	Average of Squares	f	p
Intergroup	70.85	3	23.61	1.62	0.23
Intragroup	174.89	12	14.57		
Sum	245.75	15			

When Table 4 is examined, it is seen that there is no significant relationship between the critical thinking skills of the students who took the intelligence games course and their mother's education level ($p>0.05$).

The Effect of Father's Education Level on Critical Thinking Skills of The Students Taking Intelligence Games Course

The critical thinking test values of the experimental group students according to their fathers' education levels are given in Table 5, and the results of the Anova test for the effect of fathers' education levels on their critical thinking skills are given in Table 6.

Table 5.

Critical thinking scale post-test scores according to father's education level

Father's Education Level	Critical Thinking Skill Test		
	N	x̄	SS
Elementary	5	14.4	5.41
High School	5	19.6	0.89
University	6	18	3.2

Table 5 shows that the mean critical thinking skills test scores of the students who took the intelligence games course were 14.4 ($\bar{x}$= 14.4) for 5 students whose fathers graduated from primary school, 19.6 ($\bar{x}$= 19.6) for 5 students who graduated from high school, and 18 ($\bar{x}$= 18) for 6 students who graduated from university.

Table 6.

Anova test results for the effect of father's education status on the critical thinking skills of the students taking the intelligence games course.

Source of Variance	Sum of Squares	sd	Average of Squares	f	p
Intergroup	71.35	2	35.67	2.65	0.10
Intragroup	174.4	13	13.41		
Sum	245.75	15			

When Table 6 is examined, it is seen that there is no significant relationship between the father's education level and critical thinking skills of the students who took the intelligence games course ($p>0.05$).

The Effect of Intelligence Games Activities On The Science Course

In order to determine the effect of intelligence games on the science course, interviews consisting of 5 questions were conducted with the students at the end of the intelligence games course. By performing content analysis, the answers given were divided into themes and codes.

Student Opinions on the Question of "Do you think that intelligence games contribute to your success in science course? If yes, why? If no, why?"

Eight of the 14 students interviewed (S1, S3, S4, S5, S8, S10, S12, S14) stated that intelligence games contributed positively to their achievement in the science course; five students (S6, S7, S9, S11, S13) stated that intelligence games had no effect on their achievement in the science course; and one student (S2) was undecided on this issue.

Table 7.

Themes and Codes Related to the Question "Do you think that Intelligence Games contribute to your success in Science Course? If yes, why? If no, why?"

Theme	Code	f	%	Student
Cognitive Skills	Logical deduction	2	12.5	S1, S5
	Practical thinking	1	6.25	S3
	Foresight	2	12.5	S4, S14
	Inquiry	1	6.25	S8
	Making the Right Decision	1	6.25	S8
	Commenting	1	6.25	S12
Ability to solve questions	Speed	1	6.25	S1
	Attention	1	6.25	S2
	Inferring	1	6.25	S4
	Understanding correctly	2	12.5	S10, S3
	Making transaction	1	6.25	S14

Table 7 Continuing

Intelligence Games	Entertainment	2	12.5	S2, S9
Science	Academic	4	25	S2, S7, S9, S11

In Table 7, it is seen that students who think that intelligence games contribute to their success in science courses generally state that intelligence games are effective in the development of their cognitive skills and question solving skills. Some student responses on this topic are as follows:

S3: *"...it made me understand the questions easier",*

S4: *"It is necessary to be foresighted because it is necessary to predict the opponent's next move",*

S10: *"...it helped me understand what I read",*

S14: *"Being foresighted can be used in science lessons",*

The students who thought that intelligence games did not contribute to their success in science course emphasized the fun aspect of intelligence games and the academic aspect of science. Some student responses on this subject are as follows:

S6: *"It can contribute more to the mathematics course instead of the science course".*

S13: *"... Their fields are distinct from one another. I cannot find a common feature",*

Student Opinions on the Question "In Which Subject of Science Course, Do You Think Intelligence Games Increase Your Success and Why?"

Each student answered this question according to the subject they learned at their own grade level. Student opinions are presented in Table 8.

Table 8.

Table of Subjects for the Question "In which subject of the Science Course do you think that Intelligence Games increase your success?"

Class Level	Topics	f	%	Student
6th grade	Unit 1: Solar System and Eclipses (Solar and Lunar Eclipses)	1	6.66	S4
	Unit 2: Systems in Our Body (Circulatory System)	1	6.66	S2
	Unit 3: Force and Motion (Constant Speed Motion)	1	6.66	S14
	Unit 4: Matter and Heat (Density)	1	6.66	S14
	Unit 7: Transmission of Electricity	1	6.66	S1
7th grade	Unit 2: Cell and Divisions (Cell)	2	13.32	S7, S13
	Unit 3: Force and Energy (The Relationship of Force, Work and Energy)	1	6.66	S12
	Unit 4: Pure Substances and Mixtures (Granular Structure of Matter)	4	26.64	S5, S7, S8, S11
	Unit 7: Electrical Circuits (Ways Light Bulbs Are Connected)	3	19.98	S6, S10, S13

Table 8 shows that students in the sixth and seventh grades naturally stated that intelligence games helped them succeed in various science subjects in accordance with the subjects they learned at their own grade level. The following are some examples of student responses to this topic:

S2: *"It had an effect in the systems unit, especially on the circulatory system. It made me pay attention to small details",*

S7: *"...it helped me memorize the elements",*

S9: *"It had an effect in general, but I cannot choose a specific topic".*

Table 9.

Themes and Codes Table for the Question of "In which subject of the Science Course do you think that Intelligence Games increase your success and why?"

Theme	Code	f	%	Student
Cognitive Skills	Analytical thinking	1	7.14	S1
	Attention	2	14.28	S2, S8
	Problem solving	1	7.14	S3
	Decomposing	2	14.28	S3, S10
	Establish a cause-and-effect relationship	1	7.14	S4
	Reading comprehension	1	7.14	S5
	Focusing	1	7.14	S8
	Memory	2	14.28	S7, S11
Mathematical skills	Making a transaction	2	14.28	S13, S14
Visual Intelligence	Visual perception	1	7.14	S12

According to Table 9, students thought that some cognitive and mathematical skills and visual perception improved with intelligence games. Some of the students' opinions on this subject are as follows:

S4: *"Since a cause-effect relationship has been established, I need to predict the opponent's move",*

S5: *"I understand better what is asked of me in the questions",*

S7: *"It may have helped me memorize organelles and elements. It improved my memory",*

S12: *"On work and energy. Since there are visual questions on this subject, I think intelligence games are helpful".*

S14: *"The subject of Electricity. Since there are numbers, transactions and placing light bulbs in their places",*

Student Opinions Regarding the Question of "Which Feature of Intelligence Games Do You Think Has Affected Your Success in Science Lesson? Explain."

The students were asked which features of intelligence games had an effect on achievement in the science course, and the answers were divided into themes and codes by content analysis and the findings are given in Table 10.

Table 10.

Table of Themes and Codes for the Question of "In your opinion, which feature of brain teasers affected your success in science course? Explain."

Theme	Code	f	%	Student
Cognitive Skills	Quick thinking	4	22.22	S1, S5, S9, S10
	Decision making	1	5.55	S1
	Logical inference	2	11.11	S3, S9
	Attention	2	11.11	S2, S8
	Memory	6	33.33	S4, S6, S7, S11, S12, S13
	Inquiring	1	5.55	S8
	Focusing	1	5.55	S10
Mathematical Skills	Making a transaction	1	5.55	S14

When Table 10 is examined, it is seen that students mainly think that "memory" and "memorization" skills developed through intelligence games are effective in their success in science courses. The second most common response is "quick thinking". The students who have given this answer are mostly 7th

grade students. The students stated that they accelerated over time while giving their answers in the trials they took. They said that these gains would contribute to the High School Entrance Examination they would take in the 8th grade.

Student Opinions on the Question of "Do you think brain teasers are necessary to be successful in science course?"

The answers given by the students to this question were analyzed and summarized in Table 11.

Table 11.

Student Opinion Table for the Question "Do You Think Intelligence Games are Necessary to Succeed in Science Course?"

Opinion	f	%	Student
Necessary	5	35.71	S1, S3, S6, S8, S10
A little necessary	3	21.42	S2, S5, S9
Not required	6	42.85	S4, S7, S11, S12, S13, S14

According to Table 11, the opinions of some students who think that intelligence games are necessary to be successful in science courses are as follows:

S1: *"Logical thinking and quick decision-making can be gained through intelligence games"*,

S3: *"It helped me to solve questions"*,

S10: *"It improved my memory"*.

Student opinions who think that it is a little necessary:

S2: *"It is not necessary in all subjects"*,

S5: *"...maybe we can understand the subjects better"*,

S9: *"It can contribute to success. Focusing provides fast and logical thinking"*.

The opinions of some students who think that intelligence games are not necessary to be successful in science are as follows:

S4: *"There are no concepts related to science in intelligence games"*,

S7: *"I don't think intelligence games are related to science, they may be more related to math or Turkish lessons"*,

S13: *"...two different fields"*.

Student Opinions on the Question of "Would you like to have intelligence games in the science course and why?"

The opinions of some of the 12 students who answered this question as "Yes, I would like to" are as follows:

S1: *"Acquisitions in science is in mutual interaction with quick thinking, visual perception and memory in intelligence games"*,

S7: *"I don't like science class very much, it would be very good. The class can become more fun"*,

S8: *"...I enjoy playing. It increased my focus. It provided success in my lessons. It will contribute to this lesson too"*,

S10: *"It becomes more memorable"*,

S13: *"I think that the numerical part of our brain develops with brain teasers. Science is a numerical course too, so it can be useful"*.

Conclusion and Discussion

Bottino et al., (2007) stated that the intelligence games course has significant effects on problem solving and creative thinking skills; Ott and Pozzi (2012) stated that learning activities developed with technological games can support creative thinking. Reiter, Thornton and Vennebush (2014) mentioned in their studies that the 'kendoku' game improves reasoning skills. Bottino and Ott (2006), Bottino, Ott, Tavella & Benigno (2010), Bottino, Ott & Benigno (2009) and Bottino, Ott & Tavella (2013) showed that mind games increase students' academic success in their courses and contribute to reasoning skills. But in this study, in which the effect of intelligence games on the critical thinking skills of 6th and 7th grade students and the opinions of the students participating in the study on the success of intelligence games in science course were examined, a small change occurred between the mean results of the critical thinking skill test pre-test and post-test in favor of the post-test. It was thought that the number of students in the sample group, the duration of the study, the pandemic conditions, and the fact that the course and scales were conducted remotely (via EBA, live course) were effective in this result. Intelligence games may cause the result to change when the lessons and scales are conducted face to face. The lesson hours and the number of students per student may also have an effect on this result. Different results can be achieved with more students and intelligence games lessons. However, in Savaş (2019)'s study with science teacher candidates who took an intelligence games course, it was discovered that intelligence games provided an increase in the critical thinking skills of teacher candidates.

The findings of the study showed that mother's and father's education levels did not have any effect on the critical thinking skills of the students who took the intelligence games course. Similarly, Ekinci and Aybek (2010, p. 825) and Can and Kaymakçı (2015, p. 80) reported that the education levels of mother and father did not have any effect on critical thinking tendencies. Tümkaya and Aybek (2008, pp. 393-394), on the other hand, found that father's education level had no effect on students' critical thinking skills, but mother's education level had an effect on critical thinking skills. They found that students with mothers who had higher education levels or higher had better critical thinking skills.

In this study, the majority of the students stated that intelligence games contributed positively to their success in science courses, and that their cognitive and question-solving skills increased thanks to intelligence games; especially their skills such as logical inference, farsightedness, practical thinking, questioning, correct decision-making and interpretation improved. In terms of question-solving skills, some students thought that their speed, attention, inference-making and correct comprehension skills improved. Similarly, Savaş (2019) stated that practical thinking ability emerged through intelligence games; Baki (2018) stated that students realized the importance of being careful through these games and Çalışkan (2019) stated that students can think quickly and practically thanks to intelligence games. In the interviews, the students who thought that intelligence games had no effect on their success in the science course pointed out that intelligence games are fun and science is an academic course.

The students who participated in the study and took the intelligence games course stated that intelligence games improved their cognitive and mathematical skills and visual perception, thus contributing to many subjects of science. Similarly, Yöndemli (2018) also found that students' mathematical and reasoning skills increased with intelligence games.

Within the scope of the study, the majority of the students stated that intelligence games were not necessary to be successful in the science course, but the presence of intelligence games in the science course could make the course more fun and memorable.

Recommendations

1. The study was conducted through distance education (via EBA). Since this system was new for both students and teachers, problems on the issues such as motivation and attention occurred. For this reason, the results of the study can be compared by conducting studies at which intelligence games and scales are applied face-to-face.
2. The study can be conducted with a larger sample and another age groups and the results can be compared.

3. The effect of intelligence games not only on critical thinking skills but also on different thinking skills and developmental characteristics can be investigated.
4. Quantitative research can be conducted on the effect of intelligence games on science course.
5. Research can be conducted on the effects of intelligence games not only on science but also on other courses such as mathematics and Turkish.
6. Intelligence games can be modified according to some subjects of science course and applied as in-class activities and the effect of these activities on students' achievement in science course can be investigated.

Acknowledgment

Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

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References

Baki, N. (2018). Zekâ oyunları dersinde uygulanan geometrik-mekanik oyunların öğrencilerin akademik öz yeterlik ve problem çözme becerilerine etkisi (The effect of geometric-mechanical games applied in intelligence games course on students' academic self-efficacy and problem-solving skills) [Master thesis]. *Kırıkkale University.*

Bottino, R.M., & Ott, M. (2006). Mind games, reasoning skills, and the primary school curriculum: hints from a field experiment. *Learning Media & Technology, 31*(4), 359-375.

Bottino, R. M., Ott, M., & Benigno, V. (2009). *Digital mind games: experience based reflections on design and interface features supporting the development of reasoning skills*. In Proceedings of the 3rd European Conference on game based learning (pp. 53-61).

Bottino, R. M., Ott, M., Tavella, M., & Benigno, V. (2010). *Can digital mind games be used to investigate students' reasoning abilities.* In Proceedings of the 4th ECGBL Conference on Games Based Learning Copenhagen, Denmark, Academic, Conferences, 31(10), 31-39

Bottino, R. M., Ott, M., & Tavella, M. (2013). *Investigating the relationship between school performance and the abilities to play mind games*. In Proceedings of the European conference on games based learning (pp. 6271).

Bottino, R. M., Ferlino, L., Ott, M., & Tavella, M. (2007). Developing strategic and reasoning abilities with computer games at primary school level. *Computers and Education, 49*(4), 1272-1286.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş. & Demirel, F. (2019). *Eğitimde bilimsel araştırma yöntemleri*. Pegem Akademi.

Can, Ş. & Kaymakçı, G. (2015). Öğretmen adaylarının eleştirel düşünme eğilimleri (Critical thinking tendencies of teacher candidates). *Education Sciences, 10*(2), 66-83. http://dx.doi.org/10.12739/NWSA.2015.10.2.1C0633

Çalışkan, S. H. (2019). Ortaokul zeka oyunları dersi öğretim programına ilişkin öğretmen ve öğrenci görüşleri (Teachers' and students' opinions on the middle school intelligence games course curriculum) [Master thesis]. *Hacettepe University.*

Davidson, H. A. (1949). *A short history of chess*. David Mckay Company.

Demirel, T. (2015). Zekâ oyunlarının Türkçe ve matematik derslerinde kullanılmasının ortaokul öğrencileri üzerindeki bilişsel ve duyuşsal etkilerinin değerlendirilmesi (Evaluation of the cognitive and sensual effects of using intelligence games in Turkish and mathematics lessons on middle school students). Ph.D. Thesis, Atatürk University.

Devecioğlu, Y. & Karadağ, Z. (2016). Amaç, beklenti ve öneriler bağlamında zeka oyunları dersinin değerlendirilmesi (Evaluation of intelligence games course in the context of aims, expectations and suggestions). *Journal of Bayburt Faculty of Education, 9*(1), 41-61.

Education Reform Initiative (ERG), (2008). Critical Thinking [ERG reports]. http://www.egitimreformugirisimi.org/wp-content/uploads/2017/03/Elestireldusunme_0.pdf

Eğmir, E. & Ocak, G. (2016). Eleştirel düşünme becerisini ölçmeye yönelik bir başarı testi geliştirme (Developing an achievement test to measure critical thinking skills). *Electronic Turkish Studies, 11*(19). http://dx.doi.org/10.7827/TurkishStudies.9961

Ekinci, Ö. & Aybek, B. (2010). Öğretmen adaylarının empatik ve eleştirel düşünme eğilimlerinin incelenmesi (Investigation of empathic and critical thinking tendencies of pre-service teachers). *İlköğretim Online (elektronik), 9*(2), 816-827.

Eryılmaz, S. & Uluyol, Ç. (2015). 21. yüzyıl becerileri ışığında FATİH projesi değerlendirmesi (FATIH project evaluation in the light of 21st century skills). *GEFAD/ GUJGE, 35*(2), 209-229.

Fıske, J. (1996). *İletişim çalışmalarına giriş.* (S. İrvan, Çev.). Ankara: Bilim ve Sanat Yayınları.

Güven, M. & Kürüm, D. (2004, July). Öğrenme stilleri ve eleştirel düşünme arasındaki ilişkiye genel bir bakış (An overview of the relationship between learning styles and critical thinking). III. National Educational Sciences Congress, Malatya, Türkiye.

Kurnaz, A. (2019). Eleştirel Düşünme Öğretimi Etkinlikleri Planlama-Uygulama ve Değerlendirme (Planning, Implementation and Evaluation of Critical Thinking Teaching Activities). Eğitim Publishing.

Metin, O. & Ünal, Ş. (2022). İçerik analizi tekniği: İletişim bilimlerinde ve sosyolojide doktora tezlerinde kullanımı. *Anadolu Üniversitesi Sosyal Bilimler Dergisi, 22*(Özel Sayı 2), 273-294.

Miles, M. B. & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage Publicatios.

Ministry of National Education (2013). Ortaokul ve imam hatip ortaokulu zekâ oyunları dersi öğretim program (Middle school and imam hatip middle school intelligence games course curriculum). Ministry of National Education (MEB) Publications.

Ministry of National Education (2016).Ortaokul ve imam hatip ortaokulu zeka oyunları 5, 6, 7 ve 8. sınıflar öğretmenler için öğretim materyali (Middle school and imam hatip middle school intelligence games 5th, 6th, 7th and 8th grades teaching material for teachers). Ministry of National Education (MEB) Publications.

Ministry of National Education, (2018*).* Fen bilimleri dersi öğretim programı (ilkokul ve ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar)(Science curriculum (primary and secondary school grades 3, 4, 5, 6, 7 and 8). Ministry of National Education (MEB) Publications.

Ott, M., & Pozzi, F. (2012). Digital games as creativity enablers for children. *Behaviour and Information Technology, 31*(10). 111-119.

Öner, K. & Dindar, S. (2018, 15 November). Mangala oyunu belgesel (Mangala game documentary)[Video].Youtube. https://www.youtube.com/watch?v=iVE6KCToQ88&ab_channel=HTSt%C3%BCdyo

Reiter, H. B., Thornton, J., & Vennebush, G. P. (2014). Using KenKen to build reasoning skills. *Mathematics Teacher, 107*(5), 341-347.

Savaş, M. A. (2019). Zeka oyunları eğitiminin fen bilimleri öğretmen adaylarının eleştirel düşünme becerileri üzerine etkisi (Determination of intelligence games effect on critical thinking skills of science teacher candidates) [Master thesis]. *Bartın University.*

Şenşekerci, E. & Bilgin, A. (2008). Eleştirel düşünme ve öğretimi (Critical thinking and its teaching). *U.U. Faculty of Arts and Sciences Journal of Social Sciences, 9*(14), 15-43.

Tümkaya, S. & Aybek, B. (2008). Üniversite öğrencilerinin eleştirel düşünme eğilimlerinin sosyo-demografik özellikleri açısından incelenmesi (Investigation of critical thinking tendencies of university students in terms of socio-demographic characteristics). *Ç.U. Journal of Social Sciences Institute. 17*(2), 387-402.

Yıldırım, A. & Şimşek, H. (2016). *Sosyal bilimlerde nitel araştırma yöntemleri*. Seçkin Yayınları.

Yöndemli, E. N. (2018). Zekâ oyunlarının (strateji ve geometri) ortaokul düzeyindeki öğrencilerde matematiksel muhakeme yeteneğine ve matematik dersinde gösterilen çabaya etkisi (The effect of intelligence games (strategy and geometry) on mathematical reasoning ability and effort in mathematics course in middle school students) [Master thesis]. *Kırıkkale University.*

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The Awareness of Special Education Teachers about Comprehensive Sex Education

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Abstract

Comprehensive sex education aims to equip individuals with relevant knowledge, skills, attitudes and values, assist them in the establishment of adequate social and sexual relationships, and maximize their awareness about decision-making and their rights. It was reported in the literature that individuals with autism spectrum disorder (ASD) are one of the disability groups that require sex education. It was emphasized that teachers play a key role in sex education. The present descriptive study aimed to determine the knowledge and experience levels, and professional development requirements of the teachers who instruct individuals with ASD in comprehensive sex education. The study was conducted with 200 volunteering teachers, and the study data were collected with a survey form. The study findings indicated that only 10% of the teachers instructed sex education to individuals with ASD, and the teachers did not have adequate knowledge on comprehensive sex education content. They focused on the biological dimension of comprehensive sex education, and they did not instruct the content associated with relationship, rights, culture, and skills that ensure the health and well-being of the individuals. The findings are discussed based on the previous studies, and practical recommendations and suggestions for further research are presented.

Keywords: Comprehensive sex education, autism spectrum disorders, teachers, sexuality, descriptive research

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Introduction

Comprehensive sex education could allow the individuals to acquire accurate, scientific and age-appropriate knowledge on sexuality and it is an educational field that includes the understanding of the human body, emotional attachment, and love, sex, gender, sexual identity, sexual orientation, sexual intimacy and reproduction, and should be systematically available from early childhood [United Nations Educational, Scientific and Cultural Organization (UNESCO), 2018; Pan American Health Organization (PAHO)/ World Health Organization (WHO), 2000; 2006]. To provide comprehensive and healthy sex education, various organizations have developed guides that included knowledge on the content of sex education for corresponding age groups. The first guide, International Technical Guidance on Sex education was published in 2009 by UNESCO in collaboration with the Joint United Nations Program on HIV and AIDS (UNAIDS), the United Nations Population Fund (UNFPA), UNICEF and WHO. The guide included five key concepts, values, attitudes and skills, culture, society and human rights, human development, sexual behavior, and sexual and reproductive health. The scope and complexity of the key content were determined for four age ranges (5-8, 9-12, 12-15, and 15-18+). This guide has been employed as an evidence-based educational resource based on universal practices that allows the adaptation of local context in these practices. Later, a new guide was published based on the curricula adopted by 12 countries (Botswana, Ethiopia, Indonesia, Jamaica, Kenya, Namibia, Nigeria, South Africa, Tanzania, Thailand, USA, and Zambia). The guide updated the key concepts for 5-18+ years old individuals (UNESCO, 2018), and the five key concepts were expanded to eight key concepts for the same age ranges. These eight key concepts and related content are presented in Table 1.

Table 1.

Key Concepts In Comprehensive Sex education (UNESCO, 2018)

Key concept	Topics
Relationships	Families
	Friendship, love and romantic relationships
	Tolerance, inclusion and respect
	Long-term commitments and parenting
Values, Rights, Culture and Sexuality	Values and sexuality
	Human rights and sexuality
	Culture, society and sexuality
Understanding Gender	The Social Construction of Gender and Gender Norms
	Gender Equality, Stereotypes and Bias
	Gender-based Violence
Violence and Staying Safe	Violence
	Consent, Privacy and Bodily Integrity
	Safe use of Information and Communication Technologies
Skills for Health and Well-being	Norms and Peer Influence on Sexual Behavior
	Decision-making
	Communication, Refusal and Negotiation Skills
	Media Literacy and Sexuality
	Finding Help and Support
The Human Body and Development	Sexual and Reproductive Anatomy and Physiology
	Reproduction
	Puberty
	Body Image
Sexuality and Sexual Behavior	Sex, Sexuality and the Sexual Life Cycle
	Sexual Behavior and Sexual Response
Sexual and Reproductive Health	Pregnancy and Pregnancy Prevention
	HIV and AIDS Stigma, Care, Treatment and Support
	Understanding, Recognizing and Reducing the Risk of STIs, including HIV

The final guide developed by the UNESCO (2018) stated that the main objective of comprehensive sex education was to ensure that individuals are equipped with related knowledge, skills, attitudes and values, support them to establish adequate social and sexual relationships, improve their decision-making skills, realize the impact of these decisions on their well-being, and maximize their awareness about their rights. Sex education studies conducted based on the guide demonstrated that it

strengthened the communication skills, improved the self-efficacy of the participants, and positively affected their behavior (Constantine et al., 2015b; Rohrbach et al., 2015; UNESCO, 2016). However, it was also reported that it did not improve the likelihood of participation in sexual activities and exhibition of risky behavior (Fonner, Armstrong, Kennedy, O'Reilly and Sweat, 2014; Shepherd et al., 2010; UNESCO, 2009). For these positive effects, both guides recommended the development of a curriculum that would include comprehensive sex education learning objectives both at school and out-of-school.

Although the guide content is instructive for the development of the curricula, it should be noted that the guide does not include the intervention methods required in the training. Furthermore, the literature also does not mention clear intervention methods; however, research demonstrated that effective interventions would have positive effects on knowledge, attitudes and behavior in various environments (Fonner et al., 2014; Kirby, Laris and Rolleri, 2006), and help the generalization of the acquired knowledge and behavior (Gardner, Montgomery and Knerr, 2016; Leijten, Melendez-Torres, Knerr and Gardner, 2016). The literature emphasized the significance of comprehensive sex education, inclusion of the the above-mentioned topics in the curricula, and the right of the individuals with disabilities for comprehensive sex education, similar to other individuals (Daymon and Holloway, 2011; UNESCO, 2018). However, it was frequently underlined that the curricula should be adapted for individuals with disabilities. Individuals with autism spectrum disorder (ASD) were also emphasized among the groups that require sex education (Travers and Tincani, 2010).

ASD is a neurodevelopmental disorder characterized by communication and social interaction problems and repetitive and limited behavior, activities, and interests (American Psychological Association [APA], 2013). Due to specific diagnostic characteristics, individuals with ASD could experience limitations in the comprehension of the changes and related needs associated with developmental periods and adequate expression of these needs (Travers and Tincani, 2010). This could lead to the perception of individuals with ASD as immature or sexually passive individuals by the society and experts, leading to the exclusion of these individuals from sex education programs (Stokes and Kaur, 2005). However, previous studies reported that it was essential to include individuals with ASD in comprehensive sex education programs due to their diagnosis (Ogur, Olcay and Baloglu, 2023; Travers and Tincani, 2010), and their exclusion from sex education would lead to inadequate circumstances in the meeting of these needs (Pecora et al., 2020), and prevent the development of skills that could protect the individuals with ASD in case of security threats such as sexual abuse (Ballan and Freyer, 2017; Hannah and Stagg, 2016; Ogur, 2023).

Although studies emphasized that comprehensive sex education was essential for individuals with ASD, these individuals are less included in comprehensive sex education that were tailored to their developmental requirements instead of those of the individuals with typical development, and their access to sexual health sources was quite limited (Mackin, Loew, Gonzalez, Tykol and Christensen 2016; Stokes et al., 2007; WHO, 2020). One of the important reasons for this was that the teachers with a key role in providing the education were not aware of the sex education needs of individuals with ASD, and even when they were aware, they did not have adequate knowledge and skills on the comprehensive sex education content and related methods and techniques (Ogur et al., 2023; Rodriguez, 1995). In a study conducted with teachers in 11 countries who worked with individuals with special needs, 56.2% of the teachers stated that they did not include any sex education content in their syllabi for students with special needs at any stage in their professional life, and the included content was limited to certain areas and the relevant country. They were under the influence of their cultural and religious stereotypes (i.e., teachers in Saudi Arabia considered comprehensive sex education as a means of protection against the dangers associated with illegal sexual behavior), they were unaware of sex education content, and they did not have adequate knowledge and skills to instruct comprehensive sex education. Furthermore, it was reported that a significant number of teachers argued that only individuals diagnosed with mild intellectual disabilities should attend sex education (Ogur et al., 2023). In parallel with this finding, research studies regarding teachers working with individuals with intellectual disabilities often focus on inappropriate sexual behaviors (Akdemir, 2024), sexuality (Girgin-Büyükbayraktar et al., 2017; Maia et al., 2015), relationships, good practices and methods (Brown et al., 2024; Bourke et al., 2024), attitudes (Fu et al., 2024; Lonescu et al., 2019;

Raj & Chavhan, 2023), challenges (Girgin-Büyükbayraktar et al., 2017), health and safety (Jeyachandran et al., 2024), and experiences and perspectives (Strnadová et al., 2022). In addition, studies have shown that teachers generally teach specific rules (Frawley & Wilson, 2016), sexual abuse (Johnston, 2010; Ray et al, 2004; Sevlever, 2013), HIV and AIDS prevention (Groce, 2013; Hamilton, 2009; Rohleder & Swartz, 2009), hygiene (Girgin-Büyükbayraktar et al., 2017), self-care skills (Mattson et al., 2016; Richman et al., 1984; Veazey et al., 2016), gender-appropriate dressing and behavior skills (Akdemir, 2024; Girgin-Büyükbayraktar et al., 2017), masturbation (Akdemir, 2024; Gill, 2012; Walsh, 2000), and interpersonal skills such as going on a date or establishing an emotional relationship with others (Maia et al., 2015). However, teachers usually neglect the instruction of communication, conscious choices, and awareness of the values and rights (McCabe & Schreck, 2009).

Studies conducted with teachers demonstrated that teachers did not have adequate knowledge of the related instructional methods and techniques and employed instructional strategies such as video modeling (Ariyanti and Royanto, 2017), modeling (Bollman, Davis and Zarcone, 2009; Wells, Clark and Sarno, 2012), social stories (Ariyanti and Royanto, 2017; Stankova and Trajkovski, 2021), role play (Bollman et al., 2009; Hayashi, Arakida, and Ohashi, 2011), discussion (Hayashi et al., 2011), behavioral skill training, traditional instruction, and drama (Ogur et al., 2023). Certain studies emphasized that scientific practices should be employed to present sex education content (Brown et al., 2024). Ogur et al. (2023) observed that teachers adopted measures to reduce or eliminate negative behavior, such as time-out, ignoring, and response interruption/redirection.

In conclusion, the literature evidenced that (a) comprehensive sex education guides included diverse content for 5-18+ years old individuals and it was every individual's right to access comprehensive sex education (SIECUS, 2004; UNESCO, 2009; UNESCO 2016; UNESCO, 2018), (b) individuals with ASD required comprehensive sex education and related content more than individuals with typical development due to their diagnostic traits; however, they experienced difficulties to access and were less included in comprehensive sex education (Mackin et al., 2016; Stokes et al., 2007; WHO, 2020), (c) the inclusion of the individuals with ASD in comprehensive sex education would improve their communication and social skills and positive behavior, and reduce negative behavior (Pecora et al., 2020), (d) the limitation of the individuals with ASD to sex education could be due to the inability of their teachers to recognize their needs, (e) and even when these needs were recognized, teachers had limited knowledge and skills on sex education and related instructional methods and techniques (Ogur et al., 2023; Rodriguez, 1995). However, the literature lacks studies on the knowledge, experience, and professional development requirements of teachers who instruct comprehensive sex education to individuals with ASD. However, such research will help raise the awareness of the teachers about comprehensive sex education requirements for individuals with ASD in early childhood and contribute to the determination of the goals and practices in the classroom. This will lead to the inclusion of individuals with ASD in education and equal opportunities in education, which are their legal rights. The present study aimed to investigate the status of teachers who work with individuals with ASD on comprehensive sex education, the comprehensive sex education content they instruct, the methods and techniques they employ and their competence in the instruction of comprehensive sex education, the methods they use to evaluate the impact of the education on individuals with ASD, their participation in professional development activities, and their needs. Thus, the following research problems were determined.

1. What are the views of teachers who instruct comprehensive sex education to individuals with ASD on the instruction of comprehensive sex education to these individuals?
2. What are the experiences of teachers who instruct comprehensive sex education to individuals with ASD on comprehensive sex education (the context, individual traits, instructional methods, and techniques)?
3. What are the views of teachers who instruct comprehensive sex education to individuals with ASD on their competence and the impact of comprehensive sex education on these individuals?

4. Do the teachers who instruct comprehensive sex education to individuals with ASD participate in professional development activities, and what are the associated needs?

Method

This section discusses the research model, participants, development of the data collection instrument, and data collection.

The Research Design

The present study, designed to determine the knowledge, experiences, and professional development requirements of teachers who instruct comprehensive sex education to individuals with ASD, is descriptive research. Descriptive research aims to describe a case, situation, event, or sample comprehensively. These studies investigate an existing case, relationships, processes, and trends (Hocaoğlu and Baysal, 2019). In descriptive research, data is collected with surveys, observations, or interviews (Büyüköztürk et al., 2019). The present study data were collected using a survey form. Surveys are data collection tools that include several questions that aim to determine individuals' views, ideas, and attitudes about a topic or a case. Surveys could include open-ended or close-ended questions (Büyüköztürk et al., 2019). The survey developed in the present study included both open-ended and close-ended questions.

Participants

Hacettepe University Ethics Commission approved the current study. Since the study aimed to collect comprehensive data from individuals who meet certain criteria, the participants were assigned with criterion sampling, a purposive sampling method (Johnson and Christensen, 2014). Inclusion criteria were: (a) experience with individuals with ASD and (b) employment as a special education teacher. Participants who met these criteria were contacted online. The author contacted the administrators of the schools and institutions attended by individuals with ASD in seven geographical regions in Turkey. They were informed about the study and asked to communicate the hyperlink to the survey form to the special education teachers in their schools. Furthermore, the teachers were informed about the research, and the hyperlink to the survey form was sent to their e-mails and WhatsApp groups. The study was conducted with 200 volunteer participants. Participant demographics are presented in Table 2.

Table 2.
Participant Demographics

Age			Seniority			School Type			Region of employment		
	f	%		f	%		f	%		f	%
20-29	69	%34.5	1-5	81	%40.5	Special education kindergarten	18	%9	Central Anatolia	29	%14.5
30-39	99	%49.5	6-11	76	% 38	Private kindergarten	1	%0.5	Southeastern Anatolia	49	%24.5
40-49	25	%12.5	12-17	28	%14	Special education school (1st level)	16	%8	Eastern Anatolia	23	%11.5
50-59	7	%3.5	18-23	4	%2	Special education school (2nd level)	29	% 14.5	Black Sea	22	%11
			24-30	11	%5.5	Special education school (3rd level)	18	%9	Marmara	32	%16
						Special Education Vocational High School	23	%11.5	Aegean	21	%10.5
						Guidance and Research Center	16	%8	Mediterranean	21	%10.5
						Other	79	%39.5	Unknown	3	%1.5

Data Collection Instrument

The study data were collected using a structured survey form. The steps specified by Taherdoost (2021) were adopted in the development of the survey: (a) Determination of the required data, (b)

determination of the method to implement the survey, (c) determination of the question types, (d) development of the questions, (e) organization of the questions, (f) pre-tests, (g) finalization of the survey. A literature review was conducted to determine the required information, and it was decided to conduct the survey online to reach more participants in various regions. Both open- and close-ended questions were included in the survey to ensure comprehensive data collection. The questions were organized based on the topical content and submitted for review by three experts in ASD and sex education. Lawshe content validity ratio was calculated with the following formula (Sencan, 2005):

$$\text{Content Validity} = \frac{\text{ne} - \frac{\text{N}}{2}}{\frac{\text{N}}{2}} \qquad \text{Content Validity} = \frac{3 - \frac{3}{2}}{\frac{3}{2}}$$

ne = Number of agreements across the raters N = Total number of raters

Thus, the content validity ratio was 1.00, indicating excellent content validity. The survey form, revised based on the experts' recommendations, was uploaded to Google Forms for the pilot scheme. After the pilot scheme, the form was finalized. The pilot scheme is detailed below. The form included nine open-ended and 56 close-ended questions.

The study data was collected using a structured survey form. The survey included two sections. Furthermore, it included an introduction section where the study's aim, participants' expectations, and ethical principles were explained. The first section included questions on demographic variables that could affect special education teachers' ability to instruct comprehensive sex education to individuals with ASD. The second section aimed to investigate the status of the special education teachers in the instruction of comprehensive sex education to these individuals, the characteristics of target individuals and the context in which they instructed comprehensive sex education, the methods and techniques they employed in the instruction of comprehensive sex education, their views on their competence, the impact of comprehensive sex education on individuals with ASD, their professional skills, and the professional needs. Thus, the section first included open-ended questions without providing any information to determine whether the participants instructed comprehensive sex education, the content they included in the instruction, and the instructional methods and techniques they employed. Then, information was provided about the comprehensive sex education content, and close-ended questions were asked to determine whether they included each key content in instruction. The survey form was developed based on the eight key content in the comprehensive sex education guide developed by UNESCO in 2009 and revised in 2018.

Pilot Scheme

Before the study data were collected, a pilot scheme was conducted to determine the fit of the survey form. The pilot scheme was conducted with three special education teachers who had experience with individuals with ASD. Also, a semi-structured interview was conducted with pilot scheme participants, and they were asked whether the form was easy to use, whether the time to fill it out was adequate, and whether any content should be added to or removed from it. The form was finalized based on feedback from the pilot scheme.

Data Collection and Analysis

The finalized form was employed to collect the study data online. The content validity of the data collection instrument was determined to be excellent. The author contacted relevant schools and institutions to communicate the link for the survey on Google Forms. Descriptive analysis was conducted to analyze the qualitative study data. A descriptive analysis framework was developed, and the data were analyzed based on the thematic framework. Thus, the data were first transferred to an Excel file. Then, adequate participant responses were coded to achieve the thematic framework based on similar codes (Yıldırım and Şimşek, 2016). Both qualitative and quantitative data are reported in frequencies and percentages.

In the process of preparing the questionnaire, it was not allowed to move to the next page without marking all the questions on one page; thus, it was ensured that all questions were filled in completely and accurately. In addition, the transcripts obtained through Google Forms were analysed separately by two researchers and the analyses continued until 100% consistency was achieved by the researchers. In addition, the data of 25 randomly selected participants were shared with an independent researcher who continues her postgraduate education in the field of special education; the independent researcher was expected to analyse the data by creating a coding key for the open-ended interview questions. Subsequently, the analyses of the researchers and the independent researcher for each question were examined one by one and compared. The same answers were coded as 'Agreement' and different answers were codded as 'Disagreement'. Miles and Huberman's (1994) formula 'Agreement / (Agreement + Disagreement) X100' was used to calculate the inter-coder reliability data and the inter-coder reliability was found to be 100%.

Findings

In this section, the comprehensive sex education instructed by the teachers to individuals with ASD, the comprehensive sex education content they taught, the instructional methods and techniques they employed, their views on their competence in the instruction of comprehensive sex education, the impact of the education on individuals with ASD, their participation in professional development activities, and their needs are discussed.

Participant Views on The Instruction of Comprehensive Sexuality to Individuals with ASD

In the study, participants were asked whether they provided comprehensive sex education to any students with ASD during their tenure. Only 10% of the participants stated that they provided comprehensive sex education to individuals with ASD, while 90% stated that they did not. Furthermore, participants who indicated that they offered comprehensive sex education to individuals with ASD were asked about the instructional content and the methods and techniques they adopted. Tables 3 and 5 present tabulated responses to the open-ended questions in frequencies. Tables 4, 6, and 7 present responses to all close-ended questions.

Table 3.

Sexuality Instruction to Individuals with ASD

Sex education			Content			Methods and Techniques			
	f	*%*		*f*	*%*			*f*	*%*
Yes	20	%10	Recognition of private parts	3	%27.27	Instruction Methods and Techniques	Applied behavioral analysis interventions	3	%15.7
No	180	%90	Privacy education	2	%18.18		Errorless teaching	3	%15.78
			Masturbation	1	%9.09		Video model instruction	2	%10.52
			Circle of trust	1	%9.09		Direct instruction	2	%10.52
			Changing peds	1	%9.09		Modeling	2	%10.52
			Good touch and bad touch	1	%9.09		Traditional instruction	1	%5.26
			Gender awareness	1	%9.09		Verbal prompts	1	%5.26
			Protection from sexual abuse	1	%9.09		Social stories	1	%5.26
							Cycle of trust	1	%5.26
						Material	3D visuals	2	%10.52
							Visual material	1	%5.26

Three out of the six participants who instructed sex education to individuals with ASD stated that they instructed in content such as recognition of private parts (27.27%), and two out of them privacy education (18.18%). They generally employed methods and techniques such as applied behavioral

analysis interventions, errorless teaching, modeling, and direct instruction. Three participants (15.78%) indicated materials among the methods and techniques they employed in comprehensive sex education.

Comprehensive Sex education Experiences

The findings on the instruction of comprehensive sex education content and the ages and traits of the individuals with ASD who were instructed are presented in Table 4. As seen in Table 4, 81%-98% of the participants reported that they did not instruct comprehensive sex education to individuals with ASD. In contrast, 2%-19% reported that they instructed at least one comprehensive sex education content to these individuals. Participants stated that they predominantly instructed gender awareness (19%), and only a few instructed sexuality and reproductive health (2%) to individuals with ASD. The participants who instructed comprehensive sex education content had experience with four age groups of individuals with ASD. It was observed that the participants mainly instructed sexuality and reproductive health content (33.33%), and only 17.14% instructed values, rights, culture, and sexuality content to 5-8-year-old individuals. They did not instruct sexuality and reproductive health content to 9-12-year-old individuals, while a significant number instructed relationship content (38.09%) to these students. They instructed the relationship content the least to 12-15-year-old individuals (21.42%), while they predominantly instructed values, rights, culture, and sexuality (42.85%). The participants instructed values, rights, culture, and sexuality content the least to 15-18+ years old individuals (11.42%), while they mainly instructed sexual and reproductive health content (33.33%) to this group.

As seen in Table 4, the participants instructed comprehensive sex education to individuals with ASD and with all degrees of requirement. Only a few (13.33%) instructed values, rights, culture, and sexuality content to individuals with ASD who required first-level assistance, while a higher number of participants instructed violence and safety content (23.18%). A few participants instructed values, rights, culture, and sexuality content (6.66%) to individuals with ASD who required second-level assistance, and a higher number of participants instructed sexuality and reproductive health content (20%) to this group. A few participants instructed values, rights, culture, and sexuality content (4.44%), and a higher number instructed sexuality and sexual behavior content (18.18%) to individuals with ASD who required third-level assistance. They did not instruct sexual and reproductive health content to individuals with ASD without a concomitant disability; they mainly instructed gender awareness (9.58%) to these individuals. A few participants instructed sexual and reproductive health content to individuals with mild intellectual disability and ASD (20%), while most (40%) instructed values, rights, culture, and sexuality content. Only a few participants instructed sexuality and sexual behavior content (12.12%) to individuals with moderate to severe intellectual disability and ASD, and they mainly instructed relationship content (22.44%). It was determined that a few participants instructed relationship content to individuals with auditory, visual, or physical disabilities and ASD (4.08%), while the most instructed sexuality and reproductive health content (10%).

Participants were asked about the methods and techniques they employed in the instruction of comprehensive sex education. Participants' responses were analyzed in four categories: instruction methods and techniques, instruction principles, instruction materials, and settings (Table 5).

As seen in Table 5, the participants who reported that they instructed comprehensive sex education preferred conventional instruction (range = 8.10%-33.33%). The most frequently employed methods and techniques included modeling (range = 6.97%-20%), direct instruction (range = 9.30%-15.51%), and video model instruction (range = 2.38%-14.28%), while the least employed methods were learning by doing (1.72%), discrete trial training (2.32%), and computer-assisted instruction (3.44%).

Table 4.

The Comprehensive Sex education Content Instructed by the Participants and the Characteristics of the Students

		Relationships		Values, rights, culture and sexuality		Gender awareness		Violence and safety		Health and well-being skills		Human body and development		Sexuality and sexual behavior		Sexuality and reproductive health	
		f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Instruction	Yes	28	%14	24	%12	38	%19	35	%17.5	18	%9	%13.5	27	13	%6.5	4	%2
	No	172	%86	176	%88	162	%81	165	%82.5	182	%91	%86.5	173	187	%93.5	196	%98
Age	5-8 age group	9	%21.42	6	%17.14	16	%26.22	15	%25.42	8	%25	%21.42	9	5	%19.23	2	%33.33
	9-12 age group	16	%38.09	10	%28.57	18	% 29.50	19	% 32.20	7	% 21.87	%33.33	14	7	%26.92	0	%0
	12-15 age group	9	%21.42	15	%42.85	16	%26.22	13	% 22.03	9	%28.12	% 26.19	11	6	%23.07	2	%33.33
	15-18+ age group	8	%19.42	4	%11.42	11	%18.03	12	% 20.33	8	%25	%19.04	8	8	% 30.76	2	%33.33
Student characteristics	1st level assistance requirement	9	%18.36	6	% 13.33	16	%21.91	16	%23.18	7	%19.44	%20.40	10	5	%15.15	2	%20
	2nd level assistance requirement	7	%14.28	3	%6.66	7	%9.58	8	%11.59	5	% 13.88	%12.24	6	4	%12.12	2	%20
	3rd level assistance requirement	6	% 12.24	2	%4.44	5	%6.84	5	%7.24	4	% 11.11	% 8.16	4	6	%18.18	1	%10
	No concomitant disability	3	%6.12	4	%8.88	7	%9.58	4	%5.79	1	% 2.77	% 8.16	4	3	%9.09	0	%0
	Mild intellectual disability + ASD	11	%22.44	18	%40	19	%26.06	21	%30.43	10	% 27.77	% 24.48	12	8	% 24.24	2	%20
	Moderate-severe intellectual disability + ASD	11	%22.44	9	%20	15	%20.54	12	% 17.39	7	%19.44	%20.40	10	4	%12.12	2	%20
	Auditory, visual, or physical disability + ASD	2	%4.08	3	%6.66	4	% 5.47	% 4.34	% 4.34	2	%5.55	%6.12	3	3	%9.09	1	%10

Table 5.

The Methods and Techniques Employed by the Participants in the Instruction of Comprehensive Sex education

		Relationships		Values, rights, culture and sexuality		Gender awareness		Violence and safety		Health and well-being skills		Human body and development		Sexuality and sexual behavior		Sexuality and reproductive health	
		f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Instruction methods and techniques	Conventional instruction	9	%20.93	8	%19.04	6	%8.10	6	%10.32	3	%10.71	7	%16.27	4	%16	2	%33.33
	Modeling	6	%13.95	4	%9.52	12	%16.21	9	%15.51	2	%7.14	6	%6.97	5	%20		
	Direct instruction	6	%13.95	5	%11.90	11	%14.86	9	%15.51	3	%10.71	4	%9.30	3	%12		
	Social stories	3	%6.97	2	%4.76	5	%6.75	1	%1.72								
	Video model instruction	3	%6.97	1	%2.38	7	%9.45	7	%12.06	4	%14.28	6	%13.95	3	%12		
	Roleplay	1	%2.32	1	%2.38	1	%1.35			1	%3.57						
	Applied behavioral analysis interventions	1	%2.32	1	%2.38	1	%1.35	2	%3.44	2	%7.14			1	%4	1	%16.66
	Errorless teaching	1	%2.32	2	%4.76	7	%9.45	3	%5.17	2	%7.14	2	%4.65	2	%8		
	Discrete trials	1	%2.32														
	Script-fading									1	%3.57						
	Incidential instruction			1	%2.38			1	%1.72	1	%3.57						
	Peer-mediated instruction					1	%1.35	1	%1.72	1	%3.57						
	Question and answer	3	%6.97	1	%2.38	2	%4.05	2	%3.44	1	%3.57			1	%4		
	Cognitive theory					1	%1.35										
	Problem-solving	1	%2.32														
	Computer-assisted instruction							2	%3.44								
	Parent-mediated instruction	2	%4.65	2	%4.76	2	%2.70	2	%3.44	2	%7.14	1	%2.32	1	%4		
	Game-based intervention							1	%1.72			1	%2.32				
	Differential reinforcement	1	%2.32														
	Learning by doing							1	%1.72								
	Chaining									1	%3.57						
Instructional principles	Based on individual differences	1	%2.32			1	%1.35	1	%1.72	1	%3.57						
	Simple to complex			1	%2.38												
	Counselor-assisted					1	%1.35	1	%1.72	1	%3.57			2	%8		
Materials																	
	Picture cards	3	%6.97	1	%2.38	6	%8.10	5	%8.61	2	%7.14	7	%16.27	3	%12	1	%16.66
	3D material					2	%2.70					3	%6.97				
	Written material			1	%2.38	2	%2.70	1	%1.72							1	%16.66
	Digitak material					1	%1.35										
	Story cards			1	%2.38												
	Interactive board			1	%2.38												
Setting	Simulation	1	%2.32			1	%1.35	1	%1.72								

Instructional Methods and Techniques

The participants employed conventional instruction (33.33%). They applied behavioral analysis interventions (16.66%) in the instruction of sexuality and reproductive health content, modeling in the instruction of sexuality and sexual behavior content (16.21%), direct instruction in violence and safety content (15.51%), social stories (6.97%) and question and answer method (6.97%) in the instruction of relationships, video model instruction (14.28%), parent-mediated instruction (7.14%), role play (3.57%), incidental instruction (3.57%), and peer-mediated instruction (3.57%) in the instruction of health and well-being skills, errorless teaching methods in the instruction of gender awareness (9.45%), game-based learning in the instruction of the human body and development and sexuality and sexual behavior (2.32%) content. Furthermore, the participants employed discrete trial instruction, problem-solving techniques, and differential reinforcement only in the instruction of relationships, script-fading and chaining only in the instruction of health and well-being skills, the cognitive theory only in the instruction of gender awareness, and learning by doing, and computer-assisted instruction only in the instruction of violence and safety.

Instructional principles

The participants who instructed comprehensive sex education content stated that they focused on individual differences during the instruction of gender awareness, violence and safety content, and health and well-being skills, and they included a counselor in the process. 2.3% of the participants stated that they were interested in the values, rights, culture and sexuality, and sexuality and sexual behavior content and adopted instruction hierarchy from simple to complex content.

Materials

Participants stated that they mainly employed picture cards (range = 2.38% - 16.66%) and written material (range = 1.72% - 16.66%) during the instruction of comprehensive sex education. They preferred picture cards in the instruction on sexual and reproductive health (16.66%), three-dimensional material in the instruction on human body and development (6.97%), written material in the instruction on sexual and reproductive health (16.66%), and the table of rules in the instruction of relationships (2.32%). Furthermore, participants employed only digital media and animations in the instruction of gender awareness, story cards, interactive boards, and puppets only in the instruction of values, rights, culture, and sexuality.

Setting

Only a few participants reported that they employed simulations in the instruction. Only a few participants stated that they employed simulations (1.35%) in the instruction of gender awareness, and others employed simulations (2.32%) in the instruction of relationships.

Comprehensive Sex education Competency of the Participants and Quality of the Education

When the participants were asked to assess their competence in the instruction of comprehensive sexual content, it was determined that they did not feel inadequate in sexuality and sexual behavior content (0%). Furthermore, they felt most inadequate in sexuality and reproductive health (25%). It was determined that the participants considered themselves moderately competent in instructing the remaining topics, except the human body and development (33.33%). Also, the participants did not feel competent in the instruction of any topic except sexuality and sexual behavior (7.69%).

The participants who reported that they taught comprehensive sex education content were asked to assess the impact of the instruction on individuals with ASD. They considered that their instruction on relationships, gender awareness, violence and safety, health and well-being skills, and sexuality and sexual behavior was not effective (0%), and they were least proficient in the instruction of sexuality and reproductive health (50%). It was determined that the participants considered themselves moderately competent at best in instructing all topics. The participants stated that instruction of sexuality and sexual behavior content (46.1%) was most effective, while values, rights, culture, and sexuality (0%) instruction was not effective. Furthermore, they considered the instruction on gender awareness (7.8%) quite compelling. In contrast, the instruction on health and well-being skills, the human body and its development, sexuality and sexual behavior, and sexuality and reproductive health

(0%) topics were considered relatively ineffective. Participant views on their competence in the instruction of comprehensive sexuality content and the impact of this instruction are presented in Table 6.

Participation in Professional Development Activities and Participant Needs

The participants attended comprehensive sex education activities at different frequencies. It was observed that 31.57% - 75% of the participants stated that they attended training on sex education, and 25% and 68.42% indicated that they did not participate in any training. Participants who attended professional development activities stated that the contents they were trained on sexuality and reproductive health (75%), sexuality and sexual behavior (69.23%), relationships (53.57%), values, rights, culture and sexuality (50%), violence and safety (37.14%), human body and development (37.03%), health and well-being skills (33.33%), and gender awareness (31.57%). Furthermore, the participants were asked whether they needed further professional development activities on comprehensive sex education. It was determined that the participants mostly (85.7%) required further professional development on relationships, violence, and safety, as well as health and well-being skills (83.3%), human body and development (81.4%), gender awareness (76.3%), values, rights, culture and sexuality (75%), sexuality and sexual behavior (53.8%). And sexual and reproductive health (50%). The participant' views on their educational level and training requirements in comprehensive sex education are presented in Table 7.

Discussion and Conclusion

The present descriptive study aimed to investigate the instruction of comprehensive sex education to individuals with ASD, the sexuality content that the teachers instructed, the methods and techniques the teachers employed in instruction, instructional competence of the teachers in comprehensive sex education, the impact of the instruction on individuals with ASD, the participation of the teachers in professional development activities, and teacher requirements. The study was conducted with 200 volunteering teachers in seven regions in Turkey. All participants were special education teachers. The participant age varied between 22 and 59 and their mean seniority was 8 years (range = 1-30 years). Participants worked with individuals with ASD at different educational levels in various institutions such as kindergartens, special education schools (levels I, II, and III), special education vocational high schools, and guidance research centers.

In the study, the participants were asked whether they instructed sexuality content to individuals with ASD during their professional lives, the comprehensive sex education content they instructed, and which instructional methods they employed. 90% of the participants stated that they did not instruct comprehensive sex education to individuals with ASD. This could be due to the fact that the participants did not receive comprehensive sex education; thus, they lacked knowledge and skills required for comprehensive sexuality instruction. Previous studies also mentioned the lack of formal teacher training on sex education (Lindsay, Bellshaw, Culross, Staines and Michie, 1992). The Turkish special education undergraduate programs lack compulsory courses on comprehensive sex education (Council of Higher Education, 2018). It could also be because individuals with ASD are considered sexually passive (Stokes and Kaur, 2005) or they could not understand sexuality (Ogur et al., 2023). Ogur et al. (2023) reported that comprehensive sex education was considered to be limited to certain age groups and students with high cognitive skills by the teachers. Furthermore, since comprehensive sex education is influenced by the beliefs, social and cultural background of the society and perceived as a taboo in certain societies (Brown and Pirtle, 2008; Christian, Stinson and Dotson, 2001; Swango-Wilson, 2008), the participants could have been reluctant in instructing sexuality.

The research findings indicated that the participants who instructed comprehensive sex education did not include topics such as relationships, values, rights, culture and sexuality, sexuality and sexual behavior, health and well-being skills, sexuality and reproductive health, but certain topics associated with the human body and development, gender awareness, and violence and safety content. Also, the study findings were consistent with the previous reports that the instructions were limited by the biological dimension of the discussed topics, and the culture, society and belief dimensions were ignored (McCabe and Schreck, 2009; Ogur et al., 2023).

Table 6.

Participant Competency in the Instruction of Comprehensive Sex education and Participant Views on the Impact of the Instruction

		Relationships		Values, rights, culture and sexuality		Gender awareness		Violence and safety		Health and well-being skills		Human body and development		Sexuality and sexual behavior		Sexuality and reproductive health	
		f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Competency	Incompetent	1	%3.57	2	%8.33	2	%5.26	3	%8.57	1	%5.55	1	%3.70	0	%0	1	%25
	Not competent	9	%32.14	7	%29.16	13	%34.21	9	%25.71	4	%22.22	6	% 22.22	1	%7.69	0	%0
	Moderately competent	14	% 50	11	%45.83	14	%36.84	13	%37.14	8	%44.44	9	%33.33	8	%61.53	2	%50
	Competent	4	%14.28	4	% 16.66	9	%23.68	10	% 28.57	5	%27.77	11	% 40.74	3	%23.07	1	%25
	Very competent	0	%0	0	%0	0	%0	0	%0	0	%0	0	%0	1	%7.69	0	%0
Instructional impact	Ineffective	0	%0	10	%41.66	0	%0	0	%0	0	%0	2	%7.40	0	%0	2	%50
	Low impact	4	%14.28	5	% 20.83	4	%10.52	7	%20	3	%16.66	2	% 7.40	1	%7.69	0	%0
	Moderate impact	13	%46.42	8	% 33.33	20	%52.63	16	%45.71	10	% 55.55	13	%48.14	6	%46.15	1	%25
	Effective	9	%32.14	0	%0	11	% 28.94	11	%31.42	5	%27.77	10	%37.03	6	%46.15	1	%25
	Very effective	2	%7.14	1	%4.16	3	%7.89	1	%2.85	0	%0	0	%0	0	%0	0	%0

Table 7.

Participation in Professional Development Activities and Further Requirements

		Relationships		Values, rights, culture and sexuality		Gender awareness		Violence and safety		Health and well-being skills		Human body and development		Sexuality and sexual behavior		Sexuality and reproductive health	
		f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Previous training on content	Yes	15	%53.57	12	%50	12	%31.57	13	%37.14	6	%33.33	10	%37.03	9	%69.23	3	%75
	No	13	%46.42	12	%50	26	%68.42	22	%62.85	12	% 66.66	17	%62.96	4	%30.76	1	%25
Training requirement	Yes	24	%85.71	18	%75	29	%76.31	30	%85.71	15	%83.33	22	%81.48	7	%53.84	2	%50

This could be due to the lack of knowledge on comprehensive sex education content. Furthermore, misrecognition of the significance of these topics for individuals with ASD could be another reason. The significance of comprehensive sex education for all individuals was emphasized in the literature [CRPD (Convention on the rights of persons with disabilities) 2016; UNESCO, 2018]. The said education should be instructed systematically to individuals who cannot express their needs such as individuals with ASD (Ogur et al., 2023). Furthermore, the seniority of more than half of the participants (f = 119; 59.1%) was between 6 and 30 years, and they worked with individuals with various ASD severity in different age groups. It could be suggested that such experienced teachers should have instructed comprehensive sexuality content further.

It should also be noted that one participant stated that he instructed masturbation skills. Teachers do not have the skills to instruct masturbation skills, and instruction of such topics should be provided by field experts. Mann and Travers (2020) emphasized that comprehensive guidance is required for effective masturbation training to ensure the safety of the individual. In the same study, it was emphasized that experts who could provide masturbation training should be familiar with the traits, requirements and education level of the individuals with special needs, and possess certain knowledge on human physiology, sexuality and law; thus, attorney assistance is required in the instruction of such topics. Previous studies conducted with teachers and parents reported that classroom training was limited to the management of masturbation behavior (i.e., consultation about the right settings) rather than the instruction of masturbation skills (Flynn and Lo, 2016; Patterson and Scott, 2011), and studies where masturbation skills are instructed were generally conducted by sexuality or psychiatry experts (Kaeser and O'Neill, 1987; Patterson and Scott, 2013). Thus, it could be suggested that comprehensive sex education content should be included in the curriculum and individualized curricula should be developed for individuals with ASD. To improve the competency of the teachers in comprehensive sex education, undergraduate courses and in-service training activities should be organized. In fact, in a study involving 103 studies on the views and attitudes of teachers regarding sex education for individuals with intellectual disabilities, it was reported that teachers needed further training on sex education. (Bruno, Baiocco and Pistella, 2024). Furthermore, it could be recommended to organize expert and institutional assistance for teachers in the instruction of content they are not familiar with. The research conducted by Brown et al. (2024) also emphasized the need for studies on sex education to be carried out in cooperation with all stakeholders in light of evidence-based programs. It could also be recommended to ensure continuous training. The literature has frequently emphasized that it was insufficient to transform instructional methods or provide single in-service training to improve comprehensive sexuality pedagogy (Haberland and Rogow, 2015).

Determination of the methods and techniques employed in the instruction of comprehensive sexual educational content requires expertise as well as the methods and techniques employed in the instruction of this content (Haberland and Rogow, 2015). Haberland and Rogow (2015) emphasized that strengthening teacher skills is an urgent priority for the dissemination or improvement of comprehensive sex education. They indicated that teachers should utilize various interactive methods in the instruction of comprehensive sex education. Studies also recommended the employment of methods and techniques that do not only allow the acquisition of knowledge but support the acquisition of critical thinking and practical skills. Furthermore, it was reported that non-scientific methods and techniques could lead to problems in sex education, and these could even be dangerous for the students (Kaeser and O'Neill, 1987). It was determined in the present study that only 50% of the 20 participants, who stated that they instructed sexuality, mentioned that they employed conventional instruction, modeling, and video modeling techniques. This finding was consistent with previous reports (Hayashi et al., 2011; Ogur et al., 2023). Although this was a promising finding, since the participants did not mention behavioral skill training, the effectiveness of which has been demonstrated in studies where comprehensive sexual education content was instructed to individuals with ASD (Egemo-Helm et al., 2007; Oğur, 2023), teaching with cool versus not cool instruction (Olcay-Gul and Vuran, 2019), critical thinking instruction (Dupas, 2011), and only half of the participants, who stated that they instructed comprehensive sex education, mentioned the methods and techniques they employed, demonstrated the gap between theory and practice as frequently emphasized in the literature (Bayrak-Özmutlu, 2022; Korthagen 2010, 2011). This finding suggested that the participants did not employ scientific methods and techniques in instruction, and they even did

not have knowledge on evidence-based practice. To eliminate this problem, it could be recommended to encourage the use of scientific methods and techniques in the instruction of comprehensive sexuality content.

After the participants were informed about comprehensive sex education content and related topics, and asked whether they instructed comprehensive sex education, the participants, who stated that they did not instruct sexuality content in the previous open-ended question, mentioned that they instructed related content. Furthermore, it was determined that there was an increase in the diversity of methods and techniques that the participants employed in the instruction. After they were informed about comprehensive sex education content, there was an increase in the number of participants who stated that they instructed content such as relationships, values, rights, culture and sexuality, gender awareness, violence and safety, and human body and development; however, the participants did not have adequate knowledge on comprehensive sex education content.

In the study, it was observed that the participants, who reported that they instructed comprehensive sexuality content were experienced in working with individuals with various ASD of all age groups. It was observed that more studies were conducted with the 12-15 age group in the literature. Since this age group includes adolescents, it could be expected that comprehensive sex education should be prioritized for the individuals in this age group. In the UNESCO guide (2018), the comprehensive sex education content was organized based on the age groups employed in the present study, and it was stated that the quality and quantity of the content should continue to increase for each age group, starting from the $5\text{-}18^{+}$ age group, in other words, the content should be instructed sequentially. Thus, since the knowledge that would be instructed in one age group would support the topics that would be instructed in the next age group, improving the effectiveness of comprehensive sex education, the exclusion of certain content, or inclusion of only limited topics by the participants in certain age groups should be taken into consideration. It was determined that the number of participants who instructed sexuality to individuals with auditory, visual, or physical disabilities and ASD was quite low (range = 4.08% - 10%), and most participants instructed sexuality to individuals with mild intellectual disability and ASD (range = 20% - 40%) and individuals with moderate-severe intellectual disability and ASD (range = 12.12% - 20.54%). This finding was consistent with the findings reported by previous studies that comprehensive sex education could be instructed to individuals with mild intellectual disabilities (Ogur et al., 2023). However, the limitation of the instructed sexuality content was similar to the previous study findings (Stokes & Kaur, 2005) indicating that individuals with ASD were considered sexually passive individuals. Since it has been considered that individuals with ASD did not need comprehensive sex education and these individuals has limited access to required knowledge, it could be suggested that their access to comprehensive sex education is a primary need. Further research that would contribute to the full understanding of comprehensive sex education and its content, reduce existing stereotypes, and reveal the significance of the inclusion of individuals with special needs, including individuals with ASD, in comprehensive sex education.

It was determined in the study that the methods and techniques employed by the participants in the instruction of sexuality content were similar to the methods and techniques reported in the literature, and the preferred method was conventional instruction (range = 8.10% - 33.33%), and modeling, direct instruction, errorless teaching and video model methods were also employed. Since the conventional instruction is the first stage in all methods, it was expected to be the most employed method in sexuality instruction. However, it was emphasized in the literature that, especially due to the advances in information and communication technologies, instruction should prioritize acquisition of skills and practice rather than providing information, leading to more active learning and ensuring active participation of individuals with ASD in education (Gatheridge et al., 2004; Himle, Miltenberger, Flessner and Gatheridge, 2004; Kelso, Miltenberger, Waters, Egemo-Helm and Bagne, 2007). Thus, the neglect of methods that would ensure active participation of individuals with ASD suggested that they only instructed the knowledge dimension of comprehensive sex education. Furthermore, it should also be emphasized that technology adaptation was quite limited in the instruction of the individuals with ASD, who are known to have high interest in technology (Mazurek, Engelhardt and Clark 2015; van Schalkwyk, Ortiz-Lopez, Volkmar and Silverman, 2016). Non-adoption of methods and techniques that support critical thinking skills should also be noted since

previous research emphasized that the use of these methods was critical in the instruction of sexuality (Haberland and Rogow, 2015). Finally, it should be mentioned that parents were not adequately involved in sex education (range = 2.32% - 7.14%). Parental collaboration and participation is extremely important for individuals with ASD, similar to all individuals with special needs, as well as parent-mediated interventions in certain topics (e.g., changing pad, tolerance, respect, social impact on gender roles) (Shepherd, Goedeke, Landon and Meads, 2020). Therefore, further studies should be conducted to determine effective methods and techniques in comprehensive sexuality instruction to ensure parental participation.

When participants were asked to assess their competence in comprehensive sexuality instruction, it was observed that participants considered themselves moderately competent (range = 33.33% - 61.53%) or competent (range = 14.28% - 40.74%) in almost all topics. Furthermore, when they were asked whether they had participated in professional development activities on comprehensive sex education, it was determined that the majority of participants attended at least one comprehensive sex education activity (range = 31.57% - 75%). It was thought-provoking that although the participants attended professional development activities on all comprehensive sexuality content, they mentioned only a limited number of topics, especially when the question was asked before they were informed about these topics by the author. It could be possible that the professional development activities that the participants attended focused on limited content, and the teachers had reduced comprehensive sex education to certain topics such as reproduction, menstruation, developmental periods, masturbation, and sexual abuse. On the other hand, more than half of the participants (f = 9; 69.23%), who stated that they instructed sexuality and sexual behavior, stated that they attended professional development activities on sexuality and sexual behavior, and they considered their instruction moderately effective (f = 6; 46.15) or effective (f = 6; 46.15) when compared to the instruction of other content. It could be suggested that the quality of the instruction could improve when they could participate in future activities. Furthermore, it was a promising finding that most participants (range = 50% - 85.71%) reported that they needed to participate in professional development activities on comprehensive sex education, and it was surprising that a smaller number of teachers (range = 14.28% - 50%) reported that they did not need to participate in any activity. It was surprising that although the participants had limited knowledge on comprehensive sex education and related methods and techniques, they reported that they did not need training. Thus, it could be suggested that professional development activities should be planned based on the literature and cover all content included in the International Technical Guidance on Sex education (ITGSE).

Specific strengths of the study differentiate it from other studies. Although there are studies in the literature mainly on teachers working with individuals with intellectual disabilities, this study was conducted with teachers working with individuals with ASD. Unlike other studies, the holistic approach to teacher views and experiences on comprehensive sex education, along with the fact that data were collected from teachers employed in various regions of Turkey—since sex education could be affected by cultural factors—were among the strengths of this research. The study also has certain limitations. The present study is limited by the views of 200 special education teachers on the instruction of comprehensive sex education to individuals with ASD. Furthermore, the study data were collected with a survey form developed by the authors; thus, the study data were self-reported. Self-reported data only reveals participant perceptions rather than objective facts (Mills and Gay, 2016). Thus, future research should be conducted with different research models, data collection instruments such as observations (e.g., classroom observations, parental education, etc.), and document reviews (e.g., individualized syllabi or plans developed by participants) to obtain objective findings. Finally, the data were collected on the comprehensive sex education content that the participants instructed; however, data were not collected on the topics that they instructed. This also could be considered a limitation. Future studies could collect participant views on the instructed topics.

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Ethics statement: All procedures performed in this study involving human participants were in accordance with the ethical standarts of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Written informed consent was obtained from the volunteers.

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Data Availability Statement: Data generated or analyzed during this study should be available from the authors on request.

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References

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Washington, DC: American Psychiatric Association.

Akdemir, B. (2024). Opinions of special education teachers on inappropriate sexual behaviors in adolescents with intellectual disabilities. *International Journal of Developmental Disabilities*, *70*(4), 641-650. doi.org/10.1080/20473869.2022.2129127

Ariyanti, T. D., & Royanto, L. R. (2017, September). The effectiveness of social stories and video modeling in improving self-care skills in female adolescents with mild intellectual disabilities during menstrual periods. In *1st International Conference on Intervention and Applied Psychology (ICIAP 2017)*(pp. 189-199). Atlantis Press. doi.org/10.2991/iciap-17.2018.16

Ballan, M. S., & Freyer, M. B. (2017). Autism spectrum disorder, adolescence, and sex education: Suggested interventions for mental health professionals. *Sexuality and Disability, 35*(2), 261-273. doi.org/10.1007/s11195- 017-9477-9

Bollman, J. R., Davis, P. K., & Zarcone, J. (2009). Teaching Women With Intellectual Disabilities to Identify and Report Inappropriate Staff-To-Resident Interactions. *Journal of Applied Behavior Analysis*, *42*(4), 813-817, doi.org/10.1901/jaba.2009.42-813

Bourke, A., Cullen, C., & Maunsell, C. (2024). Preparing to teach relationships and sexuality education: student teachers' perceived knowledge and attitudes. *Sex Education*, 1-18. doi.org/10.1080/14681811.2024.2337860

Brown, R. D., & Pirtle, T. (2008). Beliefs of professional and family caregivers about the sexuality of individuals with intellectual disabilities: examining beliefs using a Q-methodology approach. *Sex Educatio, 8* (1), 59-75. doi.org/10.1080/14681810701811829

Brown, M., Linden, M., Marsh, L., Truesdale, M., Sheerin, F., & McCormick, F. (2024, May). The experiences of young people with intellectual disability, parents and professionals in relationships and sexuality education programmes: findings from a qualitative study. In *Healthcare* (Vol. 12, No. 11, p. 1105). MDPI. doi.org/10.3390/healthcare12111105

Bruno, V., Baiocco, R., & Pistella, J. (2024). Teachers' Attitudes and Opinions Toward Sexuality Education in School: A Systematic Review of Secondary and High School Teachers. American *Journal of Sexuality Education, 1*-39. doi.org/10.1080/15546128.2024.2353708

Christian, L., Stinson, J., & Dotson, L. A. (2001). Staff values regarding the sexual expression of women with developmental disabilities. *Sexuality and Disability*, *19*, 283-291. doi:10.1023/a:1017957409670

Constantine, N. A., Jerman, P., Berglas, N. F., Angulo-Olaiz, F., Chou, C. P., & Rohrbach, L. A. (2015). Short-term effects of a rights-based sex education curriculum for high-school students: a cluster-randomized trial. *BMC Public Health*, *15*(1), 1-13. doi:10.1186/s12889-015-1625-5

CRPD. (2006). Convention on the rights of persons with disabilities. Retrieved from https://www.un.org/development/desa/disabilities/convention-on-the-rights-opersonswith-disabilities/convention-on-the-rights-of-persons-with-disabilities-2.html

Daymon, C., & Holloway, I. (2011) *Qualitative research methods in public relations and marketing communications*, 2nd ed. . Abingdon , UK : Routledge .

Dupas, P. (2011). Do teenagers respond to HIV risk information? Evidence from a field experiment in Kenya. *American Economic Journal: Applied Economics*, *3*(1), 1-34.

Egemo-Helm, K. R., Miltenberger, R. G., Knudson, P., Finstrom, N., Jostad, C., & Johnson, B. (2007). An evaluation of in situ training to teach sexual abuse prevention skills to women with mental retardation. Behavioral Interventions: *Theory & Practice in Residential & Community-Based Clinical Programs*, *22*(2), 99-119. doi.org/10.1002/bin.234

Flynn, S. D., & Lo, Y. Y. (2016). Teacher implementation of trial-based functional analysis and differential reinforcement of alternative behavior for students with challenging behavior. Journal of Behavioral Education, 25, 1-31. doi.org/10.1007/s10864-015-9231-2

Fonner, V. A., Armstrong, K. S., Kennedy, C. E., O'Reilly, K. R., & Sweat, M. D. (2014). School based sex education and HIV prevention in low-and middle-income countries: a systematic review and meta-analysis. *Plos One*, *9*(3), e89692. doi:10.1371/journal.pone.0089692

Frawley, P., & Wilson, N. J. (2016). Young people with intellectual disability talking about sex education and information. *Sexuality and Disability, 34,* 469-484. doi:10.1007/s11195-016-9460-x

Fu, W., Huang, L., Liu, R., & Zhang, Y. (2024). Special education teachers' attitudes towards teaching sex education to students with intellectual disabilities in Malaysia. *International Journal of Developmental Disabilities*, 1-12. doi.org/10.1080/20473869.2024.2340188

Gardner, F., Montgomery, P., & Knerr, W. (2016). Transporting evidence-based parenting programs for child problem behavior (age 3–10) between countries: Systematic review and meta-analysis. *Journal of Clinical Child & Adolescent Psychology, 45*(6), 749-762. doi.org/10.1080/15374416.2015.1015134

Gatheridge, B. J., Miltenberger, R. G., Huneke, D. F., Satterlund, M. J., Mattern, A. R., Johnson, B. M., & Flessner, C. A. (2004). Comparison of two programs to teach firearm injury prevention skills to 6-and 7-year-old children. *Pediatrics*, *114*(3), e294-e299. doi.org/10.1542/peds.2003-0635-L

Gill, M. (2012). Sex can wait, masturbate: The politics of masturbation training. *Sexualities*, *15*(3-4), 472-493. doi.org/10.1177/1363460712439

Girgin-Büyükbayraktar, Ç., Konuk-Er, R., & Kesici, S. (2017). According to the Opinions of Teachers of Individuals with Intellectual Disabilities: What Are the Sexual Problems of Students with Special Education Needs? How Should Sexual Education Be Provided for Them? *Journal of Education and Practice*, *8*(7), 107-115.

Groce, N. E., Rohleder, P., Eide, A. H., MacLachlan, M., Mall, S., & Swartz, L. (2013). HIV issues and people with disabilities: a review and agenda for research. *Social Science & Medicine 77*, 31-40. doi.org/10.1016/j.socscimed.2012.10.024

Haberland, N., & Rogow, D. (2015). Sex education: Emerging trends in evidence and practice. Journal of Adolescent Health, *56*(1), S15-S21. doi.org/10.1016/j.jadohealth.2014.08.013

Hamilton, C. A. (2009). 'Now I'd like to sleep with Rachael'–researching sexuality support in a service agency group home. *Disability & Society*, *24*(3), 303-315. doi.org/10.1080/09687590902789461

Hannah, L. A., & Stagg, S. D. (2016). Experiences of sex education and sexual awareness in young adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 46*(12), 3678-3687. doi.org/10.1007/ s10803-016-2906-2

Hayashi, M., Arakida, M., & Ohashi, K. (2011). The effectiveness of a sex education program facilitating social skills for people with intellectual disability in Japan. *Journal of Intellectual and Developmental Disability*, *36*(1), 11-19. doi.org/10.3109/13668250.2010.549463

Himle, M. B., Miltenberger, R. G., Flessner, C., & Gatheridge, B. (2004). Teaching safety skills to children to prevent gun play. *Journal of Applied Behavior Analysis*, *37*(1), 1-9. doi.org/10.1901/jaba.2004.37-1

Hocaoğlu N. & Akkaş Baysal E. (2019). *Eğitimde bilimsel araştırma yöntemleri*, 1st. edn, Ankara: Pegem Akademi.

Jeyachandran, V., Ranjelin, S. D., & Kumar, A. (2024). Sexual health and safety of adolescents with intellectual disability: Challenges and concerns among special educators in India. *Journal of Intellectual Disabilities*, *28*(1), 104-117. doi.org/10.1177/17446295221136

Johnston, M. (2010). Teaching sexual abuse prevention skills to two children with intellectual disabilities through game play. hdl.handle.net/10464/3065

Johnson, R. B., & Christensen, L. (2014). *Educational research: Quantitative, qualitative, and mixed approaches* (5th ed.). Thousand Oaks, Calif.: SAGE Publications. ISBN 978-1-4129-7828-6).

Ionescu, C. E., Rusu, A. S., & Costea-Bărluţiu, C. (2019). Attitudes of Special Education teachers towards sexual education of students with intellectual disabilities: Effects of religiosity and professional experiences. *Educatia 21*, (17), 102-111.

Kaeser, F., & O'Neill, J. (1987). Task analyzed masturbation instruction for a profoundly mentally retarded adult male: A data based case study. *Sexuality and Disability, 8,* 17-24. doi:10.1007/bf01112431

Kelso, P. D., Miltenberger, R. G., Waters, M. A., Egemo-Helm, K., & Bagne, A. G. (2007). Teaching skills to second and third grade children to prevent gun play: A comparison of

procedures. *Education and Treatment of Children, 30*(3), 29-48. doi.org/10.1353/etc.2007.0016

Kirby, D., Laris, B. A., & Rolleri, L. (2006). The impact of sex and HIV education programs in schools and communities on sexual behaviors among young adults. *Research Triangle Park, NC: Family Health International, YouthNet Program*.

Korthagen, F. A. J. (2010). The relationship between theory and practice in teacher education. *International Encyclopedia of Education*, *7*(669-675).

Korthagen, F. A. (2011). Making teacher education relevant for practice: The pedagogy of realistic teacher education. *Orbis Scholae*, *5*(2), 31-50.

Kurulu, Y. (2018). Öğretmen yetiştirme lisans programları. Ankara: Ankara Üniversitesi Basımevi.

Leijten, P., Melendez-Torres, G. J., Knerr, W., & Gardner, F. (2016). Transported versus homegrown parenting interventions for reducing disruptive child behavior: A multilevel meta-regression study. *Journal of the American Academy of Child & Adolescent Psychiatry, 55*(7), 610-617. doi.org/10.1016/j.jaac.2016.05.003

Lindsay, W. R., Bellshaw, E., Culross, G., Staines, C., & Michie, A. (1992). Increases in knowledge following a course of sex education for people with intellectual disabilities. *Journal of Intellectual Disability Research, 36*(6), 531-539. doi.org/10.1111/j.1365-2788.1992.tb00571.x

Mackin, M. L., Loew, N., Gonzalez, A., Tykol, H., & Christensen, T. (2016). Parent perceptions of sexual education needs for their children with autism. *Journal of Pediatric Nursing, 31*(6), 608-618. doi.org/10.1016/j.pedn.2016.07.003

Maia, A. C. B., Reis-Yamautı, V. L. D., Schıavo, R. D. A., Capellini, V. L. M. F., & Valle, T. G. M. D. (2015). Teacher opinions on sexuality and Sexual Education of students with intelectual disability. *Estudos de Psicologia (Campinas), 32*, 427-435. doi.org/10.1590/0103166X2015000300008

Mann, L. E., & Travers, J. C. (2020). A systematic review of interventions to address inappropriate masturbation for individuals with autism spectrum disorder or other developmental disabilities. *Review Journal of Autism and Developmental Disorders, 7*, 205-218. doi:10.1007/s40489-019-00192-9

Mattson, J. M. G., Roth, M., & Sevlever, M. (2016). Personal hygiene. *Behavioral Health Promotion and Intervention In Intellectual and Developmental Disabilities, 43*-72. doi:10.1007/978-3-319-27297-9_3

Mazurek, M. O., Engelhardt, C. R., & Clark, K. E. (2015). Video games from the perspective of adults with autism spectrum disorder. *Computers in Human Behavior, 51*, 122-130. doi.org/10.1016/j.chb.2015.04.062

McCabe, M. P. (1999). Sexual knowledge, experience and feelings among people with disability. *Sexuality and Disability, 17*, 157-170. doi:10.1023/a:1021476418440

Mills, G. E., & Gay, L. R. (2016). Educational research: Competencies for analysis and applications. Pearson.

Oğur, Ç., (2023). *Otizm spektrum bozukluğu olan bireylere çevrim içi cinsel istismarla başa çıkmada davranışsal beceri öğretiminin etkililiği* [Doctoral dissertation, Hacettepe University] National Thesis Center. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Ogur, C., Olcay, S., & Baloglu, M. (2023). An International Study: Teachers' Opinions About Individuals With Developmental Disabilities Regarding Sex education. *Sexuality and Disability, 41*(4), 739-756.

Olcay-Gul, S., & Vuran, S. (2019). Effectiveness of teaching social skills to individuals with autism spectrum disorders using cool versus not cool. *Education and Training in Autism and Developmental Disabilities*, *54*(2), 132-146.

Özmutlu, E. B. (2022). Kuram ve Uygulama Arasındaki İlişki: Öğretmen Adaylarının İnançları Temelinde Bir İnceleme. *Journal of Qualitative Research in Education*, (30).

PAHO & WHO. (2000). Promotion of sexual health: recommendations for action. Guatemala. Retrieved from https://iris.paho.org/bitstream/handle/10665.2/42416/promotionsexualhealth.pdf?sequence=1&isAllowed=y

Patterson, T., & Scott, C. (2013). Behavioral management of inappropriate masturbation in an 8-year-old girl. *Child & Family Behavior Therapy*, *35*(3), 256-263. doi.org/10.1080/07317107.2013.818907

Pecora, L. A., Hancock, G. I., Hooley, M., Demmer, D. H., Attwood, T., Mesibov, G. B., & Stokes, M. A. (2020). Gender identity, sexual orientation and adverse sexual experiences in autistic females. *Molecular Autism*, *11*(1), 1-16.

Ray, F., Marks, C., & Bray-Garretson, H. (2004). Challenges to treating adolescents with Asperger's Syndrome who are sexually abusive. *Sexual Addiction & Compulsivity*, *11*(4), 265-285. doi.org/10.1080/10720160490900614

Richman, G. S., Reiss, M. L., Bauman, K. E., & Bailey, J. S. (1984). Teaching menstrual care to mentally retarded women: Acquisition, generalization, and maintenance. *Journal of Applied Behavior Analysis*, *17*(4), 441-451. doi.org/10.1901/jaba.1984.17-441

Rodriguez, M. (1995). Teaching our teachers to teach: a SIECUS study on training and preparation for HIV/AIDS prevention and sex education. *Siecus Report*, *28*(2).

Rohleder, P., & Swartz, L. (2009). Providing sex education to persons with learning disabilities in the era of HIV/AIDS: Tensions between discourses of human rights and restriction. *Journal of Health Psychology*, *14*(4), 601-610. doi.org/10.1177/135910530910357

Rohrbach, L. A., Berglas, N. F., Jerman, P., Angulo-Olaiz, F., Chou, C. P., & Constantine, N. A. (2015). A rights-based sex education curriculum for adolescents: 1-year outcomes from a cluster-randomized trial. *Journal of Adolescent Health*, *57*(4), 399-406. doi.org/10.1016/j.jadohealth.2015.07.004

Sevlever, M., Roth, M. E., & Gillis, J. M. (2013). Sexual abuse and offending in autism spectrum disorders. *Sexuality and Disability*, *31*, 189-200.

Shepherd, J., Kavanagh, J., Picot, J., Cooper, K., Harden, A., Barnett-Page, E., ... & Price, A. (2010). The effectiveness and cost-effectiveness of behavioural interventions for the prevention of sexually transmitted infections in young people aged 13-19: a systematic review and economic evaluation. Health technology assessment (Winchester, England), 14(7), 1-206. doi.org/10.3310/hta14070

Shepherd, D., Goedeke, S., Landon, J., & Meads, J. (2020). The types and functions of social supports used by parents caring for a child with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *50*, 1337-1352.

SIECUS.: National Guidelines Task Force (2004). Retrieved from https://healtheducationresources.unesco.org/organizations/national-guidelines-task-force.

Stankova, T., & Trajkovski, V. (2021). Sexual Education of Persons with Autistic Spectrum Disorders: Use of the Technique:'Social Stories. *Sexuality and Disability*, *39*(2), 377-393. doi:10.1007/s11195-020-09655

Stokes, M. A., & Kaur, A. (2005). High-functioning autism and sexuality: A parental perspective. *Autism*, *9*(3), 266-289. doi.org/10.1177/136236130505325

Strnadová, I., Loblinzk, J., & Danker, J. (2022). Sex education for students with an intellectual disability: teachers' experiences and perspectives. *Social Sciences*, *11*(7), 302. doi.org/10.3390/socsci11070302

Swango-Wilson, A. (2008). Caregiver perception of sexual behaviors of individuals with intellectual disabilities. *Sexuality and Disability*, *26*, 75-81. doi:10.1007/s11195-008-9071-2

Şencan, H., (2005). Sosyal ve davranışsal ölçümlerde güvenilirlik ve geçerlilik. Ankara: Seçkin

Büyüköztürk, Ş., (2020). *Eğitimde bilimsel araştırma yöntemleri*, 29. edn, Ankara: Pegem Akademi

Taherdoost, H. (2021). Data collection methods and tools for research; a step-by-step guide to choose data collection technique for academic and business research projects. *International Journal of Academic Research in Management (IJARM)*, *10*(1), 10-38.

Travers, J., & Tincani, M. (2010). Sex education for individuals with autism spectrum disorders: Critical issues and decision making guidelines. *Education and Training in Autism and Developmental Disabilities*, 284-293.

UNESCO. (2009). International Technical Guidance on Sex education: An Evidence-informed approach for schools, teachers and health educators. Paris, UNESCO. Retrieved from http://unesdoc.unesco. org/images/0018/001832/183281e.pdf

UNESCO. (2016). Meeting Notes of the consultation on updating International Technical Guidance on Sex education (ITGSE). Paris, October 2016. (Unpublished).

UNESCO, UNAIDS, UNFPA, UNICEF, UN Women, WHO. (2018). International Technical Guidance on Sex education: An Evidence-informed Approach. Paris: UNESCO.

van Schalkwyk, G. I., Ortiz-Lopez, M., Volkmar, F. R., & Silverman, W. K. (2016). 1.2 Social Media Use Improves Friendship Quality In Adolescents With Autism Spectrum Disorder. *Journal of the American Academy of Child & Adolescent Psychiatry, 10*(55), S100. (pp. S100-S100).

Veazey, S. E., Valentino, A. L., Low, A. I., McElroy, A. R., & LeBlanc, L. A. (2016). Teaching feminine hygiene skills to young females with autism spectrum disorder and intellectual disability. *Behavior Analysis in Practice, 9*, 184-189. doi:10.1007/s40617-015-0065-0

Walsh, A. (2000). Improve and care: responding to inappropriate masturbation in people with severe intellectual disabilities. *Sexuality and Disability, 18*(1), 27-39. doi:10.1023/a:1005473611224

Wells, J., Clark, K. D., & Sarno, K. (2012). A computer-based interactive multimedia program to reduce HIV transmission for women with intellectual disability. *Journal of Intellectual Disability Research, 56*(4), 371-381. doi.org/10.1111/j.1365-2788.2011.01482.x

WHO. (2006). Defining Sexual Health—Report of a Technical Consultation on Sexual Health 28-31 January 2002, Geneva. Retrieved from https://www.scirp.org/reference/ReferencesPapers?ReferenceID=1998000