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Research Article

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Scratch, computational thinking, and grit: At the beginning, during, and after the COVID-19 Pandemic

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Abstract

The Covid-19 pandemic has deeply affected the whole world. In order to continue education during the pandemic, emergency distance education applications were utilized. The purpose of the research is to evaluate how block-based programming affects computational thinking (CT) and grit at the beginning, during and after pandemic. The study used a quasi-experimental pretest-posttest design. This sample was divided into three groups based on the stage of the COVID-19 Pandemic at which they were enrolled in a programming course: before the pandemic, during the pandemic, and after the pandemic. The participants are 104 teacher candidates in the Faculty of Education of a Turkish state university. As a result of the research, it is observed that block-based coding instruction has a significant difference between the pre-test and post-test scores of computational thinking in the pre-pandemic and pandemic groups. The difference in this case has a moderate effect size. There was no significant difference between the pretest and posttest scores of the post-pandemic group. Comparing the groups revealed that the pre-pandemic and during pandemic groups had significantly higher median scores in computational thinking skills than the post-pandemic group. According to these results, it can be argued that the negative effects of the pandemic were seen in the post-pandemic group. The results of the short grit scale emphasize the importance of non-cognitive factors in distance education in the context of the consistency of interest dimension. Moreover, it indicates a significant and positive relationship between grit and computational thinking skills.

Keywords: Scratch, Computational thinking, Grit, Pandemic

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Scratch, bilgi işlemsel düşünme ve azim: Pandemi öncesi, pandemi süreci ve pandemi sonrası

Özet

Covid-19 pandemisi tüm dünyayı derinden etkilemiştir. Pandemi sürecinde eğitim-öğretimin devam edebilmesi için acil uzaktan eğitim uygulamaları işe koşulmuştur. Araştırmanın amacı, blok tabanlı programlamanın pandemi başlangıcında, pandemi süresince ve pandemi sonrasında bilgi işlemsel düşünmeyi ve azmi nasıl etkilediğini belirlemektir. Çalışmada yarı deneysel desenlerden ön test-son test kontrol gruplu yöntem kullanılmıştır. Örneklem, Türkiye'deki bir devlet üniversitesinin Eğitim Fakültesi'nde öğrenim gören 104 öğretmen adayıdır. Araştırma sonucunda blok tabanlı kodlama eğitiminin, pandemi öncesi ve pandemi süreci gruplarında bilgi işlemsel düşünme ön test ve son test puanları arasında anlamlı bir farka neden olduğu görülmektedir. Söz konusu fark orta düzeyde bir etki büyüklüğüne sahiptir. Pandemi sonrası grubun ön test ve son test puanları arasında anlamlı bir fark bulunmamıştır. Gruplar arası fark incelendiğinde, pandemi öncesi ve pandemi sırasındaki grupların bilgi işlemsel düşünme becerilerinde pandemi sonrası gruba göre anlamlı derecede daha yüksek medyan değerlerine sahip olduğu görülmüştür. Bu sonuçlara göre pandeminin olumsuz etkilerinin pandemi sonrası grupta görüldüğü söylenebilir. Azim ölçeği sonuçları, ilginin tutarlılığı boyutu bağlamında uzaktan eğitimde bilişsel olmayan faktörlerin önemini vurgulamaktadır. Ayrıca azim ve bilgi işlemsel düşünme becerileri arasında anlamlı ve pozitif bir ilişkiyi işaret etmektedir.

Anahtar Kelimeler: Scratch, Bilgi işlemsel düşünme, Azim, Pandemi

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1. Introduction

Advances in science and technology change the type, size and characteristics of the problems people face. Therefore, new methods and skills of problem solving are needed to solve contemporary challenges. According to World Economic Forum's Future of Jobs Report (2020), abilities such as critical thinking and analysis, problem-solving, active learning, resilience, stress tolerance, and flexibility will become increasingly valuable to employers in the future. The same survey suggests that the vocations that will be in higher demand in the future include those associated with information and communication technologies (ICT), such as software and application developer, robotics engineer, and artificial intelligence and machine learning specialist. Further, jobs altered by ICT, such as process automation specialist, digital transformation specialist, and digital marketing and strategy specialist, may also become more important. Considering this impending change, it is inevitable that transformation will also occur in the education systems tasked with fostering the employees of the future. Training in ICT, cognitive, and non-cognitive skills, all of which will play a significant role in future industry, is at the heart of such a transition.

Programming is the fundamental basic component of all digital solutions, software, and systems that we use. Thus, to comprehensively understand the digital world, fundamental knowledge of programming is needed. Programming represents a means of innovating, problem-solving, and applying ideas in the digital world (Nouri et al., 2020), and relates to a variety of thinking and knowledge areas (Durak and Guyer, 2019). Programing is also valued for its relationship with computational thinking (CT) which is emphasized by many researchers. CT was introduced by Papert (1980) and popularized by Wing (2006). CT is using an approach to solving problems, developing systems and understanding human behaviour that draws on concepts essential to computing (Wing, 2006). CT is an essential skill for all individuals, not just computer scientists (Wing, 2008). In addition to coding and CT, non-cognitive abilities have a significant influence on one's problem-solving skills. Zhao et all (2021) states that grit, self-efficacy of group learning and patterns of adaptive learning are important factors in programming education of different groups of learners. In addition, the Coronavirus Disease 2019 (COVID-19) Pandemic, has altered the learning-teaching processes and psychological states of individuals. Although the rapid deployment of e-learning systems during the pandemic helped prevent disruption to education systems, it remains necessary to

examine variations in the effectiveness of learning and teaching during the pandemic when compared to the pre- and post-pandemic periods.

2. Literature Review

2.1. Computational Thinking

Wing (2006) is credited with popularizing the concept of CT; however, signs of its development can be traced to as early as the 1950s (Denning, 2017). One of the most significant pillars in the creation of the CT concept was Papert's (1980) book. In addition, the book particularly focused on children and the nature of thinking. Thus, it can be asserted that CT has quite an extensive theoretical foundation. According to Wing (2006), CT includes problem-solving, system-designing, and human-behavior-understanding processes that make use of fundamental computer science concepts. Furthermore, Aho (2012) defines CT as mental processes that entail the application of computational stages to generate problem-solving procedures.

The International Society for Technology in Education (ISTE) and the Computer Science Teachers Association (CSTA) are two key bodies to have investigated CT in depth. According to these bodies, CT defined as a problem-solving process that includes the following actions:

- Formulating problems in such a way that a computer and other tools can be used to
- Systematically organizing and evaluating data in a rational manner.
- Describing data using abstractions.
- Automating solutions.
- Describing data using abstractions.
- Generalizing the technique of problem-solving and applying it to a wide range of problems.
- Additionally, the aforementioned actions should be supported by particular attitudes:
- Confidence in the face of adversity.
- Persistence in resolving challenging issues.
- Tolerance of ambiguity.
- Capability to address open-ended challenges and collaborate with others to attain a common objective or solution.

The ISTE's and CSTA's definitions of CT indicate that cognitive skills alone are insufficient for problem-solving; particular attitudes that assist cognitive abilities play a vital role in the

learning process. Additionally, the problem-solving mental processes applied in CT may be applicable to many other subjects (Barr and Stephenson, 2011; Ching et al., 2017; Hsu and Baldwin, 2018). According to Barr and Stephenson (2011), this is because numerous specialties require problem-solving, logical, or algorithmic thinking. Consequently, Barr and Stephenson believe that the community of computer science educators may play an important role in the future widespread development of algorithmic problem-solving practices and inter-disciplinary CT applications. In addition, Mishra and Yadav (2013) state that, with CT, it is possible to transcend typical human-computer interactions, while Voogt et al. (2015) believe that, with CT, not only do students become technology consumers, but also experience an boost in their creativity. Ching et al. (2018) recommend using a graphical programming interface rather than the syntax of programming languages to enable students to focus on computing concepts. As underlined by Voogt et al. (2015), this proposal is significant because it can help create familiarity with the fundamental concepts of CT among teachers of subjects other than computer science. Another key point highlighted by Voogt et al. (2015) is that real-world scenarios assist the comprehension of the fundamental concepts of CT: while teaching algorithms, teachers should start with examples from daily life such as the steps involved in brushing one's teeth or the steps of an experiment (Yadav et al., 2017).

2.2. Grit

When establishing the elements that explain success, researchers tend to focus on, in addition to intelligence quotient and other cognitive criteria, non-cognitive qualities such as perseverance, locus of control, conscientiousness, and self-control (Nichols, 2017). Duckworth and Yeager (2015) assert that non-cognitive skills support goal-directed effort, good social connections, and decision-making. In this context, the present research considers the influence of the variable grit, which has been a focus of numerous studies. Duckworth et al. (2007) define grit as perseverance and passion for long-term goals. To demonstrate grit, one must work diligently at difficult activities, sustaining his/her level of effort and interest regardless of setbacks. The achievement-oriented parts of conscientiousness and grit overlap; however, grit emphasizes long-term resilience: a gritty person not only completes the work at hand, but also pursues a certain objective over the course of several years. Persons with a need for achievement continue to work regardless of the difficulty of their goals, whereas individuals

with grit prioritize long-term goals and do not abandon them if they do not receive favorable feedback (Duckworth et al., 2007).

According to Bowman et al. (2015), during one's college years' grit can influence a variety of academic and non-academic outcomes, with the perseverance of effort (PE) component of grit being a more accurate predictor of the effect in question than the consistency of interest (CI) dimension. Similarly, Weisskirch (2018) suggested that PE is a component that favorably influences one's grade point average at universities. Further, according to Hwang et al. (2018), who considered students of the Open University, perseverance is a significant predictor of academic adjustment and degree of accomplishment while, according to Wolters and Hussain (2014), PE is a significant predictor of all aspects of self-regulated learning.

Importantly, the PE dimension has been prominently noted in studies that have observed positive results regarding the determination variable. This circumstance requires consideration of the criticisms regarding the grit variable. According to Crede (2018), grit is largely a repackaging of conscientiousness, while, according to Crede et al. (2017), grit, consisting of PE and CI dimensions, has not been confirmed to be a high-level construct. Another criticism is brought by Fosnacht et al. (2019), who conducted confirmatory factor analysis of the Short Grit Scale using data from the 2016 National Survey of Student Engagement. According to the results of the analysis, acceptable fit values were reached for the Short Grit Scale after an item from the PE dimension was excluded from the analysis; however, they do not recommend its use for important decisions due to the lack of good fit indices. Nevertheless, they state that its use in educational research is acceptable.

The Covid-19 pandemic has deeply affected the whole world and emergency distance education practices have been put into use in order to continue education during the pandemic. However, it should be evaluated how the education and instruction carried out in such an extraordinary situation affects the cognitive and non-cognitive skills of pre-service teachers. In this context, the aim of the study was to determine how block-based programming affected computational thinking and grit at the beginning, during and after the pandemic. In line with this purpose, the following questions were analyzed.

RQ1: Is there a significant difference in pretest-posttest scores for CT and grit across the three different learning environments?

RQ2: Do the three different learning environments have a significant effect on students' CT skills?

RQ3: Do the three different learning environments have a significant effect on students' grit?

RQ4: Is there a significant relationship between CT and grit?

3. Methodology

The 3.1. Research Design

In the present research, a pretest-posttest quasi-experimental design was used to determine the effect of computer programming on individuals' CT and grit levels. The research was conducted at a state university in Türkiye. The research commenced in 2020, when distance education became prevalent as a result of the COVID-19 Pandemic, and was completed in 2022, when in-person education had largely returned. In the spring term of 2019–2020, the first six weeks of the courses were taught face-to-face, and the remaining nine weeks were remote; for the spring term of 2020–2021, distance education alone was used; while for the spring term of 2021–2022 face-to-face education returned.

3.2. Participants

The participants were mathematics teacher candidates studying at a Turkish state university's faculty of education. The research sample consisted of prospective mathematics teachers because they are the only teacher training program to include the Algorithm and Introduction to Programming course in the curriculum. Therefore, the study's findings will be meaningful for teacher education. The research was conducted among students of the Algorithm and Introduction to Programming course, of whom a total of 104 participated in this study.

Of the participants, 44 were examined during their engagement in blended learning, 37 were examined during their engagement in distance education, and 23 were examined during their engagement in face-to-face learning. The gender distribution was 79 women to 23 men. The age range of the groups was 19–25 years.

3.3. Data Collection and Analysis

The CT scale developed by Korkmaz et al. (2017) and the Short Grit Scale developed by Duckworth and Quinn (2009) and adapted into Turkish by Sarıçam et al. (2016) were used as data-collection tools for this research. The Cronbach's alpha coefficient for the Short Grit scale

was determined to be .83 for the overall scale, .80 for the sub-dimension of consistency of interest, and .71 for the sub-dimension of perseverance of effort. The test-retest reliability coefficient for the overall scale was 0.69. The item-total correlations were ranged from .33 to .65. The Cronbach Alpha reliability coefficient for the CT scale is 0.822. However, it is seen that the split-half correlations for the components range from 0.406 to 0.713. The Spearman-Brown values range from 0.578 to 0.832, the Guttmann Split-Half values range from 0.578 to 0.832. The CT scale comprises the sub-dimensions of creativity, algorithmic thinking, cooperation, critical thinking, and problem-solving, while the Short Grit Scale comprises the consistency of interest (CI) and perseverance of effort (PE) dimensions.

In the analysis of the data, in accordance with the recommendations of Crede (2018) and Steinmayr et al. (2018), the sub-dimensions separately rather than merely collecting the total score for the PE scale, in addition, due to the lack of normal distribution in the data, as indicated by the Kolmogorov-Smirnov normality test ($p<.05$), nonparametric tests were chosen for data analysis.

3.4. Procedure

For the first group (blended group), which was examined during the 2019–2020 spring term, the first six weeks involved face-to-face learning, and the remaining nine weeks were conducted through distance education (Google Meet). The second group (distance group), which was examined during the 2020–2021 spring semester again used Google Meet for learning, with the class being entirely distance-based. The final group (face-to-face group) received face-to-face learning throughout the 2021–2022 spring semester. The block-based programming tool Scratch was used within the two-hour lessons of the Algorithm and Introduction to Programming course. The CT and short grit scales have administered at the beginning and end of each term. The main topics of the course comprised algorithms and flowcharts, variables, decision structures, and loops. In detail, 2 weeks for What is an algorithm? Exercises on algorithmic thinking, 2 weeks working on daily life problems with pseudo code and flowcharts were instructed. After the algorithmic thinking phase, the coding started with Scratch. At this stage 1 week for Introduction to block based programming with Scratch such as Code blocks, sprite, backdrop, costumes and sounds, 1 week for event and

motion, 2 weeks for sensing, decision structures and operators, 3 weeks for loops, looks and sound were instructed. Also problem solving exercises were done with mentioned code blocks.

At the beginning of the course, theoretical information such as what an algorithm is and what flow diagrams do was given using the direct instruction method. Then the block-based coding language and its interface were introduced. In addition, code sections such as events, operators, sensing and control and their tasks are explained. At the end of this process, problem-based learning method was used to first solve simple arithmetic problems and then to solve problems based on a scenario.

4. Findings

The Before determining the differences between the groups, the similarity of the groups was checked using the Kruskal–Wallis Test, and no significant difference was found among the pretest results.

4.1. Is there a significant difference in pretest-posttest scores for CT and grit across the three different learning environments?

In the blended group, the Wilcoxon Signed Ranks Test demonstrated a statistically significant difference ($Z=-3.110$, $p<.05$), with a moderate effect size ($r=0.33$), between the pretest and posttest scores for the CT scale. When the sub-dimensions of the CT scale were evaluated, algorithmic thinking was found to have a substantial effect size ($r=.46$, $Z=-4.292$, $p<.001$), while critical thinking showed a moderate effect size with a significant difference ($r=.34$ $Z=-3.220$, $p<.05$). The PE component of the grit scale showed a significant difference with a moderate effect size ($r=.31$, $Z=-2.871$, $p<.05$).

For the distance-learning group, no significant differences were identified between the pretest and posttest results for the sub-dimensions of the grit scale. The CT scale demonstrated a statistically significant difference with a moderate effect size ($r=0.34$, $Z=-2.960$, $p<.05$). When the sub-dimensions of the CT scale were examined, a significant difference was identified for the dimensions of creativity and algorithmic thinking. The creativity dimension showed a moderate effect size ($r=.40$, $Z=-3.422$, $p<.05$), and the algorithmic thinking dimension showed a statistically significant difference with a moderate effect size ($r=.38$, $Z=-3.278$, $p<.05$).

In the final group, face-to-face, no significant difference was found for the grit scale sub-dimensions or the overall CT scale. A significant difference, with a moderate effect size, was found only for the cooperativity sub-dimension of the CT scale ($Z=-2.220$, $p<.05$).

4.2. Do the three different learning environments have a significant effect on students' CT skills?

The Kruskal–Wallis Test was performed to determine whether there was a significant difference among the blended, distance, and face-to-face groups regarding posttest CT scale scores. Ultimately, a significant difference was found ($\chi2(2)=11.14$, $p<.05$). Consequently, the Mann-Whitney U test was performed to determine between which groups the significant difference was, and the results are presented in Table 1.

Table 1.

Mann-Whitney U test results regarding intergroup CT posttest scores

Group	n	Mean Rank	Sum of Ranks	U	p
Blended	44	37.86	1666.00	336.000	.038
Face-to-face	23	26.61	612.00		*r=.27*
Distance	37	36.05	1334.00	220.000	.002
Face-to-face	23	21.57	496.00		*r=.40*
Blended	44	36.94	1625.50	635.500	.090
Distance	37	45.82	1695.50		

As shown in Table 1, there were significant differences in favor of the pre-pandemic (blended) and during-pandemic (distance) groups. The effect size of the significant difference was higher for the distance group than the blended group. There was no significant difference in CT skills between the pre-pandemic and during-pandemic groups.

For the CT scale sub-dimensions, the Kruskal–Wallis test revealed statistically significant differences between creativity ($\chi2(2)=12.35$, $p<.05$), algorithmic thinking ($\chi2(2)=11.81$, $p<.05$), and problem-solving ($\chi2(2)=6.33$, $p<.05$). The Mann-Whitney U test was then used to evaluate, between the blended and distance groups, the direction of the significant differences in creativity, algorithmic thinking, and problem-solving, and the results are presented in Tables 2, 3, and 4.

Table 2 shows significant differences in the creativity and algorithmic thinking dimensions, favoring the distance group. In the creativity dimension, the median value of the blended group was 34.00 and the median value of the distance group was 36.00. In the algorithmic thinking

dimension, the median value of the blended group was 24.50 and the median value of the distance group was 27.00.

Table 2.

Mann-Whitney U test results comparing the blended and distance groups in terms of CT posttest scores.

Factor	Group	n	Mean Rank	Sum of Ranks	U	p
Creativity	Blended	44	36.05	1586.00	596.000	.038
	Distance	37	46.89	1735.00		*r=.23*
Algorithmic Thinking	Blended	44	36.26	1595.00	605.500	.047
	Distance	37	46.64	1725.50		*r=.22*

Table 3 presents the results of an analysis in which the blended and face-to-face groups were compared; this shows that the blended learning group achieved a better median, with a significant difference, in the creativity and algorithmic-thinking dimensions, with a moderate effect size. In the creativity dimension, the median value of the blended group was 34.00 and the median value of the face to face group was 32.00. In the algorithmic thinking dimension, the median value of the blended group was 24.50 and the median value of the face to face group was 23.00.

Table 3.

Mann-Whitney U test results comparing the blended and face-to-face groups in terms of CT posttest scores.

Factor	Group	n	Mean Rank	Sum of Ranks	U	p
Creativity	Blended	44	37.97	1670.50	331.500	.020
	Face to-face	23	26.41	607.50		*r=.28*
Algorithmic Thinking	Blended	44	37.77	1662.00	340.000	.028
	Face-to-face	23	26.78	616.00		*r=.27*

Results for the analysis of the distance and face-to-face groups are shown in Table 4. Significant differences, with moderate effect sizes, were observed between these two groups in regard to the dimensions of creativity, algorithmic thinking, and problem-solving, favoring the distance group.

Table 4.

Mann-Whitney U test results comparing the distance and face-to-face groups in terms of CT posttest scores.

Factor	Group	n	Mean Rank	Sum of Ranks	U	p
Creativity	Distance	37	36.04	1333.50	220.500	.002
	Face-to-face	23	21.59	496.50		*r=.40*
Algorithmic Thinking	Distance	37	36.04	1333.50	220.500	.002
	Face-to-face	23	21.59	496.500		*r=.40*
Problem Solving	Distance	37	34.78	1287.00	267.000	.015
	Face-to-face	23	23.61	543.000		*r=.31*

Comparing the different groups in terms of the sub-dimensions of the CT scale revealed that the distance group had the highest median scores for creativity, algorithmic thinking and problem solving (Md=36.00, Md=27.00, Md=25.00) followed by the blended group (Md=34.00, Md=24.50, Md=24.00) and the face-to-face group (Md=32.00, Md=23.00, Md=22.00), respectively.

4.3. Do the three different learning environments have a significant effect on students' grit?

The Kruskal–Wallis Test was administered to assess whether, for the blended, distance, and face-to-face groups, respectively, there was a statistically significant difference between the pretest and posttest scores for the grit scale. Consequently, a statistically significant difference was found between the CI ($\chi 2(2)=6.67$, $p<.05$) and the PE sub-dimensions ($\chi 2(2)=7.33$, $p<.05$).

The Mann-Whitney U test was performed to determine which groups featured statistically significant differences for the CI and PE dimensions; the findings are presented in Table 5. In the analysis of the sub-dimensions of the grit scale, the distance group obtained the highest median score (Md=13.00) for the CI sub-dimension, followed by the blended group (Md=12.00) and the face-to-face group (Md=11.00), respectively. The blended group ranked first for the PE dimension (Md=16.00), followed by the distance group (Md=15.00) and the face-to-face group (Md=13.00), respectively.

Table 5.

Mann-Whitney U test results regarding intergroup posttest scores for grit.

Factor	Group	n	Mean Rank	Sum of Ranks	U	p
CI	Blended	44	36.23	1594.00	604.000	.045
	Distance	37	46.68	1727.00		*r=.22*
PE	Blended	44	38,86	1710.00	292.000	.004
	Face-to-face	23	24,70	568.00		*r=.35*
CI	Distance	37	34.59	1280.00	274.000	.021
	Face-to-face	23	23.91	550.00		*r=.43*

4.4. Is there a significant relationship between CT and grit?

According to Table 6, with the exception of the cooperativity dimension all sub-dimensions of the CT scale are related to the sub-dimensions of the grit scale. No significant correlation was discovered between CI and creativity. Additionally, all significant correlations were positive, and the covariance level for the critical-thinking dimension reached a maximum of 37%. Further, PE showed greater values for common variance than CI.

Table 6.

Spearman correlation coefficient between CT and grit dimensions.

	Consistency of interest	Perseverance of effort
Creativity	.12	.47**
Algorithmic thinking	.21*	.44**
Cooperativity	.17	.11
Critical thinking	.31**	.61**
Problem-solving	.24*	.30**

** p<.001 (two-tailed)

* p<.05 (two-tailed)

5. Discussion

In this research, differences between pre-service teachers' CT skills and grit scores before, during, and after the COVID-19 Pandemic, and the relationship between these two variables, were examined. The experiment process was conducted by introducing Scratch, a block-based programming tool, to a course titled Algorithm and Introduction to Programming and observing the changes in the participants CT skills and grit under different learning environments. Blended courses were held in the spring semester of 2019–2020, distance courses were held during the spring semester of 2020–2021, and face-to-face courses were held during 2021–2022.

According to our analysis for our RQ1, there was a significant difference, with a moderate effect size, between the pretest and posttest CT scores of the blended and distance groups. In addition, there were differences in the sub-dimensions of algorithmic thinking and critical thinking in the blended group, and in the dimensions of algorithmic thinking and creativity in the distance group. Moreover, the blended group showed a significant difference regarding the PE dimension of the grit scale; however, this difference was not seen in the distance group or the face-to-face group. This is in line with the research results of Kerres and Buchner (2022) and Jerebic and Urh (2023). According to Kerres and Buchner (2022), when many universities

reopened after the pandemic, returning to normal was not as easy as expected due to the reluctance of university students. As the reason for this reluctance, Jereb, Jerebic and Urh (2023) emphasize the decrease in motivation of higher education students and the difficulties experienced in focusing on learning after the pandemic. Similar results are also evident from the analysis results between groups. There were significant differences in favor of the pre-pandemic (blended) and during-pandemic (distance) groups. Examining the sub-dimensions of the CT scale revealed significant differences in the dimensions of algorithmic thinking, creativity, and problem-solving. In the algorithmic thinking and creativity dimensions, the distance group achieved much higher median values than the other two groups. Compared to the face-to-face group, the blended group similarly demonstrated significant and greater values. Further, comparing the distance group to the face-to-face group on the problem-solving dimension revealed a significant difference in favor of the distance group.

When considering the research results regarding CT in detail, a notable outcome is that, while there were significant differences between the pre-pandemic and during-pandemic groups, there were no such differences for the post-pandemic group. These findings differ from those of previous studies involving prospective teachers. For example, Gabriele et al. (2019) reported that, at the conclusion of a Scratch-based programming course, pre-service teachers in Italy had obtained intermediate–high-level ICT skills. Further, İlic (2021) observed significant differences in the CT sub-dimensions of creativity, algorithmic thinking, and critical thinking at the end of a 13-week study with preservice teachers. Lazarinis et al. (2018) similarly reported an increase in ICT skills among elementary and secondary school teachers after completion of a blended Scratch course. Meanwhile, Marcelino et al. (2018) demonstrated that, as a result of the online Scratch training they designed for classroom teachers, it is possible for teachers to learn CT, Scratch programming, and create meaningful products for classroom applications using this technology. The fact that these studies were conducted before the COVID-19 Pandemic can be considered the most important difference between these and the present research. From this perspective, it is clear that the effects of the pandemic on education must be further examined.

According to the Education in a Pandemic report (2021) by the United States Department of Education, the COVID-19 Pandemic significantly impacted academic advancement and exacerbated existing inequities. In addition, there are indications that some pupils fell further behind in fundamental areas such as mathematics and reading when compared to the pre-

pandemic period. Similarly, Betthauser, Bach-Mortensen, and Engzell (2023) state that as a result of meta-analysis studies involving 42 studies from fifteen different countries, there are higher learning gaps in mathematics and in middle-income countries than in high-income countries. Cao et al. (2020) presented further evidence of this impact, reporting that 24.9% of university students have been affected by anxiety due to the COVID-19 Pandemic. Also Cao et al. (2020) suggested that, for university students, place of residence, parental financial status, whether they (the students) live with their parents, and whether a family or acquaintance is infected with COVID-19 are factors contributing to this effect. In addition, academic delays and the impact of the pandemic on daily life have been found to be moderately and positively connected with students' anxiety levels. According to Fong (2022), the COVID-19 Pandemic has had a significant effect on students' learning, well-being, and academic motivation. It is believed that the abrupt and unanticipated move to distance education contributed to reducing students' self-esteem, increasing their sense of isolation, and altering their interests, attitudes, and actions. Moreover, Corpus et al. (2022) reported that the identified and intrinsic motives of college students diminished significantly during the pandemic when compared to the pre-pandemic period. Two studies have indicated that the aforementioned negative impacts have persisted into the post-pandemic period. According to Caron et al. (2022), the pandemic's detrimental impacts on college students' focus, flow, motivation, and perception of time are ongoing. Further, Hu et al. (2022) conducted a study on 151 university students between January 17 and February 25, 2022, finding that 95.7% of the sample had moderate or severe mood disorder; in addition, when asked how much the pandemic had impaired their learning quality, participants reported a value of 7.6 out of 10.

Bozkurt et al. (2022), who researched the influence of the pandemic on education, examined 1,150 studies in terms of thematic patterns in the titles, abstracts, and keywords, as well as citation trends in the sampled publications' citations. The thematic patterns identified for title, abstract, and keywords were: (1) the great reset, (2) the shifting educational landscape and emerging educational roles, (3) digital pedagogy, (4) emergency remote education, (5) pedagogy of care, (6) social equity, equality, and (7) the future of education. Meanwhile, as a result of the citation analysis, the following thematic clusters were identified: (1) educational response, emergency remote education affordances, and continuity of education, and (2) psychological impact of COVID-19. The first thematic cluster is consistent with the fourth

theme, emergency remote education, and the second thematic cluster, psychological impact of COVID-19, is compatible with the fifth theme, pedagogy of care. This emphasizes that education systems should be maintained continuously under all circumstances through the use of remote approaches if necessary, and that, to implement a caring pedagogy, the evaluation of students' psychological and emotional states should be the top priority. Notwithstanding their observation of persistent negative impacts such as a loss in motivation, mood disorders, difficulties with focusing and flow, feelings of isolation, and decline in self-confidence, studies conducted during the pandemic period have revealed similar results to the present study.

Despite the effects of the COVID-19 Pandemic, it can be stated that programming courses featuring block-based coding tools improve CT skills. However, despite the reopening of schools, it is believed that pupils' sense of uncertainty about the future can cause in learning deficits. The findings for the Short Grit Scale should be reviewed in order to more closely examine this potentiality. For the CI dimension, the order of the groups in terms of median values (highest to lowest) was distance, blended, and face-to-face, respectively, while for the PE dimension, the ranking was blended, distance, and face-to-face, respectively. Also, for the CI dimension the distance group showed significant differences when compared to the blended and face-to-face groups, respectively; for the PE dimension, a significant difference was detected between the blended group and the face-to-face group, with the blended group performing better. These research outcomes are distinct from those of other studies that found PE to potentially be a predictor of academic performance, but CI to not be correlated with achievement (Bowman et al., 2015; Hwang et al., 2018; Shirvan and Alamer, 2022; Wolters and Husain, 2015). In contrast, Neromi et al. (2022) stated, based on their study of the effects of academic self-efficiency, self-esteem, and grit on academic achievement in distance-based higher education, that only CI is a predictor of academic success. This indicates that online education institutions should focus on their students' CI to improve their academic success. In addition, Bono et al. (2020) stated that grit contributes to the subjective well-being of university students and their ability to cope with events such as pandemics.

Our findings relating to RQ4 are consistent with those of Christopoulou et al. (2018). Their systematic review of 29 papers published between 2012 and 2017 revealed weak to moderate relationships between grit and educational factors. They found PE to be a stronger positive predictor of academic performance; the co-variance of approximately 20% in the creative and

algorithmic thinking dimensions and 37% in the critical-thinking dimension shows that PE produces remarkable results.

The uncertainty experienced by the groups may have had a significant impact on the research results. As the Short Grit Scale is a measurement tool that can evaluate individuals' level of grit, determination, persistence, and perseverance (Sarıçam et al., 2016), the present findings confirm that the difficulties experienced during the Pandemic continue both in cognitive and affective terms.

6. Conclusion

The results revealed significant and positive outcomes in terms of the development of CT in the blended and distance groups. However, the negative effects of the COVID-19 Pandemic were reflected in the research results for the face-to-face group. Also, the positive change in CT skills as a result of distance education, which allowed learners to feel safe during the pandemic, is evidenced through the differences between the groups. In addition, the results obtained for the Short Grit Scale emphasize the importance of non-cognitive elements in distance education, especially for boosting the CI dimension. The research results also reflect that PE is the primary component to be considered when describing CT skills.

As a result, when the negative effects of the pandemic are neglected, blended, face-to-face or distance block-based coding education can positively affect pre-service teachers' CT skills. Furthermore, it is expected that teacher candidates will be grittier. In the light of these findings, the availability of block-based coding courses for teacher training programs is essential for the development of computationally thinking teachers.

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Research Article

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The Effect of Math-Supported Introductory Programming Education on Computational Thinking

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Abstract

The study aims to research the effect of an introductory programming course with math-based programming activities on computational thinking skills and self-efficacy. A static-groups pre-test post-test quasi-experimental design was used. One hundred and seventy-six 6th-grade public school students participated in the study. Eighty-nine students were in the experimental group, and 87 were in the control group. While the students in the experimental group received introductory programming education with Math-supported activities, the students in the control group received programming education with traditional course activities. Equivalent programming activities were carried out in both groups. Data were collected via the Computational Thinking Test and Self-Efficacy Perception Scale for Computational Thinking Skills. After the study, post-test scores were analyzed using ANCOVA analysis by controlling pre-test scores. The findings indicated no difference between the two groups regarding computational thinking test performance. Similarly, no conclusion stated a difference between the groups' perceptions of self-efficacy of computational thinking. According to these results, evaluations regarding the positive and negative effects of using mathematics and programming together in an elementary programming education, which is thought to be related to Computational Thinking Skills, were reached at the skills of the study.

Keywords: Math, Computational Thinking, Self-efficacy, Programming

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Matematik Destekli Programlamaya Giriş Eğitiminin Bilgi İşlemsel Düşünme Üzerindeki Etkisi

Özet

Bu çalışmanın amacı, matematik temelli programlama etkinlikleri ile temel programlama eğitiminin bilgi işlemsel düşünme becerileri ve öz yeterlilik üzerindeki etkisini araştırmaktır. Çalışmada statik gruplar ön-test son-test yarı deneysel desen kullanılmıştır. Çalışmaya bir devlet okulunda öğrenimine devam eden yüz yetmiş altı 6. sınıf öğrencisi katılmıştır. Bu öğrencilerin 89'u deney grubunda, 87'si ise kontrol grubunda yer almıştır. Deney grubundaki öğrenciler matematik destekli etkinliklerle programlamaya giriş eğitimi alırken, kontrol grubundaki öğrenciler geleneksel ders etkinlikleri ile programlama eğitimi almışlardır. Her iki grupta da eşdeğer programlama etkinlikleri gerçekleştirilmiştir. Veriler Bilgi İşlemsel Düşünme Testi ve Bilgi İşlemsel Düşünme Becerilerine Yönelik Öz Yeterlik Algısı Ölçeği aracılığıyla toplanmıştır. Çalışma sonunda, son test puanları ön test puanları kontrol edilerek ANCOVA ile analiz edilmiştir. Bulgular, iki grup arasında bilgi işlemsel düşünme performansı açısından bir fark olmadığını göstermiştir. Benzer şekilde, grupların bilgi işlemsel düşünme öz yeterlilik algıları arasında da bir fark olmadığı sonucuna varılmıştır. Bu sonuçlara göre, ilköğretim programlama eğitiminde matematik ve programlamanın birlikte kullanılmasının Bilgi İşlemsel Düşünme Becerileri ile ilişkili olabileceği düşünülen olumlu ve olumsuz etkilerine ilişkin değerlendirmelere ulaşılmıştır.

Anahtar Kelimeler: Matematik, Bilgi işlemsel düşünme, Öz- yeterlik, Programlama

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1. Introduction

Technology continues to develop rapidly and occupies more space in all areas of life. Developed countries invest more in studies in the field of technology because economic growth is parallel to technological development. They integrate computer science subjects into their curricula, starting from primary education, to increase the pace of their technological development. Countries such as England, France, Finland, Poland, Denmark, and Türkiye have recently updated their curricula, including computational thinking (CT) skills, algorithms, and coding. In Turkey, the curriculum of some courses has been rearranged, and content has been produced in recent years to improve CT skills (Gülbahar & Kalelioğlu, 2018). As a result of the rapid development of computer science and technology, the development of students' competence in solving technological problems is considered an important issue in education systems. Problems that arise in many fields, such as education, health, trade, industry, transportation, and entertainment, are solved thanks to the developed hardware and software. According to Wing (2006), solutions developed to manage our daily lives, communicate, and interact with others should not be limited to only physical software and hardware products. The main point to focus on is ensuring students gain computational concepts. The International Society for Technology in Education (ISTE) aims to contribute to educational institutions' planned use of technology and be a guide. For this reason, it develops some standards for students, teachers, administrators, coaches, and computer educators. The standards developed by the institution for students (ISTE, 2016) include (i) Empowered Learner, (ii) Digital Citizenship, (iii) Knowledge Builder, (iv) Innovative Designer, (v) Computational Thinker, (vi) Creative Communicator, and (vii) Global Collaborator has defined its features.

These standards also show that computational thinking is one of the essential skills individuals in the 21st century should acquire. The importance of computational thinking has raised questions such as "What is computational thinking?", "How is it taught?" and "How is it measured?" According to Wing (2008), computational thinking requires thinking like an engineer in addition to mathematical thinking when solving problems. Papert (1980) observed that his students' thinking abilities were significantly different when writing computer programs and that they developed their cognitive abilities. ISTE (2016) stated that computational thinking includes creative thinking, algorithmic thinking, problem-solving, and collaborative learning skills. These statements show that computational thinking is a skill

created by combining the gains of subjects such as mathematics, engineering, and computer programming. Many countries think in this direction and equip teaching programs with relevant topics to enable students to think like engineers and acquire these skills. In our country, we can also find examples of computer and non-computer coding and robotics studies starting from the primary level. For example, in the 5th and 6th grades of middle school, the example of the Algorithms and Basic Programming education in the Information Technologies and Software course can be given for the relevant situation. Scratch is generally preferred in these training carried out in block-based programming environments. In this regard, studies showing that Scratch is the primary tool and can be effective in computational thinking are available in the literature (Oluk et al., 2018; Şimşek, 2018)

However, thinking that computational thinking can only be learned by programming reflects a limited perspective. Computational thinking does not only consist of writing code in a computer environment; it is gained during the process of understanding the problem, analyzing, abstracting, algorithmic thinking, and creating flow diagrams before writing the program. Disciplines that apply problem-solving steps have the potential to develop computational thinking. Studies show that subjects such as Biology, Physics, Mathematics, and English develop computational thinking skills (Lockwood & Mooney, 2017).

From another perspective, the limitations of the underlying information processing device force computer scientists to think not only mathematically but also numerically (Wing, 2006). In other words, there is a mutually beneficial relationship between computational thinking and mathematics. A study by Sung and Black (2020) observed that when students worked on math problems thinking like a computer programmer, their task analysis, sequential thinking, procedural thinking, and coding skills improved. A similar result was obtained in a study conducted by Rodríguez-Martínez et al. (2020), and they showed that programming activities contributed relative to the adequacy of solving some math problems. In conclusion, it can be inferred that integrating mathematics gains with computer science concepts may impact computational thinking skills.

This research investigates the effects of mathematics-supported introductory programming education in the Information Technologies and Software course on the computational thinking test performance and self-efficacy of 6th-grade students. By presenting the gains of information

technologies and mathematics courses that effectively teach computational thinking skills in the same activity, the role of mathematics-supported activities in developing computational thinking skills in Scratch-based basic programming education is focused. Another aim is to focus on the role of mathematics-supported programming education in developing students' computational thinking skills and making inferences about the direction of interdisciplinary studies. Additionally, this study aims to provide examples of research in the fields of programming, computational thinking, and mathematics in terms of content, method, duration, activities, and implementers. In this context, the following research questions have been attempted to be answered:

(1) Does mathematics-supported basic programming education affect the computational thinking test performance of 6th-grade students?

(2) Does mathematics-supported basic programming education affect the self-efficacy perception of computational thinking of 6th-grade students?

2. Theoretical Framework

2.1. Computational Thinking

Although computational thinking has become quite popular recently, the concept dates back a few decades. Studies on the logic behind computer functioning as a problem-solving method were first initiated by Alan Perlis in the 1960s (Özçınar, 2017). The term computational thinking was first used by Papert (1996) in 1996. However, much earlier, Papert (1980) observed that the thinking abilities of his students significantly differed when they wrote computer programs, and this situation also developed their cognitive abilities. He stated that children could develop computational thinking skills by learning the LOGO programming language. This idea emerged from recognizing the development of thinking skills that occurred during the process of students' programming. The concept of computational thinking was first included in Jeannette M. Wing's study in 2006. She stated that computer science is not limited to computer programming and that thinking like a computer scientist requires thinking at multiple abstraction levels. According to Wing (2008), computational thinking is a type of analytical thinking, and the general ways of solving a problem rely on mathematical, engineering, and scientific thinking skills.

The literature provides many definitions of computational thinking. For example, Wing (2006) expresses computational thinking as problem-solving, system design, and understanding human behavior using basic computer science concepts. According to Aho (2012), it contains thinking processes in which problem-solving solutions can be presented in steps and algorithms compatible with computer logic. Syslo and Kwiatkowska (2013) defined it as mental activity in formulating a problem. Korkmaz et al. (2015) expressed it as a method of problem-solving, system design, drawing attention to the basic concepts of computer science, and understanding human behavior. Curzon (2015) attempted to explain computational thinking as a problem-solving ability for humans. According to Angeli et al. (2016), it is a thought process that uses the elements of abstraction. According to Şahiner and Kert (2016), it is a comprehensive skill that includes critical thinking, problem-solving, algorithmic thinking, and adapting the working style of the computer to daily life. In a joint statement by the International Society for Technology in Education (ISTE) and the Computer Science Teachers Association (CSTA), an operational definition is proposed for the ability to solve computational problems using computer assistance. The definition includes skills such as formulating, organizing, and presenting data, algorithmic thinking, transfer, and generalization. Therefore, reaching a clear definition of computational thinking in national and international literature may not be possible. However, definitions are expressed with problem-solving, algorithms, abstraction, and critical thinking concepts.

2.2. Subcomponents of computational thinking

The subcomponents of computational thinking are also characterized by varying opinions, just as its name and definition are. For example, Wing (2006) proposed that computational thinking includes problem-solving, abstraction, decomposition, intuitive thinking, and mathematical and engineering-based thinking. The BBC's education website in the UK includes a guide to computational thinking that includes decomposition, abstraction, pattern recognition, and algorithms. ISTE (2016) listed the subcomponents of computational thinking: data collection, data analysis, data presentation, decomposition, abstraction, algorithms, automation, testing, parallelism, and simulation. Tosik Gün and Güyer (2019) systematically reviewed the literature on computational thinking. The study stated that the most commonly accepted components in evaluating computational thinking are abstraction, algorithmic thinking, decomposition, testing and debugging, data literacy, sorting, and flow control structures. According to the

literature review conducted by Gulbahar and Kalelioglu (2015), the most frequently encountered subcomponents of computational thinking are understanding problem, decomposition, pattern finding/recognition, abstraction, algorithms, testing/debugging, automation, data collection/analysis, and modeling.

The subcomponents of computational thinking have been influential in the measurement of this skill, and researchers have developed various tools to measure it (Dolmacı & Akhan, 2020; Gülbahar & Kalelioğlu, 2018; Korkmaz et al., 2015; Kukul & Karatas, 2019; Özmen, 2016). Similar dimensions are found in the scales developed for different participant groups (Tosik et al., 2019). Therefore, the most commonly seen subcomponents in the scales are abstraction, algorithmic thinking, decomposition, testing and debugging, and data literacy (Tosik et al., 2019).

2.3. Developing Computational Thinking and Scratch

According to Weinberg (2013), there are four different approaches to developing computational thinking: CS Unplugged, programming tools, game or robot programming, and interdisciplinary applications. In addition to tools, some strategies are also used to develop computational thinking. Hsu et al. (2018) have summarized the strategies used to impart computational thinking skills to students. Some teaching approaches for computational thinking are problem-based, collaborative, project-based, game-based, scaffolding, storytelling, computational learning theory, aesthetic experience, concept-based learning, object-oriented learning, human-computer interaction-based learning instruction, and universal design for learning. When these tools and approaches are considered, the Scratch block-based programming environment has emerged in terms of availability and usability. One of the crucial reasons for its emergence is that it works with the drag and drop logic and allows even people without programming knowledge to use it (Resnick et al., 2009) easily, and thus addresses users from the lowest level to the highest level (Grover & Pea, 2013). In this perspective, several scratch-based programming environments and studies targeting computational have been conducted (Adsay et al., 2020; Ataman-Uslu et al., 2018; Oluk et al., 2018; Vatansever, 2018; Yünkül et al., 2017).

2.4. The relationship among Math, Scratch, and computational thinking

The standards ISTE (2016) put forth do not limit computational thinking to just computer science. In addition to computer science, computational thinking is associated with mathematics, science and technology, social studies, and language. Lockwood and Mooney (2017) mention that many studies show that computational thinking skills can be integrated into Biology, Physics, Math, and English courses.

Mathematics and computational thinking are closely related to the analysis and interpretation of data and the communication of information. Mathematical methods, data collection and analysis tools, and visualizations provide an ease for students to work with large amounts of data. Furthermore, when students struggle to express findings in text or speech, they use mathematical representations, data visualizations, simulations, and graphic representations (Wilkerson & Fenwick, 2017). These sub-tools used in mathematics align with the sub-components of computational thinking and show the connection between the two fields.

Many studies in the literature have investigated the development of computational thinking skills through mathematical activities using Scratch. In their study, Sung et al. (2017) aimed to provide students with computational thinking skills through various levels of concretized activities, and the results showed that activities supported by computational thinking improved students' mathematical understanding and programming skills in Scratch Jr. Another study by Okuducu (2020) examined the effect of using Scratch on students' academic achievement and attitude towards algebra and found that Scratch-based lesson activities created a positive difference in their algebraic expression achievement and attitude. In another study, it was found that a majority of students' learning difficulties in mathematics were addressed with mathematical games designed with the Scratch programming tool (Çubukluöz, 2019).

Overall, research suggests that using Scratch programming or coding tools with Mathematics has an advantage. It has been concluded that when Mathematics is taught with Scratch, it is more successful than traditional methods (Çubukluöz, 2019; Okuducu, 2020). The fact that sub-operations such as decomposition, abstraction, modeling, simulation, and pattern recognition used in programming lessons are also frequently used in mathematics lessons may facilitate the understanding of mathematical subjects. Based on the existing literature and various

experiences, it is thought that programming education with mathematical content has the potential to impact computational thinking.

3. Method

The study used a static group's pre-test, post-test week-experimental design. Since the initial states of the groups are crucial to understanding the effect of the manipulation of the independent variable on dependent variables, researchers included similar static groups in the study to ensure that the groups were close to each other before the experiment. However, since the groups could not be formed by the researcher, the study was continued with a weak experimental design (Fraenkel et al., 2012). In the data collection process, the students were first given a computational thinking test and a self-perception of computational thinking scale as pre-tests. Then, the experimental group was given four weeks of programming education with mathematical support, and the training was supported by various examples. The mathematical support examples include mathematics topics covered in the 6th grade Math course curriculum and taught in the first month of the first semester. During the same period, various in-class activities based on the Information Technologies and Software course were applied to the control group according to the teaching program. At the end of the process, the same measurement tools were applied as post-tests.

3.1. Participants

The convenience sampling method was used in the study. According to Cresswell (2012), convenience sampling enables the study with participants who are willing to participate and available for the study. After applying convenience sampling methods, the study group consisted of 200 students in the 6th grade at a middle school in Samsun in the 2021-2022 academic year. The data of 176 of these students who had full pre-test and post-test data and students were used in the analyses. There were 89 students in the experimental group: 46 girls and 43 boys. In the control group, 87 students, 47 girls, and 40 boys participated in the study.

Before participating in the study, the students had attended the Information Technologies and Software course in the 5th grade in a way consistent with the national instructional program during the first and second semesters online due to the pandemic conditions. In the second semester of the 5th grade, activities on introductory programming topics were carried out in

the code.org and Scratch environments. In this context, participant students have prior knowledge of programming.

3.2. Instruments

Computational Thinking Test (CTT) and Computational Thinking Self-Efficacy Scale (CTSES) were used as data collection tools. The tool used to measure the students' computational thinking skill levels before and after the application was developed by Román-González et al. (2017) and adapted to Turkish by Çetin et al. (2020). The other measurement tool is CTSES, which was developed by Gülbahar et al. (2019).

CTT

CTT is a 7-section, 28-item test developed by Román-González et al. (2017) that contains computer-based coding and visual coding tools. It is designed to determine computational thinking level in the context of programming and coding. The test measures the ability to solve problems and formulate equations using fundamental concepts such as loops, conditional structures, variables, arrays, and functions in programming languages. The original form of the test was developed for students in grades 7 and 8 (ages 12-14), but the developers have stated that it can also be used for students in grades 5-6 and 9-10. Table 3.2 shows the sections and number of questions in the test. When the scale is examined, it is seen that there are 28 questions in total, including basic sorting (4 questions), loops with a specific number of repetitions (4 questions), loops until a condition is met (4 questions), simple conditional statements (4 questions), complex conditional (if-else) statements (4 questions), loops that work only when a condition is true (4 questions), and simple functions (4 questions).

CTSES

Another measurement tool used in the study is CTSES, which was developed by Gülbahar et al. (2019). This scale consists of 5 factors and 36 items: algorithm design (9 items), problem-solving (11 items), data processing (7 items), basic programming (6 items), and self-confidence (6 items). The reliability coefficients of the scale range from 0.76 to 0.93 for each dimension. These values provide sufficient evidence for the reliability of the scale.

3.3. Procedure

The activities used in the experimental group in the study were prepared in collaboration with Mathematics teachers. Four activities were administered to the students in the experimental group. These activities were (i) operator precedence in natural numbers, (ii) calculating exponents, (iii) divisibility rules, and (iv) prime numbers. These activities were accompanied by the same programming topics in the control group, which included (i) a capital city game, (ii) an apple-picking game, (iii) an English word game, and (iv) a horoscope game. All activities were planned for 80 minutes and were carried out in the Scratch environment. The features of the program that would be produced and the rules it would have to meet were shared with the students before the activities, and necessary instructions were provided.

In the "operator precedence in natural numbers" activity, a game design activity was carried out in the Scratch environment to order operations according to the operator precedence rule. The activity aimed for students to learn to create a new character, make their character speak and change their appearance, hide and show, use the send and receive commands, use variables, generate random numbers, and perform operations using loops and conditional structures. In the "calculating exponents" activity, students were asked to write a program in the Scratch environment that calculates the exponent of a number entered by the user as many times as the user enters and displays the result on the screen. The activity aimed to develop the students' algorithmic thinking, conditional statements, loops, variables, and mathematical operation skills. In the use of the "divisibility rules" activity, the students were asked to write a program that determines whether one of the entered numbers is exactly divisible by the other. This application prioritized the conditional structure, array concept, and the MOD command, a mathematical function. In addition, text concatenation was emphasized. The last activity of the experimental group was the "prime numbers" activity. In this activity, the students designed a program to determine whether a number is a prime number and display the result on the screen. The topics of variables, conditional structure, loop structure, "or" statement, MOD command, and text concatenation were discussed in the activity. The control group activities include the same programming topics in the same order as the activities in the experimental group. The only difference between the activity groups is that the programming concepts are presented in the experimental group by matching them with the contents of the mathematics course.

3.4. Data analysis

In order to determine whether there is a difference between the groups in the sub-dimensions of each scale, analyses of variance (ANCOVA) were applied. Each ANCOVA was applied for each sub-dimension, and the pre-test results were included as a control variable in the analysis. In this way, the effect of the students' differences in the relevant dimension on the results at the beginning of the study was controlled. Before applying ANCOVA for each dimension, the assumptions required for this analysis were tested. These assumptions include the continuity of dependent, independent, and control, the groups being measured independently, the limited extreme values, and the residual values (residuals) normally distributed in each category context. When the relevant situations are examined, it is seen that all assumptions are met. In addition, the homogeneous distribution of variances, the linear correlation between the control variable and the dependent variable, the linearity of the regression lines, the homoscedasticity condition, and the normal distributions are also among the controlled assumptions. The assumption analysis of ANCOVA obtained in the study indicated that the collected data are appropriate for analysis.

4. Result

4.1. Computational Thinking Test

In this section, the results of each sub-dimension of the CTT are presented. The pre-test and post-test responses of the experimental and control groups to the CTT were analyzed using ANCOVA. Based on the results obtained, whether there was development in BID skill was interpreted.

Table 1.

ANCOVA results for "Basic Sorting."

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	26.741a	2	13.37	19.05	.00	.18
Intercept	77.466	1	77.47	110.38	.00	.39
Pre-Test	25.950	1	25.95	36.97	.00	.18
Group	2.387	1	2.39	3.40	.07	.02
Error	121.418	173	.70			
Total	1626.000	176				
Corrected Total	148.159	175				

Table 1 summarizes the ANCOVA results for the Basic Sorting dimension. In the ANCOVA analysis, where the post-test scores of the CTT-Basic Sorting dimension were the dependent variable, and the pre-test results were included as the control variable, no significant difference was found between the experimental and control groups. Although the difference is not significant (F(1.176)=19.05, p=.07), the participants in the experimental group (M=2.782) scored lower than the control group (M=3.017).

Table 2.

ANCOVA results for the dimension of "Loops"

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	61.629a	2	30.81	35.47	.00	.29
Intercept	39.432	1	39.43	45.39	.00	.21
Pre-Test	61.164	1	61.16	70.41	.00	.29
Group	.354	1	.35	.41	.52	.00
Error	150.280	173	.87			
Total	1292.000	176				
Corrected Total	211.909	175				

Table 2 summarizes the results of ANCOVA in the dimension of "Loops ."ANCOVA did not show a significant difference between the experimental and control groups. Although participants in the experimental group (M=2.522) obtained higher scores than control group students (M=2.432) when controlling for pre-test results, this difference was not significant (F(1.176)=35.47, p=.52).

Table 3.

ANCOVA results for the "Loops Until Condition Is Met"

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	32.562a	2	16.28	16.38	.00	.16
Intercept	47.866	1	47.87	48.15	.00	.22
Pre-Test	31.477	1	31.48	31.67	.00	.15
Group	.466	1	.47	.47	.49	.00
Error	171.984	173	.99			
Total	974.000	176				
Corrected Total	204.545	175				

Table 3 summarizes the ANCOVA results for the "Loops Until Condition Is Met" dimension. The ANCOVA analysis, in which the CTT "Loops Until Condition Is Met" test scores were the

dependent variable and pre-test scores were the control variable, did not find a significant difference between the experimental and control groups. Therefore, although participants in the experimental group (M=2.142) scored higher than students in the control group (M=2.039), this difference was not significant (F(1.176)=16.38, p=.49).

Table 4.

ANCOVA results for "Simple Conditional Statements"

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	14.258a	2	7.13	5.80	.00	.06
Intercept	108.784	1	108.78	88.46	.00	.34
Pre-Test	14.154	1	14.15	11.51	.00	.06
Group	.451	1	.45	.37	.55	.00
Error	212.737	173	1.23			
Total	695.000	176				
Corrected Total	226.994	175				

Table 4 summarizes the ANCOVA results for the "Simple Conditional Statements" dimension. The ANCOVA analysis, in which the CTT "Simple Conditional Statements" post-test scores were the dependent variable and pre-test scores were the control variable, did not find a significant difference between the experimental and control groups. Therefore, participants in the experimental group (M=1.580) scored lower than students in the control group (M=1.682), but this difference was not significant (F(1.176)=5.80, p=.55).

Table 5.

ANCOVA results for the "Complex Conditional Statements"

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	22.761a	2	11.38	9.96	.00	.10
Intercept	83.546	1	83.55	73.10	.00	.30
Pre-Test	20.814	1	20.81	18.21	.00	.09
Group	1.800	1	1.80	1.57	.21	.01
Error	197.733	173	1.14			
Total	763.000	176				
Corrected Total	220.494	175				

Table 5 summarizes the ANCOVA results for the "Complex Conditional Statements" dimension. The ANCOVA analysis, in which the CTT "Complex Conditional Statements" post-test scores were the dependent variable and pre-test scores were the control variable, did not find a significant difference between the experimental and control groups. Therefore,

participants in the experimental group (M=1.656) scored lower than students in the control group (M=1.858), but this difference was not significant (F(1.176)=9.96, p=.21).

Table 6.

ANCOVA results for the "Loops While Condition Is True"

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	11.018a	2	5.51	6.32	.00	.07
Intercept	55.440	1	55.44	63.56	.00	.27
Pre-Test	10.563	1	10.56	12.11	.00	.06
Group	.402	1	.40	.46	.50	.00
Error	150.891	173	.87			
Total	546.000	176				
Corrected Total	161.909	175				

Table 6 summarizes the ANCOVA results for the "Loops While Condition Is True" dimension. The ANCOVA analysis, in which the "Loops While Condition Is True" post-test scores were the dependent variable and pre-test scores were the control variable, did not find a significant difference between the experimental and control groups. Therefore, participants in the experimental group had lower pre-test scores (M=1.430) than students in the control group (M=1,526), but this difference was not significant (F(1.176)=6.32, p=.50).

Table 7.

ANCOVA results for "Basic Functions"

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	38.211a	2	19.10	13.77	.00	.13
Intercept	53.394	1	53.39	38.49	.00	.18
Pre-Test	38.211	1	38.21	27.55	.00	.14
Group	.002	1	.00	.00	.97	.00
Error	239.970	173	1.39			
Total	860.000	176				
Corrected Total	278.182	175				

Table 7 summarizes the results of ANCOVA in terms of "Basic Functions". According to the ANCOVA analysis, in which the post-test scores of the Basic Functions were the dependent variable, and the pre-test results were the control variable, no significant difference was found between the experimental and control groups. According to this table, although the participants in the experimental group (M=1.815) scored lower than the students in the control group (M=1.821), this difference was not significant (F(1.176)=13.77, p=.97).

4.2. Computational Thinking Self-Efficacy

Table 8.

ANCOVA results in terms of Algorithm Design Self-Efficacy.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	729.757a	2	364.88	18.59	.00	.18
Intercept	2049.913	1	2049.91	104.42	.00	.38
Pre-Test	687.004	1	687.00	34.99	.00	.17
Group	13.823	1	13.82	.70	.40	.00
Error	3396.237	173	19.63			
Total	68539.000	176				
Corrected Total	4125.994	175				

Table 8 summarizes the results of ANCOVA in terms of Algorithm Design Self-Efficacy. According to the ANCOVA analysis, in which the post-test scores of Algorithmic Design Self-Efficacy were the dependent variable, and the pre-test results were the control variable, no significant difference was found between the experimental and control groups. Despite scoring higher than the students in the control group (M=18.846), the participants in the experimental group (M=19.409) did not have a significant difference (F(1.176)=18.59, p=.40).

Table 9.

ANCOVA results in terms of Problem-Solving Efficacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	573.810a	2	286.90	29.01	.00	.25
Intercept	334.666	1	334.67	33.84	.00	.16
Pre-Test	560.393	1	560.39	56.67	.00	.25
Group	17.996	1	18.00	1.82	.18	.01
Error	1710.826	173	9.89			
Total	106172.000	176				
Corrected Total	2284.636	175				

Table 9 summarizes the results of ANCOVA in terms of Problem-Solving Self Efficacy. According to the ANCOVA analysis, in which the post-test scores of Problem-Solving Competence were the dependent variable, and the pre-test results were the control variable, no significant difference was found between the experimental and control groups. When controlling for pre-test results, the participants in the experimental group (M=23.979) scored lower than the students in the control group (M=24.619), but this difference was not significant (F(1.176)=29.01, p=.18).

Table 10.

ANCOVA results in terms of the Data Processing Efficacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	260.643a	2	130.32	11.95	.00	.12
Intercept	1611.190	1	1611.19	147.75	.00	.46
Pre-Test	247.865	1	247.86	22.73	.00	.12
Group	12.545	1	12.54	1.15	.28	.01
Error	1886.578	173	10.90			
Total	46027.000	176				
Corrected Total	2147.222	175				

Table 10 summarizes the results of the ANCOVA in terms of the dimension of Data Processing Efficacy. In the ANCOVA, the Data Processing efficacy final test scores constituted the dependent variable, and the pre-test results were the control variable. No significant difference was found between the experimental and control groups. Participants in the experimental group (M=16.054) scored higher on the pre-test than the control group (M=15.520), but this difference was not significant at a meaningful level (F(1.176)=11.95, p=.28).

Table 11.

ANCOVA results in terms of the Basic Programming Efficacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	171.025a	2	85.51	14.05	.00	.14
Intercept	817.348	1	817.35	134.28	.00	.44
Pre-Test	156.330	1	156.33	25.68	.00	.13
Group	11.012	1	11.01	1.81	.18	.01
Error	1053.015	173	6.09			
Total	22807.000	176				
Corrected Total	1224.040	175				

Table 11 summarizes the results of the ANCOVA in terms of the dimension of the Basic Programming Efficacy. The ANCOVA results showed no significant difference between the experimental and control groups; the Basic Programming Competence final test scores were the dependent variable, and the pre-test results were the control variable. According to this table, although participants in the experimental group (M=11.321) scored higher on the pre-test than the students in the control group (M=10.821), this difference was not significant at a meaningful level (F(1.176)=14.05, p=.18).

Table 12.

ANCOVA results in terms of Self-Confidence

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	99.487a	2	49.74	11.51	.00	.12
Intercept	487.262	1	487.26	112.70	.00	.39
Pre-Test	92.962	1	92.96	21.50	.00	.11
Grup	4.732	1	4.73	1.09	.30	.01
Error	747.945	173	4.32			
Total	25952.000	176				
Corrected Total	847.432	175				

Table 12 summarizes the results of the ANCOVA in terms of the dimension of the Self-Confidence ANCOVA in terms of the dimension of the Self-Confidence. No significant difference was found between the experimental and control groups with control in the pre-test scores. Participants in the experimental group (M=11.781) scored lower on the pre-test when the results of the control group (M=12.109) were controlled, but this difference was not significant at (F(1.176)=11.51, p=.30).

5. Discussion and Conclusion

Studies have been conducted to understand the role of information technology and mathematics lessons in acquiring computational thinking skills (Cui & Ng, 2021; Ng & Cui, 2021; Sung & Black, 2020). This study examines the role of activities that present the gains from these two subjects together in developing Computational Thinking skills. Toward this end, activities designed for middle school 6th-grade students were implemented. Experimental group students applied supported activities on topics included in the teaching program of the first term mathematics lesson order of operations, negative numbers, division rules, and prime numbers) using the Scratch program, while the control group students carried out game design activities according to the information technology and software teaching program using the Scratch program. In the research in which the pre-test-post-test-control-group design was used, the students' mean scores obtained from CTT and CTSES were compared.

5.1. Computational Thinking Skills

In the CTT scope, there are seven sub-dimensions: basic sorting, loops that repeat a specific number of times, loops that run until a condition is met, simple conditional statements and complex conditional statements, loops that run as long as the condition is true and simple

functions. The experimental process result indicated no statistically significant difference between the experimental and control group students in any dimension. Since the basic sorting dimension consists of relatively easy questions that include coding (move forward, turn right, and turn left) operations at an introductory level, it can be thought that both groups scored at similar levels. In addition, existing pedagogical and methodological might not provide a fundamental to merge math and introductory computer science education (Nordby et al., 2022).

Students in both groups have carried out block-based coding activities in their 5th-grade Information Technology and Software classes and are experienced in this regard. Indeed, Çetin et al. (2020) showed that as the class level increases, Computational Thinking scores also increase accordingly. Therefore, taking information technology-oriented lessons and having content that can contribute to computational thinking in different lessons may have also positively affected students' natural cognitive development process. As in many points reached in the study, this situation may have caused no significant difference between the experimental and control groups in the basic sorting dimension. According to Durak and Saritepeci (2018, p. 200), computational thinking is highly predicted by ways of thinking, maths class academic success, attitude against maths class, level of education, science class academic success, information technologies academic success, attitude against information technologies class, sex, IT usage experience, period of daily internet use and attitude against science class. This situation may have also reduced the effect of the experimental process.

When the pre-test scores were controlled, there was no significant difference between the experimental and control group students in the section on loops that repeated a specific number of times. However, the students in the experimental group scored higher, although not at a significant level, than those in the control group. This dimension consists of questions that require a specific operation or operations to be repeated a specific number of times. These questions require the student to identify repeating patterns, determine the number of repetitions, and order the codes accordingly if any errors exist. Therefore, it can be thought that the activities with mathematics support in the experimental group positively affected the student's performance in this field. As in the basic sorting dimension, when the student's natural development is thought to affect the computational thinking skill, the possibility of obtaining a non-significant but higher difference in the loop dimension in a purified environment from these effects emerges. Therefore, using concepts such as pattern recognition

in computer science can contribute significantly to information processing thinking skills. In fact, within the scope of CT skills, students must recognize when algorithm steps are repeated, while at the same time, it is common in mathematics to repeat a primary step, such as adding a unit to achieve a broader goal or placing a length unit in order to perform a task. The relationship between these two disciplines is thought to be synergistic (Rich et al., 2019).

The dimension of "loops with a specific number of repetitions" consists of repetitive operations that require proper ordering until a condition is met. When controlling for pre-test scores in this dimension, it was found that although the experimental group of students scored higher than the control group, the difference was insignificant. For example, in an activity related to prime numbers, the students in the experimental group used the concept of loops to determine whether a number is prime or not while adhering to certain conditions. In this context, it can be argued that such activities support students' development in this area. Indeed, it can be said that activities in the context of mathematics classes have the potential to be transferred to programming education in terms of being concrete, containing concepts encountered in daily life, and being frequently used, for example, when subtracting a large number from a small number, there is a back-repeating counting process and a stopping point (Cui & Ng, 2021).

No significant difference between the experimental and control groups regarding simple and complex conditional statements was found. However, the students in the control group did score higher than the experimental group, albeit not significantly. In that dimension, simple conditional statements were asked but presented within repetitive loops until the condition was met. Similarly, in the questions of the complex conditional statements dimension, the questions were given again within repetitive loops until the condition was met. However, the condition structure was presented with multiple options: "If...then... Else...". It is possible that the activities the students in the control group applied had more conditional statements, which may have led to more support for these students in this area. Indeed, Cui and Ng (2021) pointed out that students' difficulties in learning a computational thinking environment and in the process that includes mathematical concepts and problem-solving applications are combined. Therefore, in mathematics-supported programming education, the experimental group students' effort to learn mathematical and programming concepts together may lead them to choose various ways in terms of prioritizing mathematics or programming. In this context, experimental group students might give priority to mathematical concepts. In addition, the

limited presence of essential mathematical topics and topics containing simple or complex conditional statements in the education process that students have received until 6th grade may have limited the potential difference to be in favor of the experimental group. Therefore, conditional statements in the created mathematical activities may have been limited. As mentioned above, the presence of game design-based activities in the control group and the need for many conditional structures from simple to complex in the nature of games may have led to the control group scoring higher, even if the result was not significant.

5.2. Computational Thinking Self-Efficacy

The Algorithm Design self-efficacy includes topics such as what an algorithm is, creating simple and conditional algorithms, predicting the algorithm's output, and debugging. It was observed that the views of the students in the experimental group on these topics were higher than those of the control group, even if the difference was not statistically significant. While solving mathematical problems, students naturally perform algorithm design stages, which may have led the experimental group students to see themselves as more competent in algorithms. Indeed, Lockwood et al. (2016) defined algorithmic thinking as a logical, organized way of breaking down a complex goal into a series of (sequential) steps using existing tools. It can be argued that mathematics-supported programming activities contain more concrete examples that support students' algorithmic thinking skills.

When examining the pre-test results in the dimension of Problem-Solving self-efficacy, it is observed that the students in the experimental group scored lower than the control group students, but the difference is insignificant. This dimension includes topics related to problem-solving skills. Mathematics is one of the most challenging subjects for students. The perception of mathematics as brutal may also have led to a decreased perception of problem-solving skills. The cognitive load of the primary programming education taught with mathematical activities may have increased for students, reducing their perception of problem-solving competency. Similarly, Psycharis and Kallia (2017) found that mathematics and programming education did not significantly affect students' problem-solving skills. Therefore, more research is needed to clarify the reasons for this situation.

The questions in the Basic Programming self-efficacy include topics such as variables, conditional structures, loops, and arithmetic operators. The students in the experimental group

scored higher, albeit not at a statistically significant level, than the control group students. This could be attributed to the fact that the mathematical activities included in the experimental group also involved the use of arithmetic operators, which may have increased the students' confidence in their abilities related to basic programming skills. Opposite results were gained from the examination of the self-confidence dimension. The control group students' firmer belief in their programming abilities may be attributed to their exposure to more complex activities and more remarkable development in abstraction, decomposition, algorithmic thinking, and problem-solving while designing games.

Despite the insignificant differences and reasons discussed in the self-efficacy, it should be noted that these differences are pretty slight and that a variety of factors, such as the environment in which the activity took place, different variables related to the students, and information learned in other classes may have contributed to the slight differences observed. Additionally, the differences that emerged may have been random and have the potential to evolve differently in repeated measurements. Therefore, it is recommended to approach the relevant results in the aforementioned situations with caution. Due to the commonalities in the nature of mathematics and programming, it is recommended that in-depth studies should be carried out. In this context, the relationship between mathematics and each dimension of computational thinking skills should be focused. In particular, the experimental investigation of cognitive skills such as algorithmic thinking and problem-solving and the investigation of the effect of programming activities will reveal essential findings in the field.

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Research Article

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Predisposition of Teachers in Turkey for Democratic School as an Alternative School Type

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Abstract

This research aims to uncover the perceptions of classroom teachers regarding the concept of 'democratic schools,' which have emerged as an alternative to traditional educational institutions. To achieve this objective, researchers developed a semi-structured interview form. Insights were gathered from 20 classroom teachers working in public primary schools in four districts affiliated with Izmir Province, selected through maximum diversity sampling method. Data were analyzed using content analysis techniques. The primary findings obtained are: The characteristics of stakeholders associated with the democratic school in teachers' minds are largely consistent with the features found in existing democratic schools. 'Love and respect,' 'equality and justice,' and 'honesty' are the predominant values delineated by teachers in their conceptualization of the democratic school. Participants believe that decision-making in the school entails equal voting rights for everyone, and each individual is responsible for the decisions made. Most teachers envisage democratic schools as being rich in classroom materials and equipment. Participants envision a classroom climate in a democratic school as 'peaceful and joyful,' characterized by 'mutual respect among individuals.' More than half of the teachers conceptualize that there are no examinations or assessments in the envisioned democratic school. In contrast, some imagine the implementation of multiple assessments. In the minds of participating teachers, decisions concerning student graduation or progression to the next grade in the democratic school are determined by the teacher, contingent upon specific conditions being met. In managing discipline within the democratic school as perceived by participating teachers, methods such as 'establishing communication and collaboration,' 'applying problem-solving strategies,' and 'focusing on the student' are employed. Despite limited knowledge of, and lack of experience working in democratic schools, the majority of participant teachers demonstrated a considerable inclination an understanding of the democratic school in various aspects based on these findings.

Keywords: Alternative schools, Democratic education, Democratic school, Teacher

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Türkiye'deki Öğretmenlerin Alternatif Bir Okul Türü Olan Demokratik Okula Yatkınlığı

Özet

Bu araştırmada sınıf öğretmenlerinin, geleneksel okullara bir alternatif olarak ortaya çıkan "demokratik okul" hakkında ne düşündükleri ortaya koyulmaya çalışılmıştır. Bu amaçla araştırmacılarca yarı yapılandırılmış görüşme formu geliştirilmiştir. Bu form kullanılarak İzmir İline bağlı 4 ilçedeki kamu ilkokullarında görev yapan ve maksimum çeşitlilik örnekleme yöntemiyle seçilen 20 sınıf öğretmeninden görüş alınmıştır. Veriler içerik analizi tekniğiyle analiz edilmiştir. Elde edilen temel bulgular şunlardır: Öğretmenlerin zihinlerindeki demokratik okulun paydaşlarının özellikleri, mevcut demokratik okuldaki özelliklerle büyük ölçüde uyumludur. Sırasıyla "Sevgi ve saygı", "eşitlik ve adalet" ve "dürüstlük", öğretmenlerin zihinlerinde şemalandırdıkları demokratik okulun başat değerleridir. Katılımcılar, karar almada okuldaki herkesin eşit oy hakkı olduğunu ve alınan kararlardan yine herkesin sorumlu olduğunu düşünmektedirler. Öğretmenlerin çoğu, demokratik okulların sınıflarının materyal ve donanım açısından zengin olduğunu kurgulamaktadırlar. Katılımcılar demokratik okulda "huzurlu ve mutlu" ve "herkesin birbirlerine saygılı olduğu bir sınıf ikliminin bulunduğunu hayal etmektedirler. Öğretmenlerin yarıdan fazlası kurguladıkları demokratik okulda sınav ve değerlendirme sürecinin bulunmadığını, bazıları ise çoklu değerlendirme yapıldığını kurgulamışlardır. Araştırmaya katılan öğretmenlerin zihnindeki demokratik okulda, öğrencilerin mezun olmasına veya bir üst sınıfa geçmesine, belirli koşulların sağlanması koşuluyla, öğretmen karar vermektedir. Katılımcı öğretmenlerin zihinlerindeki demokratik okuldaki disiplin sürecinde "iletişim ve işbirliği kurma", "problem çözme yöntemi uygulama" ve "öğrenciye odaklanma" yolları kullanılmaktadır. Bu sonuçlardan hareketle, demokratik okulda görev yapmayı deneyimlememelerine ve çoğunun bu konuda bilgi sahibi olmamasına rağmen öğretmenler, birçok açıdan demokratik okula yatkın bulunmuştur.

Anahtar Kelimeler: Alternatif okullar, Demokratik eğitim, Demokratik okul, Öğretmen

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1. Introduction

A modern culture or institution, draws upon the patterns of industrialization, technology, and economic advancement that have proliferated globally since the early 19th century. In modern systems, major formal establishments such as government bodies, corporations, universities, and schools pursue their objectives by utilizing humankind as a resource to prioritize production and development to the utmost degree. Individuals are expected to obey these institutions and play their respective roles in ensuring the smooth operation of this social machinery. Essentially, people do not manage institutions; rather, they are managed by institutions. Modern society is labeled as technocracy; the decision-makers are not human beings (democracy), but rather the merciless mechanical routines of the system (Miller, 2010). Examining the characteristics of mainstream schools among these mentioned institutions reveals a standardized, centralized, synchronized system where educational decisions are made by experts. Due to its intensive structure, it may be argued that these schools do not accommodate diverse thinking, beliefs, and learning characteristics, producing 'failed' individuals marginalized from society and perpetuating a repressive ideology (Kaya & Gündüz, 2015). Consequently, mainstream schools, in other words, traditional schools, have been questioned for over a century globally, not only by parents and educators but also by young individuals, due to all these aforementioned attributes.

Many studies conducted in Turkey affirm the negative situations concerning traditional schools. According to the results of the 'Monitoring the Student' Project conducted by the Manisa Provincial Directorate of National Education during the 2009-2010 academic year, it was determined that 477 students had run away from school. When asked why they did not attend school and felt the need to run away, a significant portion of these students stated that they skipped school because they were bored with their classes (89 individuals), encountered negative attitudes from teachers (57 individuals), and avoided school due to not completing their homework assignments (34 individuals) (Güçlücan, 2009).

Kayıkçı and Sayın (2010) determined that students attending secondary education institutions were moderately satisfied with their schools. Studies examining how students metaphorically conceptualize concepts related to school have revealed highly negative characterizations developed by students. For instance, in the research conducted by Kesik and Aslan (2020),

middle and high school students described their school happiness using negative expressions such as 'an obligation,' 'hopelessness,' 'dependency,' 'a state of loneliness,' 'a compulsory form of relationship,' and 'an expression of negative experience.' The same study highlighted students perceiving the absence of happiness in school and generally defining happiness in school as 'empty classes.' In other studies, students characterized school as 'a prison,' 'a racecourse,' 'a cage,' 'a boring place,' 'a country ruled by a monarchy' (Saban, 2008), 'a zoo,' 'hell,' 'a horror movie,' 'a robot,' 'a racetrack,' 'a grinder' (Aslan & Doğan, 2016). Additionally, students characterized being a student as 'captivity,' 'slavery,' 'imprisonment,' and 'a situation of being a guinea pig' (Saban, 2009).

Gömleksiz et al. (2008) examined the behavior of school administrators and teachers towards students in terms of children's rights in seven primary schools located in lower, middle, and upper socioeconomic environments. Findings from this research indicated that the students' right to receive education in clean, hygienic, and safe environments was not upheld. It was also revealed that teachers and administrators lacked knowledge and skills in management and discipline, leading to a general exploitation and violation of children's rights. The study observed instances where teachers and school administrators used humiliating words, struck students with sticks/rulers, behaved indifferently, pushed students, reprimanded them, kicked them, and slapped them before, during, and after ceremonies, as well as during breaks.

According to Akyol's study (2019), teachers working in private schools perceive that school principals demonstrate a semi-democratic style of management. In Yavuz's research (2023), middle school principals expressed that schools are not adequately democratic.

Research suggests the prevalence of a culture of fear in schools. Furthermore, the disciplinary system in traditional schools is fear-based, rooted in the belief that a child who does not experience fear cannot learn to be good (Mercogliano, 1998). Advocates of democratic education argue that individuals who experience oppressive education at a young age often carry the remnants of this oppression into adulthood, making it difficult for them to embrace participatory democracy or take an active role in participatory democracy later in life. Hence, proponents of democratic schools view the school as a democratic public space where individuals can experience collaboration, show respect for differences, and resolve conflicts

without violence or any violent elements (Neill, 1990). Therefore, democratic schools emerge as a solution at this juncture.

This research aims to reveal the opinions of primary school teachers regarding the emergence of "democratic schools" as an alternative to traditional schools. The study intends to assess the extent to which teachers approach the characteristics of democratic schools mentioned in the literature. Moreover, this research provides insights into teacher inclinations towards democracy and democratic schooling. It has been deemed valuable to determine whether teachers have inclinations towards transitioning from traditional schools to democratic schools. Democratic schools can be considered the foundation of democratic societies. Undoubtedly, democratic schools require democratic teachers. Therefore, identifying the concept of a "democratic school" in the minds of teachers who apply democracy firsthand and serve as role models to students is crucial. The early years of schooling are pivotal in shaping children's attitudes and beliefs. Hence, gathering opinions from primary school teachers in this research has been particularly relevant.

On a global scale, there are democratic schools at the primary and secondary education levels. Yet, in Turkey, there is a scarcity of actual implementation of democratic schools as a genuine alternative type of education. Despite the increasing interest in the subject, there has not been a widespread inclination towards democratic schools as a subset of alternative education in Turkey. Undoubtedly, it cannot be overlooked that this inclination will unfold gradually over a period. (Gülen Morhayim, 2008) It is hoped that this research, by revealing the thoughts of primary school teachers regarding this type of school, can contribute to the discussions centering on democratic schools.

There is a significant body of research on the topic of democratic schools. Some of these studies include Akyol (2019), who examined the understanding of democratic schools among school administrators from the perspective of teachers. Yavuz (2023) delved into the practical applications and recommendations of school administrators regarding their understanding of democratic schools. Korkmaz (2014) investigated the realization level of a democratic educational environment within classrooms based on teacher perceptions, exploring the factors influencing this level and the barriers to implementing these criteria. Akpınar (2018) scrutinized the structural dynamics of the management style of a school claimed to be based on a

democratic understanding, drawing from the viewpoints of students, teachers, parents, administrators, and individuals associated with the school's environment in order to analyze how these dynamics affected the school's members and its surroundings. Dündar (2007) examined the philosophical foundations feeding the paradigm referred to as "alternative education" in the literature and its manifestation in school practices. Gök (2019) investigated learning experiences in an alternative primary school owned by parents, identifying the components that made it alternative, understanding how internal stakeholders perceived alternative learning environments, and exploring the challenges encountered in practicing alternative education. The current study approximates Gülen Morhayim (2008), utilizing student opinions, aiming to fill a gap in the field by investigating the conceptualization of democratic schools by teachers based on the characteristics of such schools. However, there has been no research encountered that explores teachers' conceptualization of a democratic school based on its characteristics. The intent is for this research to fill this void in the field. Additionally, it is the opinions of teachers working in traditional schools about democratic schools that will contribute to future similar studies and practices, providing valuable data for policymakers, administrators, and teachers in this regard.

1.1. Conceptual Framework

1.1.1. Democratic Education

Democratic education forms the foundation for alternative schools. It is centered on the individual, opening up a realm of freedom based on the right to choose. In such a democratic school, the educators' role is to facilitate the exploration by students of their individual interests and talents, encouraging their progression in those areas once discovered, and providing them with free workspaces within the school. It involves empowering students and other individuals within the school community. Philosophically, thinkers such as J. H. Pestalozzi, F. Freire, L. Tolstoy, A.S. Neill, R. Steiner, J. J. Rousseau, E. Froebel, I. Illich, J. Dewey, J. Holt, E. Goldman, and E. Ferrer have influenced the foundation of these types of schools during the Enlightenment era. Moreover, activists such as L. N. Tolstoy, O. Decroly, A. B. Alcott, A. Bastian, K. Haskins, and J. A. Beane have also played a role in this philosophical foundation (Gök, 2019).

Contemporary educational philosophy, as Dewey pointed out, asserts that "school is not a rehearsal for life, but life itself" (Sönmez, 2015). For future generations, it is not just about knowing democracy; rather, integrating it into daily life within the school, living democracy, will be an effective approach to understanding and developing democracy. Miller (1995) stated that educators who embrace contemporary approaches place freedom and the concept of democracy at the heart of their expectations in education.

Democratic education emphasizes the critical factors of pluralistic learning, establishing relationships between adults and children based on trust, respect, and equality, and utilizing democratic processes in discussions and decision-making mechanisms. This environment not only equips individuals with skills for self-learning and building relationships but also fosters personal and social awareness (Gülen Morhayim, 2008). Karakütük (2001) articulated the aim of democratic education as nurturing individuals who question and analyze according to an independent worldview, internalizing the rules and practices of democracy (cited in Hotoman, 2010).

Democratic education, as stated by Hotoman (2010), is acquired by experiences offered to students. Schools, as prototypes of society, are the places where democratic experiences ought to take place. Moreover, these schools, with their educated staff, possess the capability to develop democratic education through lived experiences. The absence of decision-making authority based on students' interests, desires, and needs in today's traditional schools, along with the lack of a democratic structure within the school, creates the need for democratic schools. In this context, it is believed that traditional, non-democratic schools will eventually be replaced by democratic schools in the future.

In Turkey, democratic education was first mentioned in the 4th Education Summit in 1949. However, despite the intention for democratic education to be among the goals in today's educational institutions in Turkey, it is believed that due to the generally undemocratic structures of schools, the desired education is not fully realized. This situation is clearly evident in research results conducted in recent years (Akyol, 2009; Aslan and Doğan, 2016; Gömleksiz et al., 2008; Kayıkçı and Sayın, 2010; Kesik and Aslan, 2020; Saban, 2008; Yavuz, 2023).

1.1.2. Democratic School

Hecht and Ram (2010) explain the developmental process of present-day democratic schools through three waves, also including free schools within the scope of democratic schools. Accordingly, they categorize the progressive education movement of the early 1900s as the first wave, the emergence of free schools in the 1960s as the second wave, and the development of democratic schools since the 1990s as the third wave.

Based on the foundations of democratic education, democratic schools are institutions centered around the student. They provide equal rights to students alongside other school stakeholders, allowing them the opportunity to make decisions for themselves and take on responsibilities. These schools are managed according to democratic principles. Hecht (2002) mentions pluralistic learning and curriculum that allow students in democratic schools to choose what they will learn, make independent decisions about their learning, and offer opportunities for self-directed learning. The relationship between the teacher and child is based on trust, and students, like teachers, have equal rights and participate in the decision-making process. Therefore, for a student who experiences democracy throughout their school life by practicing it, democracy will not remain confined to definitions or limited applications.

Democratic schools are established by a small number of parents and educators who are generally dissatisfied with the existing education system and aim to ignite the natural developmental process of children. These schools seek to provide students with the opportunity to have both the freedom and responsibility for their own education (Lathrop, 2005). They are not coincidental occurrences but conscious practices carried out by educators and other adults to integrate democracy into life (Apple and Beane, 1995; as cited in Gülen Morhayim, 2008).

According to Şahin and Turan (2004), democratic schools are institutions fundamentally based on values such as "freedom," "democracy," "trust," and "responsibility," where children shape their own education and are administrated in a democratic manner. Education in democratic schools is oriented toward democratic principles, providing individuals with a free space based on their own choices. In such schools, the duty of educators is to facilitate the expression of a child's desires and potential, encouraging, supporting, and granting authority to the child (Dündar, 2013).

These schools place the student at the centre, allowing freedom, and embodying democratic principles and values in their administration. Freedom is not merely a theoretical concept in democratic schools because a child attending such a school does not need to conform to the school; instead, the school should strive to adapt to the student (Mercogliano, 2006). Furthermore, an actively involving student in the administration of a democratic school learns the sense of responsibility through unconventional methods. As they learn these aspects, children also embrace democratic principles such as respect, freedom, equality, and so on (Lathrop, 2005).

Democratic schools are extensively covered in the literature, with sources detailing their definitions and characteristics (Hecht, 2002; Hannam, 2018; Korkmaz, 2014; Mercogliano, 2006; Lathrop, 2005; Dündar, 2013; Şahin and Turan, 2004). Generally, when defining or describing the characteristics of democratic schools, it can be said that they are an educational approach that respects human and children's rights, advocates for the involvement of all stakeholders in the school's governance processes and is a prerequisite for democratic education where all stakeholders have equal rights and students make decisions regarding their learning.

What sets democratic schools apart from mainstream or traditional schools is their self-governing nature. In a democratic school, most of the management processes such as problem-solving, decision-making, planning, organizing, coordinating, communicating, and evaluating are carried out collectively by all members. All decisions concerning the community are made collectively by structures such as the school assembly, school council, or school meetings involving all members (Korkmaz, 2014).

In a democratic school, there are two fundamental aspects of education. The first aspect comprises self-governing and self-directed learning and education, devoid of coercion, competition, mandatory testing, and the fear of failure. Schools under democratic control will eliminate these irrelevant preparations and schoolwork. The goal here is to abandon the production of factory workers or soldiers by designing schools where children can freely think and make their own choices. The more critical second aspect, essential for living on a sustainable planet, involves a process dictated by democratic education principles, where respect for human rights prevails, and each member has an equal right to vote and participate in decisions. Disputes are resolved through judiciary committees (Hannam, 2018).

1.1.3. Basic Concepts of Democratic Education

Below, the concepts related to democratic education, such as "learning," "child," "teacher," "parent," "decision-making process," "discipline," "content," "teaching-learning process and assessment," and "graduation and success" are discussed.

1.1.3.1. Learning

The most enduring, effective, and profound learning is the learning desired by the student. The student selects their own activities and creates their own environment. Through this, the student learns perseverance, communication skills, flexibility, self-discipline, accomplishment, and enjoying life (Şahin and Turan, 2004). Hecht (2002) has pointed out that a child needs to pose questions such as "Where do I come from?" "Where am I?," "Where am I going?," "How will I get there?," and "How will I know I have arrived?" in order to make their own choices and manifest unique qualities through a personalized education.

Some children might enjoy studying through imagination, while for others, studying might be a nightmare. Some might see books as their main source of study, while for others, they might be sleep-inducing. These instances attest to the uniqueness of every individual on the planet. Hence, pluralistic learning constitutes the essence of democratic education. Pluralistic learning is a type of learning that acknowledges each student's uniqueness and provides them with equal rights to manifest their uniqueness (Hecht, 2002). In democratic schools, students should be able to determine what they need to learn based on their interests and desires, decide when and how they want to learn, and by whom they want to learn. In this context, autonomy is granted to the student while aiming to develop a sense of responsibility.

1.1.3.2. Child

Children possess unique qualities, and they require a democratic environment to bring these qualities to light. The innate curiosity for learning within a child should be encouraged in such a way that their inner drive is supported, their creativity nurtured, and ample opportunities provided for self-expression. In a democratic school, a child should be free, (Sönmez, 2015), responsible (Cüceloğlu, 2022), curious (Moulin, 2011), social and happy (Sönmez, 2015).

1.1.3.3. Teacher

The teacher serves as a role model in any setting, whether in a traditional school or a democratic school. In a democratic environment, the teacher can be considered the most crucial source in

demonstrating democracy through their experiences to the students. In other words, the teacher is not merely an information provider but is expected to be motivational, guiding, facilitating, and embracing democratic principles. They should be individuals who adopt and implement democratic principles. Additionally, in schools that implement the so-called Sudbury model, a democratic school model where children play a significant role in administration, the teacher needs to have good communication with students and facilitate learning. To achieve this, they should take on necessary roles beyond traditional teaching roles such as imparting knowledge and guiding students, as outlined by Ellis (2015).

1.1.3.4. Parent

Democratic schools are not only shaped by educators but also influenced by parents who hold a crucial position in their establishment, and they can play an influential role in instilling democratic attitudes and behaviors. Because these schools are not artificial spaces of freedom, parents, in addition to teachers and students, possess equal rights in their relationships with the school. According to Şişman (2010), it's expected that parents participate in school decisions, engage in school activities, and collaborate with other stakeholders within the school (as cited in Akpınar, 2018). It's acknowledged that parents, like other stakeholders, have equal rights within the school. However, if this right interferes with students' ability to make their own decisions to an extent that undermines their autonomy, it would contradict the foundational principles of a democratic school.

1.1.3.5. Decision Process

In democratic schools, students have a say in decisions related to themselves. A participant in decision-making processes becomes more empowered and requires less supervision. As a result, the student becomes more motivated, and the mechanism of identification comes into play (Bursalıoğlu, 2019). In a democratic school, as mentioned by Hecht (2002), this process occurs through parliament, judicial committees, and executive committees, maintaining a democratic approach. For instance, at SVS (Sudbury Valley School), there is a school meeting held weekly where all stakeholders can contribute to the decision-making process (Ellis, 2015).

1.1.3.6. Discipline

In traditional schools and even in society, children are disciplined through fear (Mercogliano, 1998). However, in democratic schools, where there is freedom of expression, participation in

decision-making, the ability to make decisions about oneself, and taking responsibility, the need for supervision decreases.

At Sudbury Valley School (SVS), issues are resolved through the school's judicial system, involving students and school staff. There is no fear among students of their teachers or other school personnel. Students learn to resolve problems face-to-face and understand that justice applies to everyone (Ellis, 2015). Furthermore, in a democratic school, rewards are not based on externally imposed rules. Instead, when a student finishes their work, they experience intrinsic satisfaction, which is the best reward for them. External rewards can quickly turn into bribes (Neill, 1990).

1.1.3.7. Content, Learning-Teaching Process and Evaluation

At Sudbury Schools, within the framework of a natural educational approach, where there are no specific curriculums, standards, or exams, students direct their own studies. Traditional-style classes are rarely conducted and only based on student requests. The absence of a specific curriculum and standardized assessment signifies a departure from evaluating every student based on the same standards and aims to guide them towards self-assessment. A standardized assessment would contradict the philosophy of a democratic school (Ellis, 2015).

The learning-teaching process is primarily seen as a form of play. In democratic schools, activities most preferred by students include play and conversation. These schools aim to direct a child's energy for creativity and research towards learning. Village School, a democratic school, emphasizes the importance of play by stating, "If you don't play with something, you can't understand how it works" (Village School, n.d.).

1.1.3.8. Graduation and Success

In traditional schools, success is defined as achieving high grades in exams and being at the top of the class. However, the evaluation of what students have learned is often reliant on someone else (the teacher), and there may not be autonomy in self-assessment, leading to an undemocratic assessment process. In contrast, in a democratic school, students have a say in evaluating their own learning process.

At Summerhill, students move up to the next class through personal discussions. Meanwhile, at Sudbury Valley School, when a student feels ready to graduate, they are required to prepare a thesis demonstrating their readiness to become a responsible citizen in the community.

Students present this thesis to the school graduation committee, and if they receive at least 2/3 of the votes, they are eligible to graduate (Şahin & Turan, 2004; as cited in Gülen Morhayim, 2008). As observed, democratic schools display differences in their distinct democratic developments and unique learning processes.

In this research aiming to elucidate the concept of "democratic school" in teachers' minds, the following questions were addressed: What are teacher views on (1) stakeholders, (2) shared values, (3) decision-making processes, (4) teaching processes, (5) assessment processes, and (6) the concept of discipline in a democratic school.

2. Method

2.1. Research Model

In this study, the qualitative research model of phenomenology has been employed. Phenomenology represents a natural approach to defining the assumptions used to make sense of the everyday world. This model focuses on the meanings individuals construct based on their experiences of a particular phenomenon, and the data sources in this model typically involve individuals or groups (Creswell, 2021). This research delved into the tendencies of classroom teachers towards democratic schools, examining their perspectives on this educational model to some extent. Although the participants may not have experienced working in a democratic school, the assumption was based on the idea that they might consider the mentioned school to be the complete opposite of the traditional school they have experienced.

2.2. Target Group

The study group of the research consists of 20 classroom teachers working in state primary schools in the city center of Izmir, Turkey, selected using a maximum diversity sampling method (Table 1). Diversity was considered in the sample regarding the participants' gender, educational level, age, field of expertise, years of teaching experience, and the location of the school where they are employed.

Table 1.

Target group information

Code	Gender	Teaching Experience (Year)	Education Level	District of duty	Knowledge about democratic school
Zübeyde	Female	30	Bachelor	Konak	No Knowledge
İlknur	Female	24	Bachelor	Konak	No Knowledge
Serap	Female	22	Bachelor	Karşıyaka	No Knowledge
Bahar	Female	23	Bachelor	No Knowledge	No Knowledge
Emine	Female	20	Bachelor	Karabağlar	Little knowledge
Filiz	Female	17	Master	Karabağlar	Little knowledge
Elif	Female	19	Master	Buca	No Knowledge
Baran	Male	25	Bachelor	Buca	No Knowledge
Kerem	Male	21	Bachelor	Karşıyaka	Little knowledge
Fatma	Female	24	Bachelor	Konak	No Knowledge
Yasemin	Female	23	Bachelor	Karşıyaka	Little knowledge
Nuray	Female	21	Bachelor	Karşıyaka	No Knowledge
Öykü Naz	Female	24	Bachelor	Buca	Has knowledge
Mehmet Ali	Male	31	Bachelor	Buca	Little knowledge
Mustafa	Male	18	Bachelor	Konak	No Knowledge
Murat	Male	34	Bachelor	Buca	Little knowledge
Erdem	Male	28	Bachelor	Karabağlar	No Knowledge
Aslı	Female	32	Bachelor	Karabağlar	No Knowledge
Namık	Male	31	Bachelor	Buca	No Knowledge
Ayşe	Female	26	Bachelor	Karşıyaka	No Knowledge

As seen in Table 1, among the participants, 13 are female, and 7 are male. Three of the participants have been teaching for 20 years or less, nine for 21-25 years, two for 25-30 years, and five for 31 years or more. Two teachers hold a master's degree, while the remaining 18 teachers have completed their education at the undergraduate level. Seven teachers work in primary schools in Buca, five in Karşıyaka, four in Karabağlar, and four in Konak districts of Izmir, Turkey. Twelve of the participating teachers stated that they do not have knowledge about democratic schools, six have some knowledge, and two teachers mentioned that they have information about these schools.

2.3. Instrument

The researchers used a semi-structured interview form prepared by them as a data collection tool to determine the participants' views on the democratic school, or in other words, how inclined they were towards this particular school model. Each interview question was formulated to understand how teachers conceptualized the democratic school, starting with the

phrase "Let's imagine...". Expert opinions were obtained from four faculty members in the Education Administration Department of a public university, including four teachers who were also students in the Education Administration and Supervision master's program. Additionally, one faculty member from the Turkish Language Education Department reviewed the language aspects of the questions in the measurement tool. Following the feedback, after conducting a pilot study with four teachers using the finalized form of questions, the actual implementation took place. For instance, the second research question was formulated as follows:

"Let's imagine a democratic school. You notice a wall where the values of this school are written. What do you think are the values/values written here? Why? Could you explain? What demonstrates the existence of these values in this school? Could you provide examples?"

2.4. Data collection methods

Research data was collected during the last phase of the global Covid-19 pandemic when schools were closed in Turkey. As a result, face-to-face interviews could not be conducted. Instead, appointments were scheduled with teachers, and interviews were conducted via the internet with audio recordings. The duration of each interview was approximately 60 minutes. After transcribing the participants' responses, the written content was sent to their email addresses. Participants were asked to review the text and make any changes, deletions, or additions if they wished. Except for three participants, no alterations were requested in their responses.

2.5. Data analysis

The responses provided by the participants were analyzed using the content analysis technique. Content analysis involves a closer examination of the obtained data to reach concepts and themes that explain these data (Yıldırım and Şimşek, 2008). Initially, all interview texts were read by two researchers, and the texts were categorized into themes and categories. Subsequently, the two researchers collaborated to compare the analysis results and reached a consensus. Different names were used instead of the participants' real names.

3. Result

In this section, the analysis results of the responses given by the teachers to the questions asked to determine their inclination towards democratic schools have been discussed.

3.1. Teachers' views on stakeholders in a democratic school

In order to obtain the opinions of the teachers regarding the stakeholders in a democratic school, they were asked the primary question, "When you hear the term 'democratic school,' what comes to your mind regarding the individuals in this school?" To elaborate on this question, participants were further asked, "How would you define a teacher? Why?", "How would you define a student? Why?", "How would you define a school administrator? Why?", "How would you define support staff? Why?", "How would you define parents? Why?", and "How would you describe the relationship between these individuals? Why?" The teachers' opinions regarding the stakeholders in a democratic school were grouped under six themes: "teacher," "student," "school administrator," "support staff," "parent," and "relationships among school stakeholders." Below are the presented themes along with the categories gathered under these themes, and some of the participants' views are explained directly through quotations.

Theme 1. Teacher: Teachers, in their perceptions of a teacher in a democratic school, mostly emphasized the qualities of being a "guide, facilitator, and encourager of critical thinking" (mentioned by 8 participants). They also mentioned characteristics such as being an "effective communicator" (6 participants), "open to innovation and development" (5 participants), "collaborative" (5 participants), "fair" (4 participants), "free" (4 participants), "democratic" (3 participants), "leader of the class" (3 participants), "versatile and intellectual" (3 participants), "role model" (1 participant), "competent in their field" (1 participant), "hardworking and responsible" (1 participant), "patient" (1 participant), and "observer" (1 participant).

Zübeyde, one of the teachers who expressed her opinion on this issue, said:

"The teacher knows how to listen. They observe well. They set an example for their colleagues and students. Because they themselves should be fair and democratic so that their surroundings are too. They don't make quick decisions; they listen to everyone and take them into account. They are patient. Because listening to everyone, everything, all the time is not easy. It is necessary to show students 'How can a democratic student be?', 'What does democracy mean?', 'How to be fair?' For instance, through elections..."

This emphasizes that the teacher working in a democratic school possesses effective communication skills, is fair, and is a democratic individual, showcasing these qualities through their actions.

Theme 2. Student: Teachers have expressed that the student in their minds within a democratic school setting is primarily seen as the most “free" individual (9 participants). Among the attributes of this particular student, they are also described as "self-confident" (7 participants), "responsible" (4 participants), "actively engaged in lessons" (3 participants), "problem solver" (1 participant), "happy" (3 participants), "effective communicator" (2 participants), "fair and egalitarian" (1 participant), and "mature" (1 participant).

Fatma, serving as a teacher for 24 years, indicated that the student in a democratic school in her mind as follows:

”The students are happy, their emotional states are positive, they don’t carry heavy backpacks, and they are free. There are no walls in the schoolyard. They run and play in a green, grassy area. There are places where animals are raised and plants are grown. Perhaps the children take on tasks in these places on a daily or hourly basis. In the cafeteria, they work on tasks that aren’t dangerous. No one follows behind them to pick up their trash. They are capable of doing their own work for the sake of individual equality and taking responsibility for themselves. They can self-regulate. Students can choose classes based on their interests and talents. They don’t spend too many hours on subjects they are not interested in. They don’t have fixed classrooms. They respect their teachers.”

With these statements, it is understood that Teacher Fatma emphasizes that in a democratic school, the student is not only free but also a happy, responsible, self-regulated, and respectful individual.

Theme 3. School administrator: More than half of the participating teachers have reported that in their perception of a democratic school, the school administrator embodies the characteristic of being "fair and egalitarian" (11 participants). Additionally, the teachers have envisioned other characteristics of the school administrator in the democratic school as follows: having a "participatory management approach" (7 participants), being a "facilitator and organizer of school operations" (6 individuals), an "effective communicator" (4 participants), "visible and accessible everywhere" (4 participants), a "guiding force," "motivational and honoring" (3 participants), a "problem solver" (2 participants), possessing "merit" (2 participants), being

"responsible" (2 participants), "engaging and empathetic" (2 participants), "open-minded" (1 participant), "paternal/maternal" (1 participant), and an "effective observer" (1 participant).

Zübeyde, a teacher with 30 years of professional experience, described the manager of her democratic school as follows:

"The administrator takes into account all ideas from school staff; they don't act independently. They listen to everyone and implement their views because where there is democracy, the school should be managed together with teachers, administrators, and of course, students. We might not be able to see some things. What is discussed in the school should be communicated to higher authorities. The school administrator conducts meetings at the school to gather parents' opinions about practices in the democratic school. The school administrator frequently meets with students and teachers at the school. Planning for democratic practices is made together."

With these views, teacher Zübeyde underlined that the administrator of her dream democratic school is fair and egalitarian and also has a participatory management approach.

Theme 4. Support staff: Approximately half of the teachers have expressed that in their envisioned democratic school, the support staff is "responsible and hardworking" (9 participants). According to participating teachers, among the characteristics of the support staff in their envisaged democratic school, the second most mentioned trait is being "valued" (5 participants), followed by having "expertise in different areas" (4 participants), being "respectful, understanding, and loving towards children" (3 participants), and being "friendly and helpful" (2 participants). Additionally, one teacher each described the staff in the democratic school as "free," "democratic," and "happy."

Teacher Erdem, who has 28 years of professional experience, compared the assistant staff in the traditional school with the democratic school in his mind and expressed the following opinions on this subject:

"In traditional schools, the school staff perceives themselves as the least valued members because they feel like subordinates. For instance, their tasks are communicated to them in a commanding tone, orally. However, in a democratic school, they perceive themselves as crucial cogs in the wheel. They know that what they do is valuable. For example, ensuring the cleanliness and security of the school, etc."

Erdem teacher's observations indicate that within the current school organization, he believes that the school staff doesn't receive the deserved value. However, he mentions that in his envisioned democratic school, this situation is reversed.

Theme 5. Parents: The characteristic most frequently mentioned (12 participants) among the teachers participating in the study regarding the parents of a democratic school is "collaborative and supportive." More than a quarter of the participants envision the parents in the democratic school as an "equal component of the school." Other qualities attributed to these parents of the mentioned school include being "conscious and educated" (5 participants), "respectful and trusting of the teacher" (5 participants), and lastly, being "happy and peaceful" (1 participant) according to the expressions of the participants.

"Parents are always open to collaboration. They are not intrusive. They provide support to the school administration and teachers both financially and morally. They trust the expertise of the teacher. They are aware that they are one of the cornerstones of the school."

Aslı, like many other teachers participating in the research, has conceptualized that parents in a democratic school provide support to the school in every aspect.

Theme 6. Relationships among school stakeholders: Half of the teachers participating in the research suggested that stakeholders in a democratic school engage in communication based on "politeness, honesty, and trust." "Strong collaboration, interaction, and mutual assistance" ranked second (7 participants). Additionally, stakeholders in the envisioned democratic school, according to the participants, "value each other" (2 participants), establish "harmonious" (2 participants), and "friendly" (1 participant) relationships.

Mehmet Ali, expressing his thoughts about the relationships among individuals in a democratic school, highlighted the prevalence of positive human relationships by stating, *"Everyone, from the support staff to the teachers, from the students to the administrators, comes to school eagerly. This is because everyone trusts each other and acts extremely honestly towards one another. There is a sense of sharing among everyone. They are friends, companions..."* This underscores the presence of positive interpersonal dynamics within that context.

3.2. Teachers' views on the shared values of the democratic school in their minds

The teachers participating in the research were asked questions to understand the shared values of the democratic school they envisioned. They were asked, "Let's imagine a democratic school. You notice a wall where the values of this school are written. What do you think are the values/value written here? Why? Could you explain? What are the things that demonstrate the existence of these values in this school? Could you provide examples?" The shared values of the democratic school envisioned by the teachers were not thematically categorized; instead, these values were ranked in terms of their frequency from highest to lowest. According to this ranking, more than half of the teachers (11 individuals) emphasized that "love and respect" were adopted as values in the democratic school. Secondly, "equality and justice" (9 individuals) and "honesty" (9 individuals) were mentioned. Thirdly, "tolerance" (8 individuals), followed by "empathy" (7 individuals), "freedom" (6 individuals), "kindness and solidarity" (4 individuals), "peace and brotherhood" (3 individuals), and in the eighth place, "unity and togetherness" along with "responsibility" (2 individuals) were values perceived as adopted in the envisioned democratic school by the teachers. Additionally, one participant identified "happiness," "modernity," and "determination" as values adopted in the mentioned democratic school.

Baran, who mentioned that he does not have any theoretical knowledge about democratic schools, stated that the values adopted in the envisioned democratic school are "love, respect, tolerance, equality, and justice." He expressed, "Because these values are what we long for in the society we live in." Regarding the indicators of these values in the imagined democratic school, Baran teacher expressed the following view:

"Values are taught to students through exemplary situations, stage plays, and fictional scenarios. Participation of individuals in all kinds of school-related decisions is ensured. Thus, democratic elements are put into action. Students are given the opportunity to send the best message to each other as active individuals."

Namık, who indicated knowledge about democratic schools and possesses 31 years of teaching experience, expressed that the prominent values in the envisioned democratic school are 'rights and freedom,' 'honesty,' 'sincerity,' 'tolerance,' 'love,' 'respect,' and 'freedom.' As reasons for this

perspective, Namık mentioned, "Because these are essential qualities that a democratic person should possess."

3.3. Teachers' views on the decision process in democratic schools

To gather teachers' opinions regarding the decision-making process in a democratic school, they were asked the following questions: "Let's imagine you are in a democratic school. The school's notice board displays school rules. In your opinion, who decides what these rules will be, when, and how? Additionally, who is responsible for implementing the decisions? How and by whom is the implementation process of decisions monitored?"

After analyzing the teachers' views on the decision-making process in a democratic school, their opinions were categorized into six themes: "decision-makers for school rules," "timing of decision-making for school rules," "method of decision-making for school rules," "responsibility for implementing decisions," "controllers of decision implementation," and "method of overseeing decision implementation." These themes are presented below, along with their respective categories.

Theme 1. Decision-makers for school rules: Half of the participating teachers expressed that in their envisioned democratic school, decisions regarding rules were made by "all internal stakeholders of the school." Three teachers envisioned that in the democratic school, "students" were the decision-makers for school rules, while another three teachers mentioned that it was the "students and teachers" jointly determining these rules. Two teachers stated that in their envisioned democratic school, "every stakeholder" had a say in decisions related to themselves. Additionally, one teacher imagined that in the democratic school, the "Ministry of National Education (MNE)" was responsible for making decisions about school rules, and another teacher mentioned that it was the "MNE, school administration, and teachers" collectively deciding on these rules.

The opinion of a teacher, who expressed having no knowledge about democratic schools and has been teaching for 24 years, emphasized the involvement of all individuals in the school in decision-making in the envisioned democratic school.

"Decisions are made collectively by all participants: teachers, students, staff, and school administrators. These decisions are not made as if they were taken together... There are certain situations that are akin to the constitution of education. These are already established. Beyond these issues, teachers, administrators,

students, parents, and other staff share their opinions. All stakeholders are together. Something that doesn't occur to a parent about a certain issue might come to a teacher's mind. Everyone reflects their own perspective. Individuals in this environment know that they can freely express their opinions, feel safe, and won't be judged. In short, in the democratic school I envision, all members of the school participating in decision-making." (İlknur)

Theme 2. Timing for decision-making on school rules: More than half of the participating teachers (12 participants) expressed that in their envisioned democratic school, decisions about school rules are made "at the beginning of the academic year." Four teachers mentioned "at the beginning of the academic year and as needed," two teachers said, "as needed," one teacher stated, "at the establishment of the school and as needed," and one teacher mentioned "at the end of the academic year for the next academic year."

Filiz, a teacher who indicated having limited knowledge about the democratic school, like many other participants, conveyed that decisions about rules are made "at the beginning of the academic year." *She also mentioned, "However, these rules can be subject to change based on situations or needs that arise."*

Theme 3. Decision-making process for school rules: Nearly half of the participants (9 participants) expressed that in their envisioned democratic school, decisions are made by 'everyone coming together and having an equal say.' Four teachers responded with 'discussions in classes and consolidating decisions.' Three teachers mentioned 'by voting,' one teacher stated, 'based on scientific research,' another teacher mentioned 'under the guidance of a committee consisting of teachers and administration,' one teacher responded, 'according to decisions from the Ministry of National Education (MoNE),' one teacher mentioned 'by conducting surveys and discussing,' and yet another teacher stated, 'first discussing together and then voting.'

Baran, who stated that he has no knowledge about a democratic school and has been teaching for 25 years, shared the following comprehensive opinions regarding the decision-making process about what rules should be followed in the envisioned democratic school:"

"There is a platform where teachers, students, administrators, and auxiliary staff come together. This can be referred to as the 'school council' or 'school executive committee.' A democratic school is a living organism. In a traditional school meeting, auxiliary staff might bring tea, but in a democratic school, a

representative of the auxiliary staff takes part in the school executive committee. Everyone expresses their opinions through pluralistic participation. There are representatives from every subject group, every class, and every group within the school, and they ensure active participation. They gather at the beginning of the year. This meeting is crucial. All activities to be carried out throughout the year are planned here. Whenever needed, rules will be revised. Teachers can provide ideas to students regarding school rules. However, if students do not embrace these ideas, they are not implemented. When making decisions about school rules, students' opinions are considered more important. Students serving on the committee present ideas from their classes to the executive committee. Teachers refine these ideas to make them workable and implementable."

Tema 4. Responsible parties for implementing decisions: More than half of the participating teachers (12 participants) indicated that in the envisioned democratic school, "all stakeholders of the school" are responsible for implementing the decisions made. Four teachers specified "students" as responsible for implementing decisions in the school. Three teachers in their envisioned democratic school suggested that "each stakeholder in decisions concerning themselves" bears responsibility, while one teacher has mentioned that a "committee consisting of teachers and class representatives" is responsible for implementing decisions.

Similar to most participants, Ayşe expressed that in her envisioned democratic school, *"Everyone in the school is responsible for the decision made." Likewise, Erdem teacher has stated, "Just as everyone is involved in making decisions, everyone in the school is responsible for their implementation."*

In contrast, Öykü Naz, who claims to have knowledge about democratic schools and has been teaching for 25 years, offered a different opinion regarding the responsible parties for enforcing rules in the democratic school she envisions. She stated, *"Students adhere to the rules they establish themselves. Teachers and school administrators jointly set rules regarding the functioning of the school, and they adhere to these rules. It is easier and more satisfying for everyone to abide by rules they themselves have established."*

Theme 5. Supervisors of implemented decisions: Half of the 20 participating teachers in the research have indicated that in their envisioned model of a democratic school, "all stakeholders" of the school supervise the implementation of decisions. Two teachers have mentioned that it is supervised by "teachers, class representatives, and school representatives," while another two

teachers have stated that a "committee consisting of teachers and class representatives" or "teachers and students" oversee the implementation of decisions. One teacher each suggested that in the democratic school construct, the implementation of decisions is supervised by a "committee consisting of teachers and student representatives," "students, teachers, and school management together," or solely by "students." Lastly, another participant teacher mentioned that decisions in the envisioned democratic school are subject to self-regulation.

Regarding the question of who supervises the enforcement of rules in the envisioned democratic school, Öykü Naz teacher expressed the following views:

"Through self-control, everyone monitors themselves. Moreover, they can also alert each other. For example, because both teachers and students jointly determine the rules regarding the functioning of the class, teachers also abide by these rules. If teachers violate these rules, students can caution them."

On the other hand, Mustafa, who declared having no knowledge about democratic schools despite an 18-year professional experience, emphasized a hierarchical supervision model in his envisioned democratic school: *"During the process of implementing decisions, the teacher supervises the students; the school principal, the teacher, and other staff members; and the Provincial Director of National Education supervises the school principal."* This indicates a hierarchical oversight based on a top-down approach.

Theme 6. Method of supervising the implementation of decisions: One-fifth of the participating teachers in the research expressed that in their envisioned democratic school, the implementation of decisions is supervised through "students monitoring each other." Three teachers mentioned "self-regulation," three teachers referred to "teachers guiding students in terms of supervision," two teachers suggested "democratic supervision," two teachers mentioned "everyone warning each other when there's a mistake," and one teacher stated "compliance with decisions made by the Ministry of National Education (MoNE)" as forms of oversight.

Fatma, a teacher with 24 years of teaching experience who mentioned having no knowledge of democratic schools, shared the following thoughts regarding how compliance with rules is monitored in her envisioned democratic school: *"During the process of implementing decisions, everyone is an overseer in ensuring adherence to the decisions. They comply with the rules because they want to (referring to the students). If a student notices a rule that a teacher isn't following, they can alert*

them. The response of 'You're a child, you would not understand' is not possible. There is both self-regulation and everyone monitoring each other in this school."

3.4 Teachers' views on the teaching process in democratic schools

To gather the opinions of teachers about the teaching process in a democratic school, they were asked the primary question: 'Imagine being appointed as an administrator in a democratic school. You've observed classrooms during lessons. Explain the learning environment in these classrooms?' Additionally, to elaborate on this main question, participants were asked closing questions such as: 'What is the physical environment of the classrooms like?', 'What is the atmosphere or climate in the classrooms like?', 'How are the student-student and student-teacher relationships?', 'What do teachers do regarding the subject being taught?', 'What do students do related to the subject being taught?', 'What teaching methods and techniques are used in class? How are they determined?', and 'Who determines the subjects, teaching methods, and techniques? Why?'

The analysis revealed that teachers' views on the teaching process in a democratic school are categorized into six themes: 'physical arrangement of the classroom', 'classroom atmosphere', 'role of the teacher', 'role of the student', 'teaching methods and techniques', and 'decision-makers regarding the subject and teaching methods'."

Theme 1. Physical layout of the classroom: Nearly three-quarters of the participating teachers expressed that in their envisioned democratic school, "there is adequate material and equipment in the classroom." More than three-quarters of the participants mentioned that the classroom in the envisioned democratic school is "spacious and comfortable." Additionally, some teachers mentioned that these classrooms include "individual lockers" (3 participants), "resting corners/cushions" (3 participants), "sports and art areas" (3 participants), "digital publications" (3 participants), and "libraries" (3 participants). Three teachers stated that there is "a small class size" in these classrooms. Some mentioned that in their envisioned democratic school classrooms, there is an "in-class laboratory" (1 participant), "pets and potted plants" (1 participant), "reading corners" (1 participant), and "glass doors" (1 participant), indicating "minimalistic arrangements" (1 participant), the notion that "classrooms can change according to the lesson" (1 participant), and that they are "like a home environment" (1 participant).

Elif, a teacher with 19 years of experience who admits to having no knowledge about democratic schools, described her perceptions of the physical state of classrooms in a hypothetical democratic school:

"The classroom has a low number of students, and it is well-equipped with materials and technology. It's spacious, orderly, with dominant light colors, and receives plenty of sunlight. Moreover, it's a classroom with few students. Additionally, there are pets and potted plants inside, creating a comfortable, home-like atmosphere."

Theme 2. Classroom atmosphere: Among the participants, seven teachers described the classroom atmosphere as "peaceful and joyful," while four emphasized "mutual respect among everyone." Additionally, three teachers found it "a bit noisy," and two perceived it as "liberating." Another two teachers indicated it "inspired curiosity." Other opinions included the classroom being "positive" (1), "enthusiastic" (1), "creative" (1), and having a "democratic" (1) environment.

Zübeyde, one of the teachers who claimed to lack knowledge about democratic education, shared her thoughts on the classroom atmosphere in her imagined democratic school: *"The children are happy. They willingly engage in lessons with pleasure. The classroom isn't chaotic, and it's not a place where everything is forbidden. It might get a bit noisy because the kids voice their thoughts."* (She smiles slightly).

Theme 3. The teacher's role: Approximately half of the teachers imagine that in democratic schools the teacher 'comes prepared for the class (9 Teachers), a quarter perceive them as 'guide-mentors,' three participants mention they are 'accessible to every student,' two teachers depict them as 'knowledgeable/well-equipped,' and another two noted that they 'nurture curiosity.' Furthermore, in the concept of a democratic school, teachers have roles such as 'motivating students' (1 person), 'fostering collaboration' (1 person), 'providing opportunities for students to express themselves' (1 person), and 'ensuring students come prepared for class (1 person).

Öykü Naz, a teacher with 25 years of experience, who admitted to having limited knowledge about democratic schools, described the teacher's role in the educational process in her imagined democratic school: *'The teacher guides students on the subject to be learned. They conduct joint research in the classroom. Students share the work they have brought beforehand.'*

Theme 4. The student's role: Among the teachers participating in the research, the most frequently mentioned roles for students in the envisioned schema of a democratic school's educational process were being "eager and curious learners" (5 participants) and being "inclined towards peer teaching" (5 participants). Some teachers expressed that in such a school, students are "active participants in lessons" (3 participants), "researchers" (3 participants), "prepared for lessons" (3 participants), "responsible for their own learning" (3 participants), "experiential learners" (3 participants), "problem solvers" (3 participants), and "planners of their own learning process" (3 participants).

In the mind of teacher Elif, the student in the educational process of a democratic school possesses these qualities and roles: *"Students eagerly anticipate gaining knowledge about the subject they are learning. They exchange ideas with each other. They teach one another. They are definitely not in a passive state."*

Another teacher who claimed to have some knowledge about democratic schools remarked, *"The student conducts research on the subject to be learned. They come to class with information and various visuals. They actively participate in class. There is consistent activity within the classroom."* (Mehmet Ali)

Theme 5. Teaching methods and techniques: The majority of teachers participating in the research (16 individuals) indicated in their minds that in a democratic school setting, "all methods and techniques are used depending on the situation." Additionally, responses such as "active learning" (4 participants), "learning by doing or experiencing" (1 participant), and "question-answer techniques" (1 participant) were also noted among the participants.

Aslı, who has been teaching for 18 years, envisions the teaching methods and techniques used in a democratic school as follows:

"Methods like reading, writing, and demonstrating are used. There is no fixed curriculum; opportunistic education is provided. Lessons can be conducted through doing, speaking, acting out, playing games, etc., depending on the events happening at that moment. Fundamental skills such as interpretation, reading comprehension, storytelling, and basic arithmetic operations are focused on."

Theme 6. Subject matter and decision makers regarding teaching methods and techniques: In their envisioned democratic school setting, 7 participants stated that the decision maker regarding the subject matter and teaching methods and techniques is the "teacher," while 6

participants indicated "teachers and students together." Additionally, responses such as "teacher groups" (1 participant), "Ministry of National Education" (1 participant), "educational environment in the school district and teachers" (1 participant), and "teachers from lower grades, teachers from upper grades, and students together" were provided by teachers.

Serap, a teacher, expressed her thoughts on who decides on teaching methods and techniques in a democratic school: *"Teachers and students decide on teaching methods and techniques together."*

Another teacher shared their perspective on this matter: *"The teacher decides on teaching methods and techniques using their expertise."* (Bahar)

3.5. Teachers' views on the evaluation process in democratic schools

The views of teachers regarding the assessment process in a democratic school were determined by asking them the main question, 'Could you describe how the assessment process of students works in a democratic school?' Additionally, to help them answer this question more comfortably, they were asked follow-up questions: 'How are practices related to exams, homework, and grading implemented in this school?' and 'Could you explain the process of students moving on to the next grade and graduating in this school?' As a result of the analysis, teachers' views on the assessment process in a democratic school were categorized into two main themes: 'practices related to exams and grades' and 'the process of students advancing to the next grade and graduating.' The following are the details of these themes and categories."

Theme 1. Practices related to exams and grades: More than half of the teachers mentioned that in their envisioned democratic school, there is "no presence of exams and assessment processes." Almost half of the participants stated that "students' developmental progress is assessed through observation." One-fourth of the participating teachers indicated that in their envisioned democratic school, there are practices involving "multiple assessments (such as observation, portfolio presentations, project preparations, etc.)," while two teachers mentioned "self-assessment by students." Additionally, one teacher expressed that in the democratic school they envisioned "only practical exams," while another teacher emphasized that "assessment is observation-based for the first three grades and oral examination-based from the fourth grade onwards." Another teacher in their imagined democratic school indicated that "multiple-choice exams are not administered."

Bahar, who stated that she has no knowledge about democratic schools, provided the following response:

"In my imagination of a democratic school, there are no exams. The teacher assesses students by observing them in class, evaluating whether they fulfill their responsibilities like projects and assignments. The assessment is aimed at helping students complete their deficiencies. The evaluation is based on students' achievements rather than grades or exams. Unlike our current schools, multiple-choice exams are not administered as soon as a student starts first grade." (A painful smile appears on her face).

Theme 2. The process of moving up to upper class and graduating: In the process of transitioning to higher grades and graduation within the researched context, four participating teachers in a designed democratic school have stated that "students' progress to the next grade based on the achievement of learning outcomes as determined by the teacher." Three teachers articulated that, in these schools, "the teacher decides based on the level of achievement reached by the students," while another three conveyed that "there is no repetition of grades." In the envisioned democratic school setting, decisions regarding whether students move to the next grade or graduate involve varied perspectives: "The teacher decides in consultation with the opinions of parents and support staff" (1 respondent), "After conducting a process evaluation, the teacher, school administration, and parents jointly decide" (1 respondent), "The teacher decides by considering the opinions of group leaders within the class" (1 respondent), "The teacher decides based on portfolio presentations and student development" (1 respondent), "The teacher, guidance counselor, and family collectively decide" (1 respondent), "The family and teacher decide together" (1 respondent), "The teacher prepares a report about the student, and a committee makes the decision" (1 respondent), "The guidance counselor decides based on competencies outlined in the curriculum" (1 respondent), and "Subject-area teams (teachers teaching the same class and subject) make the decision" (1 respondent).

Emine, who claims to have some knowledge about democratic schools, indicated the teacher's decisive role by stating, *"In the democratic school I envision, the teacher decides on students' progression to the next grade or graduation based on the progress shown from the beginning to the end of the academic year."* Emine's statement emphasizes the teacher's authority in making decisions regarding students' advancement and graduation in this imagined democratic educational setting.

3.6. Teachers' views on the disciplinary process in democratic schools

Teachers were asked the question, "Imagine you are a teacher in a democratic school. What is done regarding students exhibiting unwanted behaviors in your school? Can you describe?" Teacher perspectives on the disciplinary process in a democratic school were categorized into three themes: "establishing communication and collaboration," "implementing problem-solving methods," and "focusing on the student." These themes and categories highlight the emphasis on fostering communication, employing problem-solving techniques, and maintaining a student-centered approach within the disciplinary process envisioned in a democratic school.

Theme 1. Establishing communication and collaboration: More than half of the participating teachers in the study indicated that in their perception of a democratic school environment, the resolution of disciplinary issues (students' unwanted behaviors) involves "establishing open communication." Seven teachers mentioned "developing collaboration with parents," while five teachers reported "seeking assistance from experts (psychiatrists, psychologists, school counselors, etc.)." One teacher highlighted the significance of communication and collaboration in overcoming students' unwanted behaviors.

"Teacher talks to the student about their unwanted behavior, attempting to understand the issue. If the teacher cannot come up with a solution, they collaborate with the guidance counselor. They conduct a joint visit to the family with the guidance counselor and the classroom teacher. They work more closely with the problem to resolve it." (Yasemin)

Theme 2. Implementing problem-solving methods: Nearly half of the participating teachers envisioned a scenario where, when students exhibit unwanted behaviors, there is a focus on "investigating the root cause of these behaviors." Two teachers mentioned "conducting observation and monitoring," while another two teachers mentioned "organizing corrective activities for unwanted behaviors." One teacher highlighted "establishing an internal monitoring mechanism" and another teacher mentioned "creating a crisis management team" within the school.

Baran, a teacher with 25 years of experience in classroom teaching, emphasized in his perception of a democratic school that addressing the source of potential unwanted behaviors

rather than just the issue itself is crucial, emphasizing the potential for effective solutions to stem from this approach.

"When the student exhibiting unwanted behavior is not present in the classroom, informational activities are conducted with other students regarding the negative behaviors displayed. Investigations into issues occurring in the home environment are carried out, aiming to delve into the root cause of the problem. School psychologists may be required to regulate these relationships. If these students persist in their negative behaviors, a meeting involving the participation of families can be arranged. A mechanism for internal oversight can be established under the school's executive board. Meetings with the family of the student displaying unwanted behaviors can be organized to devise a plan for sustaining a healthier and more democratic environment within the school."

Theme 3. Focusing on the student: Two teachers, in their envisioned democratic school setting, mentioned that when students exhibit unwanted behaviors, there is a focus on "developing empathy in students." Two other teachers emphasized "reinforcing positive behaviors of students." Additionally, two teachers highlighted "empowering students to set rules and monitor each other." One teacher mentioned "granting students more responsibility," while another teacher pointed out "the teacher warning the student exhibiting unwanted behavior." One teacher described a cycle of "valuing the student-warning-punishment-reward." Another teacher highlighted "unconditional love and patience shown to students."

Teacher Emine emphasized in her perception of a democratic school that the primary solution pathway when a student exhibits unwanted behavior revolves around showing them warm attention and care.

"Communication is crucial. The teacher ensures that the student realizes the consequences of their actions and encourages empathy. But first and foremost, the teacher loves the student. A child who feels loved will abandon unwanted behaviors. (...) The teacher remains determined and patient with the student. If the behavior doesn't change over time, seeking expert help is an option."

4. Discussion and Conclusion

Our findings suggest that teacher perceptions of educators in a democratic school align with terms such as "guiding," "facilitating critical thinking," and "effective communicator." Neill (1990) emphasized the importance of teachers having good communication with students and facilitating learning. According to Dündar (2013), in democratic schools, there is free space

based on individual preferences. Here, educators are tasked with helping children express their potential and desires; encouraging, supporting, and empowering them in this regard.

Teachers in our study expressed that for students in a democratic school, the most prominent qualities were "free," followed by "confident" and "responsible." The concept of freedom is inherent in democratic schools and is considered the most natural right of students, never to be infringed upon (Neill, 2012). Kant (2020) asserts that instilling a sense of freedom in individuals, who are the only beings in need of education, is of utmost importance. The organizational definition of the International Democratic Education Network (IDEN, 2017) explicitly acknowledges the student's freedom to choose. Furthermore, the concept of student freedom emerging from the ideas of Illich, Dewey, and Neill is becoming evident in today's democratic schools. In our research, it is heartening and consistent with the literature that teachers working in traditional schools have views aligning with the perception that students are free in a democratic school setting.

The majority of teachers in our study reported that in the democratic school, the school administrator is "fair and egalitarian." Akyol (2019) indicated that teachers expect a manager demonstrating a democratic leadership style to maintain an equal distance from all school employees, to distribute tasks fairly, and to be able to provide unbiased and accurate evaluations. Hence, it can be suggested that our findings align Akyol's results.

According to the views expressed by teachers in their perceptions of auxiliary staff in a democratic school, the most frequently identified characteristics were being "responsible and hardworking" and "feeling valued." In one study, it was observed that in a school operating with a democratic approach, auxiliary staff (such as the school cook) had active roles in the school's management and administration. They had rights and roles such as participating in decision-making meetings, contributing to the meeting agenda, voting for advocated ideas, objecting to opposing thoughts and suggestions, engaging in discussions, and making proposals (Akpınar, 2018). Based on this finding, it is reasonable to propose that auxiliary staff in a democratic school would feel valuable as they are both hardworking and responsible and possess equal rights with other school stakeholders.

The most frequently cited attributes among the parents of a democratic school, as indicated by the participating teachers, were being 'collaborative and supportive' and being 'an equal

component of the school.' In fact, it has been revealed that parents who are members of the school's management board and association in a school identified as operating under a democratic framework play roles in the administrative decision-making processes of the school. These roles encompass activities such as overseeing school renovations, managing the school's finances, organizing events, inviting guest speakers to the school, arranging meetings, providing necessary support, and generating alternative solutions to immediate issues encountered by the school (Akpınar, 2018). This finding also demonstrates that parents in a democratic school are collaborative and supportive contributors to the school and are regarded as equal stakeholders. It can be said that the research outcomes are consistent with the findings of our study.

In our research, more than half of the teachers have conceptualized the democratic school as having values such as "love and respect" are embraced, as are "equality and justice" and "honesty." However, it was found that the value of "freedom," which is an important value in democratic schools, ranked lower in priority. In Hofstede's (1984) study determining cultural dimensions, it emerged that Turkey has feminine values. Indicators of feminine culture include valuing individuals and interpersonal relationships and prioritizing the overall quality of life (Sargut, 2001). The feminine characteristic of Turkish culture leads to an emphasis on avoiding conflict and placing importance on societal equality and consensus. While individual freedom is considered important at an individual level, the emphasis on human relationships might have pushed the value of freedom, which could potentially create conflict, to a lower priority in people's minds. This observation suggests a partial alignment between the literature and the findings of our research.

According to another finding of our research, the majority of participating teachers perceive that decision making lies with "all internal stakeholders of the school," where "everyone comes together and has an equal say". It is known that in every democratic school, there exists a meeting system in the decision-making process. All participants can bring forth topics to these meetings (Mintz, 2003). Indeed, Freire (2001) emphasized that the participation of individuals in making decisions that concern them is a fundamental condition of democratic education and that respecting human rights to decision-making is an ethical obligation. Hence, it can be inferred that the conceptualizations of decision-making processes in a democratic school by the

teachers who participated in our research are in harmony with the functioning of these processes in existing democratic schools.

In the democratic school, the vast majority of teachers envisioned "adequate materials and equipment in the classroom," and that the classrooms are "spacious and comfortable." These results suggest that participating teachers working in state schools have negative feelings due to insufficient resources and the physical unattractiveness of the classrooms (Kaplan, 2016; Korkmaz, 2013). About half of the teachers mentioned that in the democratic school, the teacher "comes prepared for the lesson." This finding may infer the teacher's role in transmitting knowledge. However, in a democratic school, the teacher's role is not merely about transmitting knowledge but rather facilitation. Grille (2003, 01.11.2021) expressed that in democratic schools, teachers take on a much more passive role. To this point, the responsibilities of teachers involve establishing a trust-based relationship with students, identifying the areas where students' curiosity lies, directing this curiosity—and even passion—towards an educational direction, and assisting in the students' intellectual development.

The most frequently cited views regarding the student in the democratic instructional process were "willingness and curiousity to learn" and "inclined towards peer teaching." These results align with the relevant literature (Korkmaz, 2013). Nearly all teachers mentioned that in class, "all methods and techniques are used depending on the situation." This response appears consistent with the application of a democratic school. Regarding the decision-maker concerning the subject matter, instructional methods and techniques, the majority identified the "teacher" as the primary decision-maker, followed by "teacher and students together." This perception contradicts the characteristics of a democratic school and the principles of progressive educational philosophy.

When examining teachers' perspectives on the assessment process in their envisioned democratic school, it was observed that the majority of participants imagined that there were no exams in the democratic school setting. Secondly, they conceptualized that "students' developmental progress is assessed through observation," which aligns with the principles of a democratic school model. According to Miller (2010), the success of education is not truly measured by test scores. The value of learning is more related to the quality of life experienced by individuals rather than the quantity of correct answers provided on test questions.

Conversely, the significant majority of teachers in their envisioned democratic school schema mentioned that the decision of whether students should progress to the next grade or graduate - under certain conditions - is made by the teacher. This perception does not seem to align with the literature.

In Summerhill, there exists self-discipline and self-regulation (Neill, 1990). Teachers in democratic schools mention that students coming from traditional schools, initially characterized as problematic, often exhibit behaviors involving violence. Rare occurrences of fights or bullying in the democratic school are resolved through group consensus during meetings where students and teachers express their feelings, thoughts, and proposed solutions (Balme, 2006; cited in Gülen Morhayim, 2008). In our research, teachers proposed strategies for maintaining discipline, such as open communication with students in terms of communication and collaboration, developing partnerships with parents, and seeking expert help. These solutions seem similar to existing alternative school practices. Furthermore, among the findings of our research, addressing unwanted student behaviors include identifying the source of these behaviors through observation, monitoring, organizing corrective activities for unwanted behaviors, establishing internal monitoring mechanisms at school, and creating a crisis management team. This indicates that these conceptualizations are akin to approaches found in democratic schools such as Summerhill School (Neill, 1990).

4.1. Implications of Research and Limitations and Suggestion

In conclusion, it can be said that the opinions of the participating teachers regarding the conceptualized democratic school largely resemble existing practices in democratic schools. In other words, although all participants had experience working in traditional schools, and the majority lacked prior knowledge of democratic schools, it's evident that the participating teachers were largely inclined toward the mentioned school model. However, further research is needed to ascertain the extent to which teachers exhibit attitudes and behaviors aligned with the principles of a democratic school in practice. Based on these findings, it would be beneficial for the authorities of the Ministry of National Education and experts in the field to plan and implement coordinated efforts for the transition from traditional schools to democratic schools. This study is limited to the views of primary school teachers in the province of Izmir. Investigating the same subject based on the opinions of educators working in primary,

secondary, and tertiary education institutions in different regions across Turkey could be beneficial. Additionally, intercultural comparisons can be made on this topic.

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Research Article

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The Effect of Using Web 2.0 Tools on Smart Boards on Primary School Students' Mathematics Lesson Achievement, Anxiety, and Attitudes towards Smart Boards

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Abstract

The purpose of this research is to examine the effects of web 2.0 tools on primary school first-grade students' mathematics lesson achievement, anxiety and attitudes towards the smart board. In the research, the quasi-experimental design with pretest-posttest control group was preferred. In this direction, the study was conducted with 25 students in the control group and 26 students in the experimental group for five weeks. Mathematics lessons were taught with smart boards and course materials in the control group and with web 2.0 tools and course materials on the smart board in the experimental group. Mathematics achievement test, smart board attitude survey and math anxiety scale were used as data collection tools. While analyzing the data, dependent and independent groups t-test analyses were used to compare the pre-test and post-test averages of the experimental and control groups. According to the results, there were significant differences in favor of the experimental group in the post-tests. It has been concluded that using web 2.0 tools for mathematics lessons has led to significant changes in the increase of students' achievement in mathematics lessons, the development of their attitudes towards the smart board, and the decrease of their mathematics anxiety level. The results are discussed in detail, and suggestions for practitioners and researchers are provided.

Keywords: Web 2.0 Tools, Primary School Math Lesson, Success, Motivation, Anxiety

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Akıllı Tahtalarda Web 2.0 Araçlarının Kullanımının İlkokul Öğrencilerinin Matematik Dersi Başarılarına, Kaygılarına ve Akıllı Tahtaya Yönelik Tutumlarına Etkisi

Özet

Bu araştırmanın amacı web 2.0 araçlarının ilkokul birinci sınıf öğrencilerinin matematik dersi başarısına, kaygılarına ve akıllı tahtaya yönelik tutumlarına etkisini incelemektir. Araştırmada öntest-sontest kontrol gruplu yarı deneysel desen tercih edilmiştir. Bu doğrultuda kontrol grubunda 25, deney grubunda ise 26 öğrenci ile beş hafta boyunca çalışma yürütülmüştür. Matematik dersleri kontrol grubunda akıllı tahta ve ders materyalleriyle, deney grubunda ise akıllı tahtada web 2.0 araçları ve ders materyalleriyle işlenmiştir. Veri toplama aracı olarak matematik başarı testi, akıllı tahta tutum anketi ve matematik kaygı ölçeği kullanılmıştır. Verilerin analizinde deney ve kontrol gruplarının ön test ve son test ortalamalarının karşılaştırılmasında bağımlı ve bağımsız gruplar t-testi analizlerinden yararlanılmıştır. Sonuçlara göre son testlerde deney grubu lehine anlamlı farklılıklar bulunmuştur. Web 2.0 araçlarının matematik derslerinde kullanılmasının öğrencilerin matematik derslerindeki başarılarının artmasında, akıllı tahtaya yönelik tutumlarının gelişmesinde ve matematik kaygı düzeylerinin azalmasında önemli değişikliklere yol açtığı sonucuna varılmıştır. Sonuçlar ayrıntılı olarak tartışılarak uygulayıcılara ve araştırmacılara önerilerde bulunulmuştur.

Anahtar Kelimeler: Web 2.0 Araçları, İlkokul Matematik Dersi, Başarı, Motivasyon, Kaygı

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1. Introduction

The areas related to the rapid developments arising from the conflicts have also expanded in parallel. It has become a necessity in the use of technological education and use, which comes out of almost every aspect of life (Kabak, 2020). It is important to use it in order to live effectively. For this reason, technology and education have begun to be mentioned together in today's world, and there are significant changes in the understanding of education (Mete and Batıbay, 2019). The rapidly expanding use of technology also expands and uses the field of education. Especially with the widespread use of the Internet and smartphones, computers, tablets, etc., share duplication; it allowed the opportunity to reproduce in the fast formats it obtained and easily access all the information it contained (Batibay, 2019). In order to provide access to technology in schools, its scope has been realized in the world and Turkey. With this study, we entered a period in which education was organized according to technology from the periods included in their education. In Turkey, from preschool education institutions to universities, it is tried to be taught with content such as technological literacy all over the world (Metin, 2018). The FATIH Project in Education aims to ensure equality of opportunity in education and training and to use technology in our schools. It was initiated for effective use in lessons in a way that appeals to the body (MEB, 2016). Ekici and Yılmaz (2013) aim to take the FATIH Project carried out in our country into global competition. An example of an initiative for Turkey's effort to activate education using contemporary technology defines it as. The reflections of the technological changes emerging at the global level in the fields of education in Turkey have been increasing in the last period. The first aim of the "Movement to Increase Opportunities and Improve Technology (FATIH)" project, carried out in this direction, is to provide equality of opportunity in education and training. In addition, it is a project that has emerged to improve the technology in all educational institutions and use information technologies in learning and teaching processes in a way that will appeal to more sense organs. Within the scope of the FATIH project, it is aimed to provide Internet and smart board infrastructure to the classrooms, integrate schools with technology, and realize effective and permanent learning thanks to multiple learning environments (Similar, 2019). The objectives of the project seem to be related to 21st-century skills. It can be stated that this project, which aims to combine education and training activities with information technologies, serves the field of technology, information, and media, one of the 21st-century skills (Eryılmaz & Uluyol, 2015).

When MEB curricula are examined, it is seen that individuals need to use technology efficiently and effectively (MEB, 2018). Smart boards, the Internet, and tablets can only be used correctly by individuals with information technology literacy. When these tools are not used correctly in daily life, both cause information pollution and problems with the reliability of this information. The ability to critically look at the media and confirm the accuracy of the information accessed over the Internet is closely related to media literacy, which is one of the 21st-century skills (Eryılmaz & Uluyol, 2015). When technology is used efficiently in education, it provides significant advantages to both teachers and students in the education process (Keskin, 2021). It is usual for the new generation of individuals who are integrated with the developing technology to want to see these technological products in their school and classroom environments. It is striking that today's students tend to lose their interest and motivation towards traditional teaching environments with the developing technology (Çakır, 2019; Batıbay, 2019; Öztürk, 2022; Gök, 2022; Arslan, 2022).

It is known that the more sensory organs are addressed in educational environments, the more effective learning becomes possible. From this point of view, educational technology tools such as smart boards have a significant impact on demonstrating this permanence (Çakır, 2019). Considering that primary school students are in the concrete operational stage, it is clear that addressing their different sensory organs will greatly contribute to their education (Mata et al., 2016; Küçükgöz, 2019). It is stated that using smart boards provides significant convenience in teaching the acquisitions in the education program (Altınçelik, 2009). It is seen that there are benefits such as enabling effective learning, providing high-level thinking skills, developing effective problem-solving skills, and facilitating knowledge transfer (Hillier, 2013; Çoklar & Tercan, 2014; Koğu, 2018; Yakut, 2019). An important effect of the smart board in the field of education is to remove the uniformity of teaching. This way, course repetition becomes easier, reducing the teacher's burden. For this reason, the importance of the effective use of smart boards is better understood by educators (Choudhury, 2014; Kandemir, 2015).

1.1. Use of Web 2.0 Applications in Education

In order to improve the technological competencies of today's students, the use of digital products in teaching activities provides them with great convenience. The most important convenience and support for teachers in this regard is using web 2.0 applications on smart

boards with internet access (Horzum, 2007). Web 2.0 tools are a structure that provides the opportunity to create content on the Internet easily and to improve teaching content. Web 2.0 tools, which are very easy to prepare and implement, contribute to social interaction and cooperation when used in the field of education and training (Bidaki & Mobasheri, 2013; Atici & Yıldırım, 2010). Using web 2.0 tools in teaching activities increases the students' motivation by enabling them to actively participate in learning activities and develop positive attitudes towards the lessons (Hillier, 2013; Özipek, 2019). Web 2.0 tools are online tools that anyone with basic computer literacy can create content and share with others without needing advanced computer knowledge. Thanks to these applications, the content created can be easily shared through different channels. Quickly shared content allows users to communicate effectively (Hillier, 2013; Choudhury, 2014; Batıbay, 2019). The advantages of web 2.0 tools, such as saving time for individuals and enabling people to come together and socialize through social media, cause widespread use. In addition, the fact that data can be stored for a long time, that they are functional in producing and accessing news independently, and that the emerging applications can be easily updated also paves the way for the frequent use of these tools (Bidaki & Mobasheri, 2013; Mata et al., 2016; Önal, 2018; Eşgi & Kocadağ Ünver, 2018; Batıbay, 2019). Due to these features, web 2.0 tools are functionally preferred in every field, from education to art, commerce to journalism (Choudhury, 2014).

The importance of web 2.0 applications, which are increasingly used in educational environments, is increasing day by day. Looking at the literature (Bidaki & Mobasheri, 2013; Hillier, 2013; Choudhury, 2014; Tatlı, 2017; Önal, 2018; Koğu, 2018; Parlak, 2019), it is seen that the activities for the use of web 2.0 in today's schools and classrooms have increased. Technological tools, such as magazines, books, blackboards, chalk, etc., have been in educational environments since ancient times. With technological developments, tools such as smart boards, computers, and projectors became popular in educational environments. Along with the emerging developments, web technologies (web 1.0, web 2.0, web 3.0) have been added to these technological tools. Along with this process, teachers met with applications such as Blog and Facebook and tools built on web 2.0 applications. In order to use these new technological tools, which are increasingly taking place in human life, teachers and students are expected to have skills such as digital literacy (Demir & Eren, 2020).

Web 2.0 tools, which today's teachers and students have started to use, increase collaboration with each other and the students' active participation in the lesson. These tools make learning meaningful and fun for students and positively affect students' motivation and attitudes (Keskin 2021). These tools include educational technologies that enable easy and fast access to information and actively include the individuals who use it in education (Çekinmez, 2009). It is possible to say that web 2.0 tools, which have an important place in educational technology, have many advantages such as increasing academic success in courses, facilitating teaching by concretizing abstract concepts, motivating learning, providing permanent learning, and providing a focus on the course (Choudhury, 2014; Blannin, 2015; Korucu, 2018; Yakut, 2019; Keskin 2021). It is stated that when web 2.0 tools are used in teaching processes, they offer enriched learning environments, motivate students to learn by attracting their attention, and increase their active participation in the lesson (Darancık, 2014). The fact that the materials used in classroom environments are mostly one of the web 2.0 tools in recent years has resulted in the research of these tools in education. In educational activities using web 2.0 tools, it becomes easier for students and teachers to see the whole process and how they structure a concept, problem or event (Horzum, 2010; Eren, 2013; Mata et al., 2016). These tools used in educational environments offer environments that provide students with the opportunity to learn on their own. Thanks to web 2.0 tools, students can examine their learning situations, realize their shortcomings, and reinforce their learning (Keskin, 2021). In activities carried out using web 2.0 tools, students' academic achievement may increase, and their metacognitive awareness levels may improve positively by becoming aware of their learning (Öztürk, 2022). However, it is stated that despite the convenience and advantages these technological tools offer, their use in education is not at the expected level (Hillier, 2013; Bursalı, 2022; Mete and Batıbay, 2019; Batıbay, 2019).

1.2. Using Web 2.0 Applications at the Primary School Level

When the literature on the use of web 2.0 tools at primary school level is examined, studies in different disciplines and research areas show that web 2.0 tools increase achievement. According to many studies from the related literature (Korucu, 2018; Ahmed & Opoku, 2022; Bamoallem & Altarteer, 2022; Bolatli & Korucu; Kaur, Bhatia & Stea, 2022; Öztürk, 2022), web 2.0 tools are an interactive tool in the education and training process. It provides an environment, supports the mental skills of students, and enables a communicative structure to

be formed between the teacher and the student. These tools offer several positive possibilities compared to traditional teaching methods and textbooks. Considering the primary school level, web 2.0 tools offer the opportunity to actively use digital technologies in lessons, attracting students' attention, contributing to their mental development, and enabling them to develop positive attitudes towards the lesson. Students who are allowed to interact with these tools are more active and become technology literate over time (Blannin, 2015). In addition, with these tools, more sense organs can be included in the learning process, students can develop better cognitively, and group work can be encouraged. This leads to the socialization of students and enables them to benefit from each other's experiences (Ahmed & Opoku, 2022).

These tools make it easier for primary school students to create content and thus improve their self-confidence (Conole & Alevizou, 2010). Web 2.0 tools provide environments that support learning, and ensure active participation, especially in primary school age, and encourage collaboration (Huang, Jeng, & Huang, 2009). Education based on web 2.0 tools can offer significant benefits, especially at primary school level. In this way, it may be possible to eliminate the monotony of the classical education system (Kaur, Bhatia, & Stea, 2022).

Using web 2.0 tools supports the active participation of students at the primary school level and helps teachers to design more actively. The use of web 2.0 tools provides teachers with more visuals for students' performance and helps students learn more easily and effectively (Conole & Alevizou, 2010; Elmas & Geban, 2012; Ahmed & Opoku, 2022). In the context of the benefits of web 2.0 tools in primary school, teachers' use of learning designs prepared by using these tools has important consequences. For this reason, all primary school teachers should be trained to use web 2.0 tools actively in their lessons (Blannin, 2015).

1.3. Mathematics Achievement and Anxiety in Primary School

The reason for the failures in mathematics may be the learner's reluctance to learn mathematics, anxiety about failure, personality traits, or the inappropriateness of the applied method (Sarı et al., 2017). The reason for the failures caused by the learner and the teacher may also be the applied methods. For this reason, the method applied in mathematics education is critical. The more the classroom, which is a learning environment for students, appeals to many senses, the more success can increase (Tabuk, 2019).

Differences in students' mathematics course success are directly or indirectly related to many variables (Batı, 2021). These variables that emerge during the education process can be evaluated as personal factors depending on the student, classroom environment, teacher, educational status, and family factors. Aysan, Tanrıöğen and Tanrıöğen (1996) stated that students' mathematics failures were related to the methods used and the learning environment. Many studies reveal the effect of technological tools used in the classroom environment (Taşkın & Ezentaş, 2018). Revealing the factors determining student success in the mathematics course has long been the focus of educational research (Koç, 2019). Anxiety or positive attitude towards mathematics lessons in students is one of the affective domain features that affect mathematics achievement (Barış 2009). Studies show that there is a relationship between students' mathematics achievement, their mathematics anxiety levels, and their positive attitudes towards mathematics (Çavdar, 2015).

In addition to the factors affecting the mathematics achievement of primary school students, the increase in the instructional quality of mathematics lessons is also an important factor that directly affects the students' mathematics achievement (Tabuk, 2019). The clarity of the teaching and the technological opportunities offered to the students are important determinants of mathematics achievement (Genç and Öksüz, 2023; Batı, 2021). When the literature is examined, it has been concluded that there is a significant positive relationship between the increase in instructional clarity for the mathematics course and the preference for technological tools and mathematics achievement (Şahin et al., 2022; Yağan, 2021). Classroom environments that support the lesson, such as the use of computers or smart boards, and the tools that the teacher uses by following the current developments in the education process are among the educational opportunities in the school. When we look at the research on this subject in our country, both at the university level and Studies at primary and secondary education levels stand out. For example, Erduran and Tataroğlu (2009) stated that teachers use smart boards in science and mathematics teaching. In their study, they examined the use of smart boards among students to determine their opinions. They determined that it increased their interest, motivation, and participation. Ekici (2008) stated that mathematics education using smart boards improved students' mathematics achievement and retention levels compared to mathematics education carried out with traditional methods. He concluded that it had a strikingly positive effect. Considering the studies, it is emphasized that supportive classroom environments contribute

positively to shaping the student's mathematical success and are an important and determining factor (Sarı et al., 2017; Yılmaz & Bindak, 2016).

1.4. Importance and Rationale of the Research

The rapid change in science and technology makes it necessary to use the latest technological developments to transmit information (Bilgic et al., 2011). When the studies are examined, it seems complicated for institutions that cannot benefit from new technological opportunities and renew themselves in schools, which are the areas where learning takes place, to catch up with contemporary education standards (İnce, 2011; Önal, 2018; Gürleroğlu, 2019; Öztürk, 2022). Considering today's conditions, it does not seem easy for the new generation to actively participate in teaching activities using traditional methods. Because this new generation wants to access information quickly. At this point, web 2.0 tools appear as functional applications that will allow students to explore and learn quickly. In educational research, there are many studies on the impact of web 2.0 tools on student success. However, it can be said that there are not enough studies on the effects of certain web 2.0 applications on direct education. Today's students prefer compelling visuals and games over traditional studies instead of pages full of text. It is necessary to benefit from these technological tools in order to ensure that individuals of this age participate in learning activities effectively and develop a positive attitude towards their lessons (Batıbay, 2019; Bilgiç et al., 2011). However, due to the epidemic that emerged at the end of 2019 and was effective worldwide, countries around the world suspended education in schools, and compulsory distance education was started. In this process, educators were able to reach their students with web 2.0 tools. In this period, when printed materials lost their function, digital tools gained importance (Kabak, 2020).

Gezer (2020) states that products based on educational technology should be included more at the primary school level, which is the first step of education. This is because individuals at the primary school level need more concrete and rich educational experiences. Rich educational experiences, especially in the primary school period, require the inclusion of learning and teaching practices equipped with technological products (Kandemir, 2015). For this reason, there is a need to produce and use tools and materials prepared in accordance with these programs, which will clearly reveal and concretize the education curriculum at primary school levels (Gürleroğlu, 2019; Parlak, 2019; Mete and Batıbay, 2019). This study focuses on examining

the effects of animation and evaluation activities prepared with web 2.0 tools in mathematics education, suitable for primary school children, on course achievement, anxiety level, and attitude towards smart board. Thanks to the study, children can be willing to use web 2.0 tools as a learning tool and use them in their next education life. This study is important because it focuses on anxiety, which is important in mathematics and other basic school lessons. With the development of technology, the diversity in the number of web 2.0 tools is also increasing. This study is also critical because it determines which web 2.0 tools are more suitable for increasing the achievement of mathematics courses and reducing anxiety. In addition, the limited number of experimental studies on the effect of the use of web 2.0 applications on students in primary school mathematics education increases the importance of this study. It is thought that the data obtained from the research will guide the classroom teachers working in primary schools about the activities they will perform using smart boards and web 2.0 tools in the education process. This research is expected to provide clues to the use of technology in primary schools. In this direction, the problem sentence of this research is "Does the use of web 2.0 tools on smart boards for primary school students affect students' math achievement, anxiety and attitudes towards smart board?" poses a question. In line with the main purpose of the research, answers to the following questions will be researched:

1. Is there a significant difference in the students' mathematics achievement between the experimental and the control groups?

    a. Is there a significant difference between the pre-test and post-test scores of the groups?

    b. Is there a significant difference between the groups' post-test scores?

2. Is there a significant difference in the students' mathematics anxiety levels between the experimental and control groups?

    a. Is there a significant difference between the pre-test and post-test scores of the groups?

    b. Is there a significant difference between the groups' post-test scores?

3. Is there a significant difference in the students' attitudes towards the smart board between the experimental and control groups?

a. Is there a significant difference between the pre-test and post-test scores of the groups?

b. Is there a significant difference between the groups' post-test scores?

2. Method

This research is a quasi-experimental research with pre-test and post-test control groups. In this respect, the quasi-experimental method can be expressed as one of the most used quantitative methods in educational research (Büyüköztürk, 2020). In experimental studies, researchers try to reveal the effect of the independent variable on one or more dependent variables. 51 students of two classes who were educated in the first grade of a primary school in Gümüşhane in the 2022-2023 academic year participated the study. One of these classes was chosen as the control group and the other as the experimental group. While the "Natural Numbers" unit in the mathematics lesson was taught using smart boards and course materials with the control group students, the same unit and achievements were processed on the smart board with web 2.0 tools and course materials in the experimental group students. In the actual implementation process, first of all, Necessary permissions were obtained by relevant institutions for the implementation process of the study (The final decision is Ethics Committee meeting dated 23/12/2022, session number 14, and the decision number is 20).

During the implementation process, Powtoon and Plickers web 2.0 tools were used within the scope of the research. “Plickers”, one of the web 2.0 tools applied in the experimental group within the scope of the study, is an accessible, free and interesting educational tool used by thousands of instructors around the world to collect instant results in the classroom and to evaluate their students. The Plickers application can be accessed via the “www.plickers.com” web page. The Powtoon application, on the other hand, is an application in which fun animations are prepared using ready-made animations and templates in the system.

The experimental process within the scope of the research was well planned. Since the teachers of both classes were different, an attempt was made to ensure unity of practice through short meetings before the lesson. Following the precautions taken by the researcher to eliminate situations that would affect reliability, the course process of the experimental group started. First of all, the annual program prepared by the Ministry of National Education was examined and preparations were made in accordance with the mathematics course curriculum. These

plans are offered ready-made for each academic year in accordance with the mathematics curriculum. Daily mathematics activity plans have been prepared in accordance with the achievements of the mathematics course "Natural Numbers" unit. In practice, 40 minutes of class time is allocated for the activities prepared for each lesson. During the course teaching process of the control group, the textbook was downloaded to the smart board and opened, keywords were underlined, important parts were enlarged or colored, answers were highlighted, and this subject was tried to be explained to the students. Using the "Antropi Teach" application on the smart board, summaries and important points that students could see were written on the smart board. These practices were tried to be implemented in every lesson. In addition to the applications made in the control group (textbook download, Antropi Teach, etc.) in the experimental group, web 2.0 tools were used in both the teaching and evaluation phases of the course. Care was taken to ensure that the only difference between the two groups was the web 2.0 tools applied. Teachers have worked meticulously in this regard. Therefore, the only difference in the teaching of the two groups was web 2.0 tools. In other words, except for the manipulated variables, the experimental conditions were tried to be kept constant.

Before the applications in the experimental group, five video animations were prepared by the researchers with the "Powtoon" tool. These animations are created from visuals, short explanations and summary information on the subject. Each one was turned into a lesson video. It includes images from textbooks, worksheets, and computer-generated images. These visuals aim to help children understand and concretize the subject better. The selected images have been meticulously prepared to allow the subject to become concrete in children's minds. Various sound effects and music are also used in each animation. The videos are approximately 5-6 minutes long. While preparing these video animations, the elements were chosen to be close to the students and the activities were prepared by the classroom teacher. These applications were opened in the lessons and shown to the students and the lessons were taught.

In this part, the interaction of the students with the smart board was in the form of following the animations. "Plickers" tool was used in the evaluation step. After the questions related to the subject were prepared and shown to the students on the smart board, the students' answers were taken and reported with the help of the smartphone, thanks to the QR codes distributed to the students. The results were instantly shown to the students on the smart board. Five exams

consisting of 5 questions in total were administered to the students at the end of each week. These questions have been prepared by using instructors and textbooks who are experts in their fields. "Mathematics anxiety scale" and "Smart board attitude questionnaire", which were applied to the students as pre-test and post-test, were filled in by the researchers by interviewing them individually because they were children who can not yet read very well. These interviews lasted an average of 30-35 minutes for each student. The implementation flow process is shown in Table 1.

Table 1.

The Implementation Process

Time	Process
1 day before application	Experimental Group (EG) Pre-tests Control Group (CG) Pre-tests
Application (5 weeks)	Teaching the experimental group with web 2.0 tools Teaching the control group with traditional materials on the smart board
1 day after application	EG Post-tests CG Post-tests

The study group of this research consists of students who attend the first grade in a public school located in the city center of Gümüşhane in the fall semester of the 2022-2023 academic year and have smart boards in their classrooms. 51 first-grade students studying in two separate classes participated in the study. The gender distribution of the students is shown in Table 2 in detail.

Table 2.

Gender Distribution of the Study Group

Gender	Control	Experimental	Total
Girls	13	12	25
Boys	12	14	26
Total	25	26	51

In this study, the control group consisted of 25 people, 13 girls and 12 boys, and the experimental group consisted of 26 people, 12 girls and 14 boys. In total, 25 female and 26 male students are the participants of the study.

2.1. Achievement Test

In this study, an achievement test created by the researchers by examining textbooks and taking the opinions of three teachers who are experts in their fields was used to measure the knowledge levels of the students in the control and experimental groups. Before preparing this

achievement test, the purpose of the test was clearly stated. The purpose of the test is to understand the success levels of students. The type of measurement tool was determined as fill-in-the-blank and matching according to the levels of primary school students, and a specification table was created for the goals to be achieved. Since the students were first graders and might have difficulty reading, the questions were read to the students by the teachers and they were asked to answer them. Additionally, to avoid any problems during the answering process, the answers were taken with the help of teachers. For this purpose, each student was interviewed one-on-one. In this context, a question pool was created and the items were reviewed. The prepared items were administered as a pilot application to 40 first grade students at another school and the test were finalized. The same method was tried to be used in the pilot application and answers were received from the students. This tool was developed for the acquisitions of "Reading and writing numbers" and "Rhythmically counting forwards by one, five and eleven" in the "Natural numbers" unit specified in the mathematics curriculum (MEB, 2018).

Some methods were carefully followed to ensure the reliability and content validity of the achievement test used to measure the mathematics course success of the students participating in the research. The first of these ways is to use the achievement test as pre-test and post-test during the implementation phase of the study. In the second stage, a pilot application was conducted in a different school for testing. At the end of the pilot application, evaluations were made with two subject matter experts and three teachers from the university and the necessary arrangements were completed. As the third step, the existing behavioral targets within the scope of the subject were revealed and which achievements to be selected were determined by using these targets. In addition, for each test item, interviews were held with both teachers and two subject area experts to give the questions their final form. The KR-20 coefficient was used in the reliability calculations regarding the scoring system in the achievement test used in the application (Büyüköztürk et al., 2012). As a result of the analysis, the KR-20 of the test was found to be .58. The achievement test sections are presented in Table 3.

Table 3.

Achievement Test Sections

Section	Explanation	Example Question
1. Section	Distinguishing the number (marking the relevant number among other numbers and figures).	100-99-98-?
2. Section	It is expected to find which number will come before the number shown in the given picture (one and five).	5-10-15-?
3. Section	Ability to read and write the corresponding digit (write attribute). In this section, the student will write which number will come after the relevant number.	16-17-18-?
4. Section	Ability to write the number backwards. Match (fix) the corresponding pictures for it.	40-30-20-?
5. Section	Reading the number (makes a sequence with heavy use of related numbers accurate).	5- beş 6- ?

2.2. Mathematics Anxiety Scale for Primary School Students

In this study, a one-dimensional mathematics anxiety scale consisting of 10 items, prepared by Bindak (2005) and whose reliability and validity have been proven, was used. This scale aims to determine the anxiety levels of students in the control and experimental groups towards mathematics course. Cronbach's Alpha coefficient regarding the internal consistency of the scale was found to be 0.84. The scale includes a 10-item, 5-point, one-dimensional, Likert-type survey. Each student responding to the survey responds to each item on five subscales. These answers were obtained by asking each student one by one, since the students were first graders. In the survey, positive items regarding anxiety were scored as 5-4-3-2-1, and negative items regarding anxiety were scored as 1-2-3-4-5. In this way, an anxiety score emerged for each participant. The highest anxiety score that can be obtained from the survey is 50 and the lowest anxiety score is 10. An example of the positive and negative questions in the survey is “When I think of mathematics, complex and incomprehensible things come to my mind; "Mathematics is very fun for me" questions can be given.

In order to reveal the attitudes of students in the control and experimental groups towards the use of smart boards, the literature was examined and the "Smart board attitude survey" was developed (Akkaya, 2019; Batıbay, 2019; Gürleroğlu, 2019; Kabak, 2020; Ranger, 2015; Mete and Batıbay, 2019; Öztürk, 2022). While developing this survey, the steps expressed by Büyüköztürk

(2020) were followed. These steps; It can be expressed as planning the survey, writing the survey items, reviewing and editing the prepared items, conducting the pilot application, making arrangements according to the results and finalizing the survey. Additionally, at the beginning of the survey, there are questions about the demographic information of the participants and their use of technological tools. In order to obtain data, these questions were asked to each student separately by the researcher. Each stage has been carefully implemented to ensure that students do not have problems in reading and understanding. Teachers meticulously monitored that all students understood and answered the exam correctly. The survey contains a 10-item, 3-point Likert type survey form. In the survey, positive items regarding attitude were scored as 3-2-1, and negative items were scored as 1-2-3. Thus, an attitude score was obtained for each participant. The highest score that can be obtained from the survey is 30 and the lowest score is 10. Examples of positive and negative questions in the survey include “I like the lesson better when the smart board is used; Questions such as "I'm bored of using the smart board" can be asked.

2.3. Data Analysis

In this study, mathematics course achievement test, mathematics anxiety survey and smart board attitude survey were applied to the students. The data obtained as a result of the applications were examined with the SPSS package program. As a prerequisite for quantitative data analysis, the normality of the pretest and posttest of the test data was examined. In order to reveal whether the scores obtained from these groups showed normal distribution, Shapiro-Wilk normality test and skewness-kurtosis coefficient values were calculated. Since the number of participants in the experimental and control groups was less than 50, it was deemed appropriate to use the Shapiro-Wilk test. In the literature, it is recommended to use the Shapiro-Wilk test to calculate the normality assumption for groups of less than 50 people (O'Donoghue, 2012). Different values for skewness and kurtosis are mentioned in the literature. The fact that the skewness and kurtosis indices, calculated by dividing the skewness and kurtosis values by their standard errors, are close to 0 within the limits of -1.96 and +1.96, is considered as evidence for the existence of a normal distribution. Descriptive measurement results (arithmetic mean, standard deviation, median) of the tests applied were also obtained in order to obtain information about the general distribution of scores. When the data obtained at the specified evaluation points were examined, it was seen that the scores showed a normal distribution

according to these data. Dependent and independent sample t tests were applied to the data where normality was achieved. The Cohen d effect value of the average scores obtained by the control and experimental groups after the training and applications was also examined (Yıldırım and Yıldırım, 2011). As a general recommendation, Cohen's d effect value can be expressed as weak if this value is less than 0.2, medium if it is 0.5, and strong if it is greater than 0.8 (Cohen, 1988; Kılıç, 2014). The Shapiro-wilk values of the data obtained within the scope of the study are presented in Table 4.

Table 4.

Shapiro-wilk Values for Groups

Data collection tool	Groups	p
Math achievement test	EG Pre-test	.528
	EG Post-test	.465
	CG Pre-test	.343
	CG Post-test	.685
Math anxiety scale	EG Pre-test	.146
	EG Post-test	.112
	CG Pre-test	.095
	CG Post-test	.569
Smartboard attitude survey	EG Pre-test	.311
	EG Post-test	.095
	CG Pre-test	.120
	CG Post-test	.141

The researchers implemented the following measures to eliminate some factors that could affect the validity and reliability of the study. In the research, care was taken to develop the mathematics achievement test to be applied in the selection of surveys and scales representing quantitative data sources. The data were analyzed impartially in order to reveal the pre-test and post-test effects of these tests, especially on the students. In order to clearly demonstrate objectivity, the scores of each student taken as data were coded, and each student's own scores were recorded directly in the pre-test and post-test. In addition, in order for the students to answer the scale items sincerely and independently, the scales were administered by the researcher in a classroom environment by meeting each student one-on-one. The fact that the students were in the first grade made this mandatory, and since there were also students who could not read yet, the survey and scale data were collected through one-on-one interviews. It took an average of 30-35 minutes to fill out each survey and scale, and the data was collected

objectively. All these applications were carried out meticulously by the researchers, and the opinions of two academicians who were experts in their fields were taken at each stage. This also prevented data loss and ensured accurate measurements. The raw data collected by the researcher was examined together with two academicians who are experts in their field. An attempt was made to reduce the effect of independent variables that could affect the participants in the control and experimental groups and harm the reliability of the application process. In this context, the data of the study were collected by researchers and in their natural environment. The reason for this is to reduce the influence of external factors that could disrupt the impartiality of researchers and participants. In addition, in order to increase the reliability of the research, the opinions of colleagues (1st grade teachers) were frequently consulted during the implementation process. The opinions of three first grade teachers were taken at each stage of these applications.

3. Findings

In this part of the research, the findings that emerged as a result of the analysis of the data collected for the research questions are included. The findings were presented in accordance with the order of the research questions. In this direction, the results obtained from the findings of the study are interpreted in the discussion and suggestions section.

3.1.. Findings Related to Achievement in Mathematics Lesson

The experimental and control groups' pre-test and post-test scores were compared using t-test analyses. As seen in Table 5, a significant difference was found in favor of the post-test in the achievement test averages of the experimental group students [$t(26)= -13.255$; $p<.05$]. According to Table 6., it is seen that the web 2.0 tools applied for the mathematics lesson have a high level of positive effect on the achievement of the students. A statistically significant difference was found in the achievement test averages of the control group students in favor of the post-test [$t(25)= -5.095$; $p<.05$].

Table 5.

t-test Results Regarding Achievement Test Pre-test and Post-test Scores of Experimental and Control Group Students

Tests	n	M	SD	t	p	d
EG Pre-test	26	56.42	15.85	-13.255	.000	0.74
EG Post-test	26	88.61	13.71			
CG Pre-test	25	55.20	17.05	-5.095	.000	0.66
CG Post-test	25	82.60	14.19			

As seen in Table 6, there is a statistically significant difference in favor of the experimental group in the achievement test post-test averages [t(51)= 3.754; p<.05].

Table 6.

t-test Results of Pre-test and Post-test Scores of Achievement Test Experimental and Control Group Students

Tests	n	M	SD	t	p	d
EG Post-test	26	88.61	11.44	3.124	.002	0.47
CG Post-test	25	82.60	14.04			

3.2. Findings Obtained Regarding the Level of Anxiety in Mathematics Lesson

As seen in Table 7, there was a significant difference in favor of the post-test in the mean anxiety levels of the students in the experimental group towards the mathematics lesson [t(26)= -12.669; p<.05]. A significant difference was found in the mean anxiety levels of the students in the control group towards the mathematics lesson in favor of the post-test at the low effect level [t(25)= -5.195; p<.05].

Table 7.

t-test Results of Experimental and Control Group Students' Anxiety Levels for Mathematics Lesson, Pre-test and Post-test Scores

Tests	n	M	SD	t	p	d
EG Pre-test	26	35.30	14.85	-12.669	.000	0.83
EG Post-test	26	23.88	12.71			
CG Pre-test	25	31.00	17.95	-5.195	.000	0.31
CG Post-test	25	25.92	14.36			

As seen in Table 8, it is seen that there is a significant difference in favor of the experimental group in the post-test averages of the students [t(51)= 3.124; p<.05].

Table 8.

t-test Results of the Pre-test and Post-test Scores of the Experimental and Control Groups' Anxiety Levels towards the Math Lesson

Tests	n	M	SS	t	p	d
EG Post-test	26	23.88	11.44	3.124	.002	0.16
CG Post-test	25	25.92	14.24			

3.3. Findings Regarding Attitudes Towards Smart Board

As seen in Table 9, a significant difference was found in favor of the post-test in the mean attitude of the experimental group students towards the smart board [t(26)= -12.909; p<.05]. A significant difference was also found in the average of the control group students' attitudes towards the smart board in favor of the post-test at the moderate effect level [t(25)= -5.495; p<.05].

Table 9.

t-Test Results of the Experimental and Control Group Students' Attitudes Towards Smart Board Pre-Test and Post-Test Scores

Tests	n	M	SD	t	p	d
EG Pre-test	26	14.61	14.85	-12.909	.000	0.68
EG Post-test	26	24.57	12.71			
CG Pre-test	25	16.48	18.05	-5.495	.000	0.43
CG Post-test	25	23.68	15.04			

As seen in Table 10, it is seen that there is a significant difference at the small effect level in favor of the experimental group in the post-test averages [t(51)= 3.217; p<.05].

Table 10.

t-Test Results of the Experimental and Control Groups' Attitudes Towards Smart Board Pre-test and Post-test Scores

Tests	n	M	SD	t	p	d
EG Post-test	26	24.57	13.71	3.217	.020	0.06
CG Post-test	25	23.68	15.04			

4. Discussion and Conclusion

Within the scope of this study, the collected data on the effects of web 2.0 tools on primary school 1st grade students' success in mathematics lessons, their anxiety, and their attitudes towards smart board were analyzed and evaluated. According to the research results, the academic success of the students who learn mathematics with web 2.0 tools changes positively. As a result of teaching with web 2.0 tools, the fact that the mathematics achievement of the experimental group students was higher than that of the control group students means that

these applications have a positive effect on student success. After the experimental procedures, it was found that there was a significant difference in mathematics learning in favor of the experimental group. When the literature is examined, many studies show that web 2.0 tools have positive contributions to students' mathematics lesson achievement. Conole & Alevizou (2010), Bidaki & Mobasheri (2013), Blannin (2015), Bursalı (2022), Keskin (2021), Gürleroğlu (2019), Batıbay (2019), who stated that the academic success of the students increased at the end of the training with web 2.0 tools.), Tatlı (2017), Similar (2019) support the results of these studies. Studies showing that web 2.0 tools used in education increase the success of students are not limited to these. In their study, Deperlioğlu and Köse (2010) emphasized the use of web 2.0 tools in education, the areas of use of which are gradually expanding. According to the research, users stated that web applications facilitate interaction between users, enable them to work collaboratively over the Internet, and are effective in educational environments. Borich (2017), on the other hand, states that web 2.0 tools have been frequently used in educational environments in recent years as they facilitate teaching and learning. Many of these applications are free to use and allow collaboration. These tools, which have a dynamic structure, make students active in the education process. However, when the literature is examined, it is seen that some studies do not support these results. However, these studies are only a small part of them. As an example of these studies, İnce (2011) found no significant relationship between the use of Web 2.0 tools and their ability to write English words. When all these studies and this study are considered, it is seen that web 2.0 tools positively contribute to students' mathematics achievement. The situation that emerged because of the study offers important clues about the importance of Web 2.0 tools. Especially in primary school, these technological tools can be evaluated to facilitate mathematics teaching.

According to the results of the data obtained from this study, a significant difference was found between the mathematics anxiety levels of the students before and after the use of web 2.0 tools. According to these results, it can be stated that the use of web 2.0 tools has positive effects on students' math anxiety levels. The anxiety levels of the students who only took mathematics education on the smart board were higher than the students who took the course with web 2.0 tools on the smart board. This is the result of studies carried out in different times and conditions (Keklikci, 2011; Baştürk, 2012; Elmas & Geban (2012), Choudhury (2014), Korucu (2015), Sezgin et al., 2016; Yalçınkaya, 2016; Kesici, 2018; Süren, 2019) in parallel. As a result of

the training with web 2.0 tools, the mathematics anxiety of the students in the experimental group decreased significantly. It was observed that the mathematics anxiety pre-test average scores of the students in the experimental group were higher than the pre-test average scores of the students in the control group. It was observed that there was a significant difference between the post-test mean scores of the students in the experimental group and the post-test mean scores of the students in the control group. It was observed that there was a significant difference between the mathematics anxiety pre-test and post-test mean scores of the students in the experimental group. In parallel with the results of this research, Arslan (2008) emphasized that these technological environments have a significant effect on anxiety and success in his study, in which he examined the effects of web-based education on students' attitudes, mathematics anxiety and academic success. If the results of the study are evaluated in general, it is understood that the education made with web 2.0 tools has an effect on reducing the mathematics anxiety levels of the students. The fact that the students liked the prepared animations and had fun while watching may have resulted in this situation. In addition, it can be said that the active participation of the students in the education process during the Plickers application provides an opportunity for their active learning. In this study, it can also be stated that the students' anticipation of the mathematics lesson with excitement and their love for it more are due to the effect of these web 2.0 tools. Although there was no significant difference between the control and experimental groups regarding math anxiety in the pre-tests, there was a significant difference in favor of the experimental group according to the post-test results. These results may indicate that students who receive education with web 2.0 tools have less math anxiety. This result shows parallelism with the result of Bekdemir (2009)'s study. All these results may mean that education with web 2.0 tools and smart boards reduces math anxiety in students.

Attitude scores of the students in the experimental group, who used web 2.0 tools on the smart board, were higher than the scores of the students in the control group. As a result of this situation, it can be said that students have a more positive attitude towards web 2.0 tools and smart board. Considering the scores of the students from the smart board attitude questionnaire, it is understood that most of the students are satisfied with the use of smart boards. When we look at the previous studies, it is seen that the studies are mostly focused on the effect of web 2.0 tools on motivation. Hillier (2013), Mata et al. (2016), Yapıcı & Karakoyun

(2017), Çetin (2018), Koğu (2018), Türker & Genç (2018), Akkaya (2019), Mete and Batıbay (2019), Yüksel (2019), Gezer (2020), As a result of the research conducted by Ahmed & Opoku (2022), it was determined that web 2.0 tools were effective in increasing motivation. In the study conducted by Şeker (2020) on the effect of Plickers, one of the web 2.0 tools, on the academic success of secondary school 5th grade students, a significant difference was found in favor of the experimental group. In another study, Akkaya (2019), who investigated the effects of activities developed with multiple web 2.0 tools on academic success, reached a similar conclusion. Korucu (2015) determined that the students' motivation in the course increased in the collaborative learning environment created by using web technologies. Parallel to this, in this study, it can be concluded that different web 2.0 applications used for mathematics lessons contribute positively to individuals' attitudes towards mathematics lesson. In other words, the smart board increased the motivation of the students. At the end of the training, the motivation of the experimental group students was higher than the motivation of the control group students. This result is in parallel with the result obtained by Yüksel (2019). As a result of this study, it was seen that there was a positive development in the attitudes of the control group students towards the smart board. The effective use of the smart board in the control group may have caused this situation.

This study has limitations in terms of experimental/control groups and scope. The study is limited to the application carried out in two branches of a primary school, as an experimental/control group study limitation. The research has no scope other than the stated problem and sub-problem situation. In order to reveal the effect of web 2.0 applications on students, it is limited to the application of tests to be applied as a pre-test before the application process on a quantitative basis and as a post-test at the end of the application process.

In this part of the research, based on the research findings, some suggestions are given in the light of the data obtained after examining the effect of teaching the mathematics course with web 2.0 tools on the success, anxiety level and motivation of the students. These recommendations highlight important practical points. In addition to this, there are also suggestions for the application area of web 2.0 tools used in education and training activities and this situation. The study is limited to the data obtained from the data collection tools developed by the researchers and the students who have smart boards in their classrooms.

- Widespread use of the web 2.0 tools applied in the study in schools may enable students to gain many knowledge and skills that they cannot gain with the current program or that they can gain in a long time. It may be helpful for teachers to be aware of Plickers and Powtoon applications.
- This study was conducted to reveal the effects of two different web 2.0 tools on achievement, attitude, and anxiety level towards mathematics lesson, was carried out with a control and an experimental group. A study with more groups and more students may contribute to the results being more comprehensive and generalizable.
- This study is limited to 5 weeks and 25 lesson hours during the education and training process. In order to determine the effect of web 2.0 tools on academic achievement, attitude and mathematics anxiety, studies covering a semester, or an academic year can be conducted.
- The research was carried out on the "Natural numbers" unit of the 1st grade Mathematics lesson. Similar studies can be carried out in different subjects of the mathematics course or in different courses at different grade levels.
- It is recommended that teachers use smart board applications that appeal to more senses in lessons, considering that especially 1st grade students may have higher anxiety about mathematics starting from primary school.
- Since it is thought that the use of technology will become an important part of education wherever there is education and training, a large number of in-service trainings are organized to prepare all educators for this, especially with the help of 1st grade students to improve themselves in digital methods in order to overcome the difficulties in the initial adaptation process. It is recommended that they should attend the training.
- It is recommended to examine the mathematics anxiety levels of primary school students in more detail and to carry out studies to reduce anxiety, especially to investigate the main causes of mathematics anxiety of 1st grade students and solutions for them.

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Research Article

Analyzing Mother Tongue Interference in Turkish EFL Students' Written Products: A Lexical and Syntactical Perspective

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Abstract

Languages exhibit diverse characteristics and undergo constant evolution. The intricate nature of language interaction during Second Language Acquisition intrigues experts. Language learning involves exposure to multifaceted elements, and despite extensive research, the phenomenon of language transfer remains elusive. This study aims to identify errors stemming from the influence of Turkish, the first language, on the written English proficiency of Turkish learners in a formal setting. The objective is to scrutinize the linguistic domains affected by transfer and assess its impact on the educational process. Additionally, the study investigates the potential correlation between error rates and proficiency levels in the target language (L2). Employing qualitative and quantitative data analysis, the research involves 252 participants, excluding 16 non-native Turkish speakers from the initial 268. Results reveal negative transfer in both lexical and syntactical language aspects. Gathered evidence establishes a robust correlation between specific error types and students' proficiency levels. The study concludes with tailored recommendations to enhance Second Language Acquisition (SLA) and acknowledges its limitations.

Keywords: Second Language Acquisition, Error, Error Analysis, Language Transfer, Mother Tongue Interference

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Yabancı Dil Olarak İngilizce Öğrenen Türk Öğrencilerin Yazılı Anlatımlarında Ana Dil Etkisinin Analizi: Sözcüksel ve Sözdizimsel Bir Yaklaşım

Özet

Diller çeşitli özellikler sergiler ve sürekli evrim geçirir. İkinci Dil Edinimi sırasında dil etkileşiminin karmaşık doğası uzmanların ilgisini çekmektedir. Dil öğrenimi çok yönlü unsurlara maruz kalmayı içerir ve kapsamlı araştırmalara rağmen, dil aktarımı olgusu anlaşılması zor olmaya devam etmektedir. Bu çalışma, resmi bir ortamda yabancı dil olarak İngilizce öğrenen Türk öğrencilerin yazılı İngilizce yeterlilikleri üzerinde ana dilleri olan Türkçenin etkisinden kaynaklanan hataları tespit etmeyi amaçlamaktadır. Amaç, aktarımdan etkilenen dilsel alanları incelemek ve bunun eğitim süreci üzerindeki etkisini değerlendirmektir. Ayrıca, çalışma hata oranları ile hedef dildeki (L2) yeterlilik seviyeleri arasındaki potansiyel ilişkiyi araştırmaktadır. Nitel ve nicel veri analizinin kullanıldığı araştırma, başlangıçta 268 katılımcıdan ana dili Türkçe olmayan 16 kişi hariç bırakılarak toplamda 252 katılımcıyı kapsamaktadır. Sonuçlar hem sözcüksel hem de sözdizimsel dil boyutlarında olumsuz aktarımı ortaya koymaktadır. Elde edilen kanıtlar, belirli hata türleri ile öğrencilerin yeterlilik düzeyleri arasında sağlam bir ilişki olduğunu ortaya koymaktadır. Çalışma, İkinci Dil Edinimini (İDE) geliştirmek için belirli önerilerle sonuçlanmakta ve sınırlılıklarını kabul etmektedir.

Anahtar Kelimeler: İkinci Dil Edinimi, Hata, Hata Analizi, Dil Aktarımı, Anadilin İkinci Dile Etkisi

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1. Introduction

Language learners commonly commit errors when utilizing specific grammatical structures. The errors made by L2 learners can be traced back to two types of transfers. One of these is interlingual transfer, involving the transfer of knowledge from the first language (L1). L1 interference denotes the negative transfer from one's first language (L1) to a second language. The other one is intralingual transfer which pertains to the phenomenon of transferring linguistic elements within the same target language, such as the overgeneralization of syntactic rules discussed by Brown (1980) and Richards (1974). For Turkish students learning English as a second or foreign language, the intricate frameworks of the English language present challenges. This study aims to identify the specific lexical and syntactic factors contributing to transfer errors by learners. Additionally, we seek to establish a correlation between the number of errors and the competency levels of the students.

To set the groundwork for the research, the central inquiries guiding this study will include:

1. What categories of interlingual errors do English as a Foreign Language (EFL) learners typically commit in their written compositions?

2. What might be the origins of these errors?

3. In what manner can these errors be categorized?

4. How does mother tongue interference impact the usage of English in terms of lexical and syntactical aspects across different proficiency levels of EFL learners (Pre-intermediate, Intermediate, and Upper-intermediate)?

5. What strategies can be employed to mitigate the impact of mother tongue interference?

1.1. Interlanguage

In 1972, Larry Selinker, an American etymologist, introduced the term "interlanguage" (IL) (Gobbo, 2020). It refers to a distinct linguistic system created by language learners, visibly different from both their native language (NL) and the target language (TL) under study. This framework evolves as students immerse themselves in learning the target language, representing a modified version of the desired language. However, it often incorporates errors

resulting from the improper application of the students' native language during the process of learning the target language.

1.2. Errors

Gass and Selinker (2001) characterized errors as "red flags" that indicate a learner's proficiency in the second language. The term 'error' denotes a departure from precision or accuracy, while a 'mistake' arises from flaws like misjudgment, carelessness, or forgetfulness, resulting in an error manifestation. Individual language users' deviations from conventional language norms in grammar, syntax, pronunciation, and punctuation are commonly labeled as errors (Brown, 1980). In addition to previous studies, Turnuk and Aydin (2020) stated that students' anxiety increases with the number of interlanguage errors they make.

1.3. Analysis of Errors

Error Analysis originated in applied linguistics through the research conducted by P.S. Corder in 1982. This methodology is dedicated to scrutinizing and comprehending the errors made by students during their language learning journey, along with the impact of their interlanguage. Richards, Plott, and Platt (1996:127) note that error analysis enables experts and educators to recognize the strategies utilized by students in language acquisition, pinpoint the causes of their errors, collect data on prevalent challenges in language learning, and contribute to the creation of instructional materials. Similar to Richards, Plott, and Platt (1996), Duygun and Karabacak (2022) examined the causes of errors and asserted that students are unable to identify the proper linguistic use when they are unfamiliar with the correct version of a linguistic term.

Error Analysis Approaches

Keshavarz (1999) identifies two primary approaches to error analysis in language learning: Contrastive Analysis and Error Analysis. Contrastive Analysis involves comparing the native language and target language to predict errors, while Error Analysis focuses on recognizing and classifying errors made by learners (Keshavarz, 1999, p. 11). However, Keshavarz acknowledges that Contrastive Analysis has limitations and can lead to inaccurate predictions of errors (Keshavarz, 1999, p. 11). This limitation resulted in the emergence of Error Analysis as a more dependable method for studying errors (Brown, 1980). Corder (1967) defines Error

Analysis as the process of collecting samples of learner language, identifying errors, describing and categorizing them, and evaluating their significance.

1.4. Mother Tongue Interference

Linguistic interference refers to the influence of an individual's first language on the process of learning or using a second language (Pavlenko, 1999). It occurs when two languages overlap, particularly if they share similar word order and syntactic structures (Pavlenko, 1999). Grosjean (1982) defines interference as an unintentional phenomenon distinct from conscious activities like borrowing and code-switching. Bilingualism tends to be more prevalent when languages have similar phonological and morphological characteristics (Kellerman, 1977). Interference can also result from incomplete language acquisition and interactions between mutually spoken languages (Keshavarz, 1999).

Researchers have predominantly explored how an individual's native language influences their writing proficiency, particularly in terms of writing competence (Demirezen, 2010). For instance, the Thai language may impact the syntactic structure in written communication, showcasing features of syntactic transfer from the speaker's native language (Haryanto, 2007). Bhela (1999) notes that students often rely on structures and patterns from their first language when writing in a second language, resulting in more errors due to linguistic differences. According to Rahayu, Nurfajriah Basri (2021) learners frequently struggle to master a second language due to interference, which is influenced by ingrained habits, popular mother tongues, and bilingual contact in society. Similarly, Tamba (2023) found that mother tongue significantly effects students' academic success. Interference occurs when patterns from one's native language are transferred, leading to inaccuracies in phonology, vocabulary, and syntax (Brown, 1980). The text is unintentional and lacks grammatical precision, deviating from the established conventions of the target language.

1.5. Contrastive Analysis

The Contrastive Analysis Hypothesis suggests that the probability of transfer from the native language increases when significant differences exist between the first and second languages (Corder, 2000). The purpose of contrastive study is to examine and evaluate the linguistic structures of both the target language and the native language, identifying potential difficulties that students may face (Corder, 1983).

2. Methodology

The research framework of this study is grounded in the field of Second Language Acquisition (SLA), aiming to contribute to our understanding of language transfer phenomena and its implications for language learning. By investigating the errors that arise from the influence of Turkish on the learning of written English, this study sheds light on the intricate processes involved in second language acquisition.

The settings for this study comprise formal educational environments where Turkish learners of English engage in language learning activities. These settings provide the necessary context for observing language transfer and its effects on the educational process.

Participants in this study are 252 Turkish learners of English, carefully selected to ensure the homogeneity of the sample in terms of language background and educational context. The exclusion of non-native Turkish speakers ensures the integrity of the study's focus on Turkish learners and minimizes confounding variables.

Instruments selected for data collection include written language samples from participants, which serve as the primary source of data for identifying errors and patterns of language transfer. Additionally, standardized proficiency assessment tests or institutional language proficiency levels are utilized to measure participants' proficiency in English objectively.

Methodology for data collection involves a systematic approach to collecting written language samples from participants, ensuring representation across proficiency levels and linguistic domains. Ethical considerations are paramount throughout the data collection process, with measures in place to protect participants' confidentiality and privacy.

Data analysis encompasses both qualitative and quantitative approaches, allowing for a comprehensive examination of the errors identified in participants' language samples. Qualitative analysis involves categorizing errors into lexical and syntactical language categories, while quantitative analysis focuses on calculating error rates and exploring correlations with proficiency levels in English.

Overall, this Methodology Chapter outlines the systematic approach adopted in this study to investigate language transfer phenomena among Turkish learners of English. Through rigorous data collection and analysis, the study aims to provide valuable insights into the complexities

of second language acquisition and contribute to the enhancement of language learning pedagogy.

2.1. Research Design

The research design of this study is mixed-methods, incorporating both qualitative and quantitative approaches to address the research questions effectively. As for the qualitative analysis, errors in written English productions were qualitatively analyzed to identify patterns of language transfer. Linguistic domains impacted by transfer were examined. Also, the current study, influenced by Jarvis (2000) and Odlin (2003), uses a comparative approach to examine linguistic forms in learners' native language, second language, and interlanguage (IL). The analysis focuses on IL structures, comparing Turkish and English, to identify instances of mother tongue interference at both lexical and syntactical levels. The study employs the Error Analysis approach to achieve this objective.

With regard to quantitative analysis, error rates were quantitatively analyzed to determine correlations with proficiency levels in English. Statistical methods such as correlation analysis are employed to assess the strength and significance of the relationship between error rates and proficiency levels.

2.2. Setting and Participants

This research was conducted with English Preparatory Students at a private university in Central Anatolia, Turkey, aiming to assess the extent of mother tongue interference at lexical and syntactical levels in English. The study independently analyzes the degree of mother tongue interference based on the learners' English proficiency levels. Twelve classes from a private university, each comprising approximately twenty students at various English proficiency levels, participated in the research. The study encompassed all English Preparatory classes during the 2016-2017 Academic Year, specifically targeting levels such as Elementary, Pre-intermediate, and Intermediate.

After excluding non-native Turkish speakers, the participant counts in the study amounted to 252 out of an initial 268. These individuals were enrolled in a program offered by the English Preparatory School at a private university in Central Anatolia, Turkey. The program entails a minimum of 4 quarters, with each quarter spanning 8 weeks. Participants receive 27 hours of

English instruction weekly, covering all four language skills. Notably, all students in the program use the same coursebook, eliminating the potential risk of mother tongue interference due to material variations.

In this research, the sampling method used is purposive sampling. Purposive sampling involves selecting participants based on specific criteria relevant to the research objectives. The reason for using purposive sampling in this study is to ensure that the selected participants meet certain characteristics essential for addressing the research questions effectively. In this case, the researchers aimed to include Turkish learners of English as a foreign language in a formal educational environment. By employing purposive sampling, the researchers could target participants who fit this criterion, ensuring that the study's findings are applicable to the specific population of interest.

Additionally, the exclusion of non-native Turkish speakers from the sample further refines the participant selection process, maintaining the focus on Turkish learners of English and minimizing potential confounding variables.

To conclude, the use of purposive sampling allows the researchers to gather data from a targeted group of participants who possess the necessary language background and are situated within the context of formal language learning, thus enhancing the relevance and validity of the study's findings.

2.3. Data Collection Tools

Throughout the academic year, students undergo structured instruction in the composition of paragraphs and the exploration of various paragraph structures. This process involves familiarizing students with different paragraph variations and techniques. Subsequently, students' progress to the development of short essays, where they are introduced to diverse essay formats and styles. The instruction provided encompasses a comprehensive approach to writing, covering aspects such as paragraph coherence, cohesion, and organization, as well as essay structure and argumentation.

The pedagogical framework for teaching paragraph and essay writing typically involves several stages. Initially, students are introduced to fundamental concepts such as topic sentences, supporting details, and transitions, which form the building blocks of effective

paragraph construction. They are then guided through exercises and activities aimed at practicing these concepts and refining their paragraph writing skills. As students advance, they are exposed to more complex paragraph structures, such as comparison and contrast, cause and effect, and narrative paragraphs. Additionally, they learn strategies for developing coherent and cohesive paragraphs through the use of rhetorical devices, logical organization, and effective transitions.

In the transition to essay writing, students further develop their writing skills by exploring different types of essays, including descriptive, narrative, expository, and persuasive essays. They learn to formulate clear thesis statements, develop supporting arguments, and organize their ideas logically and persuasively. Emphasis is placed on the development of critical thinking skills, as students analyze and evaluate texts, formulate arguments, and support their claims with evidence and examples.

Throughout this process, students' written performances in both paragraph and essay formats are systematically evaluated to identify errors related to language transfer. These errors are categorized according to lexical and syntactical criteria, including issues such as word choice, verb tense, pluralization, and preposition usage. By analyzing students' written work, educators gain insights into the specific language transfer challenges faced by learners and can tailor instruction to address these challenges effectively.

In summary, the teaching of paragraph and essay writing involves a structured approach that progresses through various stages, from foundational concepts to more advanced skills. By systematically examining students' written performances, educators can identify areas for improvement and provide targeted instruction to support learners' language development.

2.4. Data Collection Procedure

Data for this study were extracted from the Third Quarter Final Writing Exam of English Preparatory School students at a private university in Central Anatolia. The program, administered by the English Preparatory School, involves a minimum of 8 weeks of instruction for accurate paragraph writing. At advanced levels, students receive at least 8 weeks of training in diverse essay writing techniques to produce clear and high-quality short essays. These instructional components are integral to the curriculum, and the data were obtained through

the regular quarterly final writing exam, following established procedures. No specific instructions were given to students to create data exclusively for the research.

Every pre-intermediate student was required to compose a paragraph of 110-120 words, addressing the instructions and topics provided in their exam paper. Conversely, each intermediate student was tasked with crafting a short essay comprising four paragraphs and totaling 250-270 words, aligning with the instructions and topics in their exam paper. To access copies of the final writing papers from 268 English Preparatory Class students, necessary permission and approval were obtained from the University Research Ethics Committee.

2.5. Data Analysis

Qualitative data underwent content analysis, with participants assigned numerical identifiers and paragraphs denoted as "A" and essays as "B". A meticulous examination was conducted, dissecting each content word by word and sentence by sentence to identify distinctive statements. Once identified, these expressions were scrutinized again to categorize and code the types of errors, employing Corder's algorithm for error recognition. To ensure intra-rater reliability, the data were analyzed and coded twice at different times. Subsequently, another coder, possessing a minimum of ten years' teaching and classroom management experience, assessed the data using the same codes to ensure inter-rater reliability.

In the subsequent stage of the investigation, error types were categorized, and their frequencies were documented. Drawing from the literature (Corder, 1974; Selinker, 1972), errors were classified grammatically, morphologically, lexically, syntactically, and semantically. Assessments of students' written performances can reveal a wide range of these error types. Grammatical classification encompasses errors in auxiliary verbs, tense, pluralization, possessive case, reported speech, relative clause, adjective and adverb usage, articles, prepositions, pronouns, conjunctions, and more.

Affixation errors fall into the morphological category. Morphological errors also encompass those resulting from overgeneralization of rules and language transfer. Spelling errors, eggcorn (oronyms) errors, malformation errors influenced by language transfer, and collocation errors resulting from language transfer and overgeneralization of rules can be categorized as lexical errors.

Concerning syntactic errors, language transfer and overgeneralization of principles are identified as root causes of errors. Ultimately, semantic errors are primarily attributed to language transfer.

Several stages were involved in applying error analysis to assess the collected data. The following steps were based on the framework outlined by Corder, as cited by Ellis (1997: 48). The phases are outlined below:

1. Sample Collection:

Selecting language proficiency tests for analysis and determining the method of gathering them.

2. Error Identification:

Thoroughly examining students' errors to identify and distinguish errors.

3. Error Classification:

Categorizing the identified errors and grouping them based on their types.

4. Explanation of errors:

Establishing the origins of errors and determining the frequency of their occurrence to provide explanations for the identified errors.

Regarding the aforementioned stages of the error analysis concept, the data were examined as outlined below:

2.5.1. Identification of errors

In this step, we scrutinized the collected data and made an effort to identify both lexical and syntactical errors. Our aim was to analyze the information as objectively as possible.

2.5.2. Classification of errors

After pinpointing the errors, we categorized them into the following groups:

a. word choice errors

b. verb tense errors

c. pluralization errors

d. preposition addition errors

e. preposition omission errors

f. preposition misuse errors

2.5.3. Calculation of errors

During this stage, we computed the errors to determine the frequency with which Turkish EFL learners made those errors.

2.5.4. Tabulating the result

After identifying and categorizing the errors, we presented the results in a table. The purpose of this table was to streamline the depiction of the percentage for each error. Thus, the outcome of the analysis of syntactical and lexical errors in paragraphs and essays written by Turkish EFL learners was visually represented in tabular form.

2.5.5. Drawing a conclusion

In the final stage, we had to draw a valid and concise conclusion through an error analysis.

3. Results

This segment reveals the outcomes and findings obtained through an error analysis of written materials by Turkish EFL learners. It provides a detailed examination of structures influenced by language transfer. The results are systematically presented, one category at a time, along with the corresponding statistical findings. Six classifications emerged from the collected data, encompassing errors induced by the native language (L1), including tenses, preposition addition, preposition omission, preposition misuse, pluralism, and word choice. Subsequently, the findings will be explained and illustrated for a comprehensive discussion.

3.1. Word Choice

This type of interference occurs when a linguistic element in the learner's native language clashes with a corresponding element in the second language. The impact of lexical interference from the mother tongue becomes more apparent when the learner translates idioms, proverbs, and phrasal verbs word-for-word, as illustrated in the following examples:

I loved my episode at university. (department)
I sat per computer. (in front of a computer)
The nurse fainted me. (anesthetized)
After day, we went to a café. (The next)
We rode a car. (drive)
I was turning from my school. (return)
My friends made a birthday. (had a birthday party)

Table 1.

One-way Anova Test of Word Choice Errors

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	89,02	5	17,80	3,82	,002
Within Groups	1143,94	246	4,65		
Total	1232,96	251			

The statistical analysis, conducted through one-way Anova, indicated a significant difference among groups (F (5,246) = 3.82, p= .002<.05) concerning the dependent variable of Word Choice.

Table 2.

Descriptive Statistics of Word Choice Error

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
upperb1	29	3,34	3,41	,63	2,05	4,64	0	13
midb1	46	2,02	2,63	,38	1,24	2,80	0	10
lowerb1	48	1,85	2,42	,35	1,15	2,56	0	10
uppera2	43	1,58	1,59	,24	1,09	2,07	0	7
mida2	44	1,41	1,08	,16	1,08	1,74	0	5
lowera2	42	1,33	1,31	,20	,92	1,74	0	5
Total	252	1,85	2,21	,14	1,57	2,12	0	13

Based on the gathered data, it is evident that each group made Word Choice errors, as indicated in Table 2. The Class Upper B1 showed the highest frequency of Word Choice errors, with a mean of 3.34, while the Class Lower A2 exhibited the fewest Word Choice errors. Table 2 highlights a noteworthy outcome, indicating that higher proficiency levels, such as B1 classes, had higher means, while lower proficiency levels, like A2 classes, had lower means for this type of error. This suggests an increase in error frequency with advancing proficiency levels.

Table 3.

Multiple Comparisons of Word Choice Error

(I) class	(J) class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
	midb1	1,32	,51	,13	-,18	2,82
	lowerb1	1,49*	,50	,04	,00	2,98
upperb1	uppera2	1,76*	,51	,01	,24	3,29
	mida2	1,93*	,51	,00	,42	3,45
	lowera2	2,01*	,52	,00	,48	3,54
	upperb1	-1,32	,51	,13	-2,82	,18
	lowerb1	,16	,44	1,00	-1,15	1,48
midb1	uppera2	,44	,45	,99	-,91	1,79
	mida2	,61	,45	,94	-,73	1,96
	lowera2	,68	,46	,88	-,67	2,05
	upperb1	-1,49*	,50	,04	-2,98	,00
	midb1	-,16	,44	1,00	-1,48	1,15
lowerb1	uppera2	,27	,45	1,00	-1,06	1,61
	mida2	,44	,45	,99	-,88	1,77
	lowera2	,52	,45	,98	-,82	1,87
	upperb1	-1,76*	,51	,01	-3,29	-,24
	midb1	-,44	,45	,99	-1,79	,91
uppera2	lowerb1	-,27	,45	1,00	-1,61	1,06
	mida2	,17	,46	1,00	-1,19	1,54
	lowera2	,24	,46	1,00	-1,13	1,63
	upperb1	-1,93*	,51	,00	-3,45	-,42
	midb1	-,61	,45	,94	-1,96	,73
mida2	lowerb1	-,44	,45	,99	-1,77	,88
	uppera2	-,17	,46	1,00	-1,54	1,19
	lowera2	,07	,46	1,00	-1,30	1,45
	upperb1	-2,01*	,52	,00	-3,54	-,48
	midb1	-,68	,46	,88	-2,05	,67
lowera2	lowerb1	-,52	,45	,98	-1,87	,82
	uppera2	-,24	,46	1,00	-1,63	1,13
	mida2	-,07	,46	1,00	-1,45	1,30

*. The mean difference is significant at the 0.05 level.

The Gabriel Post Hoc Test indicated a notable distinction between Upper B1 and Lower B1 (p=0.04) concerning the dependent variable of word choice errors. Additionally, a significant difference emerged in the comparison between Upper B1 and Upper A2 (p=.01<0.05). The comparison involving Upper B1, Mid A2, and Lower A2 demonstrated a highly significant difference (p=.00). However, when Mid B1 was compared to the other groups, no statistically significant difference was observed.

The participants encountered significant challenges due to word choice errors, leading to issues like misunderstanding and incomprehensibility. At times, we struggled to grasp the intended meaning of the student, although not consistently, given our proficiency as native Turkish speakers. The findings of this study align with Darus and Subramaniam's (2009) research, affirming the learners' struggle with selecting appropriate words.

A similar situation occurred in some of Kırkgöz's (2009) examples extracted from students' written works. The students translated words from Turkish to English, risking misunderstanding, which Kırkgöz, being a native Turkish speaker, was able to avert. This aligns with the findings of Rabab'ah (2005), who, based on his experience in teaching English majors, noted that Jordanian learners "lacked the necessary vocabulary they needed to get their meaning across" (p. 183).

3.2. Verb Tense

Another prevalent error in students' essays is related to verb tense. Frequently, they fail to select the appropriate time expression to convey the action and misuse irregular verbs. In this context, learners often employ an incorrect tense, resulting in a failure to effectively communicate a message. The subsequent examples illustrate this error type. The root cause of errors in these instances lies in the difference between English and Turkish, where the present simple tense is used in English, while the present continuous tense is employed in Turkish.

I am living in Konya for 12 years. (live)
How are you feeling? (to ask for opinion) (do you feel)
They are loving their children. (love)
He is wanting to pass university exam. (wants)
I'm coming early in the mornings. (repeated action) (come)

Table 4.

One-way Anova Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	18,25	5	3,65	4,26	,001
Within Groups	210,42	246	,85		
Total	228,67	251			

An analysis of variance (Anova) revealed a noteworthy difference among groups (F (5,246) = 4.26, p= .001<.05) concerning the dependent variable of Verb Tense.

Table 5.

Descriptive Statistics of Verb Tense Error

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
upperb1	29	,79	1,89	,35	,07	1,51	0	7
midb1	46	,09	,41	,06	-,04	,21	0	2
lowerb1	48	,58	1,16	,16	,25	,92	0	6
uppera2	43	,05	,21	,03	-,02	,11	0	1
mida2	44	,07	,25	,03	-,01	,15	0	1
lowera2	42	,36	,90	,14	,07	,64	0	5
Total	252	,30	,95	,06	,18	,42	0	7

As depicted in Table 5, Verb Tense errors were present in each group. The table indicates that Class Upper B1 exhibited the highest mean for Verb Tense errors (0.79), followed by Class Lower B1 with the second-highest mean (0.58). Conversely, Class Upper A2 showed the lowest mean for this type of error (0.05). Additionally, the table reveals that B1 classes collectively made significantly more errors than A2 classes (B1: 2.27; A2: 0.48).

Table 6.

Multiple Comparisons of Verb Tense Errors

Dependent Variable: Verb Tense

(I) class	(J) class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
upperb1	midb1	,70*	,21	,02	,06	1,35
	lowerb1	,21	,21	,99	-,43	,85
	uppera2	,74*	,22	,01	,09	1,40
	mida2	,72*	,22	,01	,07	1,38
	lowera2	,43	,22	,53	-,22	1,09
midb1	upperb1	-,70*	,21	,02	-1,35	-,06
	lowerb1	-,49	,19	,13	-1,06	,07
	uppera2	,04	,19	1,00	-,54	,62
	mida2	,01	,19	1,00	-,56	,60
	lowera2	-,27	,19	,93	-,85	,31
lowerb1	upperb1	-,21	,21	,99	-,85	,43
	midb1	,49	,19	,13	-,07	1,06
	uppera2	,53	,19	,08	-,04	1,11
	mida2	,51	,19	,11	-,06	1,09
	lowera2	,22	,19	,98	-,35	,80
uppera2	upperb1	-,74*	,22	,01	-1,40	-,09
	midb1	-,04	,19	1,00	-,62	,54
	lowerb1	-,53	,19	,08	-1,11	,04
	mida2	-,02	,19	1,00	-,61	,56
	lowera2	-,31	,20	,85	-,90	,28
mida2	upperb1	-,72*	,22	,01	-1,38	-,07
	midb1	-,01	,19	1,00	-,60	,56
	lowerb1	-,51	,19	,11	-1,09	,06
	uppera2	,02	,19	1,00	-,56	,61
	lowera2	-,28	,20	,90	-,88	,30
lowera2	upperb1	-,43	,22	,53	-1,09	,22
	midb1	,27	,19	,93	-,31	,85
	lowerb1	-,22	,19	,98	-,80	,35
	uppera2	,31	,20	,85	-,28	,90
	mida2	,28	,20	,90	-,30	,88

*. The mean difference is significant at the 0.05 level.

The multiple comparisons test for Verb Tense errors indicated a significant difference between Upper B1 and Mid B1 classes (p=.02). Notably, substantial distinctions were observed among Upper B1, Upper A2, and Mid A2 classes (p=.01<.05). Additionally, a similarity was observed

between Upper B1 and Lower B1 (p=.99). Another noteworthy resemblance was identified between Mid B1, Upper A2, and Mid A2 (p=1.00>.05). Furthermore, a significant similarity was found between classes Lower B1 and Lower A2 (p=.98).

Verb tense errors were not highly frequent in students' papers. Tenses in Turkish and English are somewhat comparable, yet there are instances where they are not used in the same way in both languages, leading to occasional difficulties. In the Turkish language, verb tenses include present, present progressive, future, definite past, indefinite past, necessity, subjunctive, conditional, and imperative.

The only tense that the Turkish language lacks compared to English is the present perfect tense. The example provided may result in confusion due to differences in tenses or the absence of the mentioned tense in Turkish. This discrepancy leads to variations in expression, where an English native speaker would say, "I have lived in Konya for 12 years," while a Turkish native speaker would express it as, "I am living in Konya for 12 years."

Yet, according to Bennui's (2008) study, students from Thailand asserted that in Thai, there is no direct connection between time and tense. This implies that time signifies the speaker's intention, and the verb form remains unchanged regardless of the time—whether it is present, past, or future. In a similar vein, one of Haryanto's (2007) students expressed, "First, it makes me love (to) read when I was young until future I read books." Bennui (2008) clarified that the learner employed the present simple tense in a sentence that referred to the past. The student also used the future word "to express a future in the past" (p. 85).

3.3. Pluralization (Singular-Plural Noun Agreement)

Pluralization errors have been noted in student essays. In the instances mentioned, it's evident that learners are applying a grammatical structure from their native language to the second language. Specifically, when referring to "four days" or "two hours," pluralization is not applied to the nouns in accordance with Turkish grammar rules. This rule in the Turkish language contradicts the corresponding one in English.

We stayed four day. (four days)
The concert lasted about two hour. (two hours)
That days were so great. (Those days)
I am young people. (I am a young person.)

Table 7.

One-way Anova Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	27,06	5	5,41	8,02	,00
Within Groups	165,92	246	,67		
Total	192,98	251			

According to the Table 7, there is a highly significant difference between groups (F (5,246) =8,02, p=.00<.05) considering the Pluralization Errors.

Table 8.

Descriptive Statistics of Pluralization Error

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
upperb1	29	1,24	1,48	,27	,68	1,80	0	6
midb1	46	,76	,92	,13	,49	1,04	0	5
lowerb1	48	,40	,79	,11	,17	,63	0	4
uppera2	43	,33	,60	,09	,14	,51	0	2
mida2	44	,25	,53	,08	,09	,41	0	2
lowera2	42	,21	,47	,07	,07	,36	0	2
Total	252	,49	,87	,05	,38	,60	0	6

As depicted in the above table, every group exhibited pluralization errors. However, the highest mean was observed in Class Upper B1 (1.24). Notably, the means of Mid A2 and Lower A2 are closely aligned (.25; .21). Despite the resemblance between these two groups, the increasing trend in means indicates that learners made more pluralization errors as their proficiency level advanced (Lower A2: .21 < Upper B1: 1.24).

Table 9.

Multiple Comparisons of Pluralization Errors

(I) class	(J) class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
upperb1	midb1	,48	,19	,20	-,10	1,06
	lowerb1	,84*	,19	,00	,27	1,42
	uppera2	,91*	,20	,00	,33	1,50
	mida2	,99*	,19	,00	,41	1,58
	lowera2	,97*	,20	,00	,39	1,57
midb1	upperb1	-,48	,19	,20	-1,06	,10
	lowerb1	,36	,17	,40	-,14	,87
	uppera2	,43	,17	,19	-,09	,96
	mida2	,51	,17	,05	-,01	1,03
	lowera2	,49	,17	,07	-,03	1,02
lowerb1	upperb1	-,84*	,19	,00	-1,42	-,27
	midb1	-,36	,17	,40	-,87	,14
	uppera2	,07	,17	1,00	-,45	,59
	mida2	,14	,17	,99	-,37	,66
	lowera2	,13	,17	1,00	-,39	,65
uppera2	upperb1	-,91*	,20	,00	-1,50	-,33
	midb1	-,43	,17	,19	-,96	,09
	lowerb1	-,07	,17	1,00	-,59	,45
	mida2	,07	,17	1,00	-,45	,60
	lowera2	,06	,18	1,00	-,47	,60
mida2	upperb1	-,99*	,19	,00	-1,58	-,41
	midb1	-,51	,17	,05	-1,03	,01
	lowerb1	-,14	,17	,99	-,66	,37
	uppera2	-,07	,17	1,00	-,60	,45
	lowera2	-,01	,18	1,00	-,54	,52
lowera2	upperb1	-,97*	,20	,00	-1,57	-,39
	midb1	-,49	,17	,07	-1,02	,03
	lowerb1	-,13	,17	1,00	-,65	,39
	uppera2	-,06	,18	1,00	-,60	,47
	mida2	,01	,180	1,00	-,52	,54

*. The mean difference is significant at the 0.05 level.

A Gabriel Multiple Comparisons Test for Pluralization errors indicated a significant difference between Upper B1 Class and all other groups (p=.00<.05), except for Mid B1 (p=.20). Furthermore, there was a significant difference between Mid B1 and Mid A2 (p=.05). It's noteworthy that there was a substantial similarity between Lower B1 and all the A2 classes.

The errors in singular/plural noun agreement observed in students' essays are clearly influenced by mother tongue interference. In the Turkish language, a noun following expressions/words like "a lot of," "various," "many," and any number exceeding one does not require the plural marker. This linguistic difference explains why learners made numerous errors in pluralization when using the aforementioned expressions/words, as illustrated.

The current study aligns with Kırkgöz's (2009) findings. Being a native speaker of Turkish, she presents instances of the Turkish rule alongside students' errors: "He is drinking three cup of coffee. We have a big garden and three dog. There is two telephone on the table. There is a few apple in the basket."

3.4. Prepositional Interference

In this study, participants made prepositional errors falling into three categories: adding the wrong preposition, omitting the preposition, and misusing the preposition.

3.4.1. Preposition Addition (Adding the Wrong Preposition)

The participants made the following examples of preposition addition errors:

He promised to me.
I went to home.
We went to in hospital.
It's impossible for to forget it.
I went to near my house.

Table 10.

One-way Anova Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4,998	5	1,00	,95	,44
Within Groups	256,891	246	1,04		
Total	261,889	251			

Based on the results of the One-way Anova test, there were no statistically significant differences among any of the groups regarding the dependent variable of Preposition Addition (Adding the Wrong Preposition) Errors ($F(5,246) = .95$, $p = .44 > .05$).

Table 11.

Descriptive Statistics of Preposition Addition Errors

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
upperb1	29	,59	,73	,13	,31	,86	0	2
midb1	46	,43	,83	,12	,19	,68	0	4
lowerb1	48	,63	1,29	,18	,25	1,00	0	7
uppera2	43	,58	,82	,12	,33	,83	0	3
mida2	44	,89	1,26	,19	,50	1,27	0	5
lowera2	42	,55	,91	,14	,26	,83	0	3
Total	252	,61	1,02	,06	,48	,74	0	7

The Descriptive Statistics results indicate that Preposition Addition Errors were present in each group within the study. Class Mid A2 exhibited the highest frequency of this error (.89), while Mid B1 demonstrated the lowest frequency (.43).

Table 12.

Multiple Comparisons Preposition Addition

(I) class	(J) class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
	midb1	,15	,24	1,00	-,56	,86
	lowerb1	-,03	,24	1,00	-,74	,67
upperb1	uppera2	,00	,24	1,00	-,72	,73
	mida2	-,30	,24	,97	-1,02	,42
	lowera2	,03	,24	1,00	-,69	,76
	upperb1	-,15	,24	1,00	-,86	,56
	lowerb1	-,19	,21	,99	-,81	,43
midb1	uppera2	-,14	,21	1,00	-,79	,49
	mida2	-,45	,21	,42	-1,09	,19
	lowera2	-,11	,21	1,00	-,76	,53
	upperb1	,03	,24	1,00	-,67	,74
	midb1	,19	,21	,99	-,43	,81
lowerb1	uppera2	,04	,21	1,00	-,59	,68
	mida2	-,26	,21	,97	-,89	,37
	lowera2	,07	,21	1,00	-,56	,72
	upperb1	-,00	,24	1,00	-,73	,72
	midb1	,14	,21	1,00	-,49	,79
uppera2	lowerb1	-,04	,21	1,00	-,68	,59
	mida2	-,30	,21	,93	-,95	,34
	lowera2	,03	,22	1,00	-,62	,69
	upperb1	,30	,24	,97	-,42	1,02
	midb1	,45	,21	,42	-,19	1,09
mida2	lowerb1	,26	,21	,97	-,37	,89
	uppera2	,30	,21	,93	-,34	,95
	lowera2	,33	,22	,86	-,31	,99
	upperb1	-,03	,24	1,00	-,76	,69
	midb1	,11	,21	1,00	-,53	,76
lowera2	lowerb1	-,07	,21	1,00	-,72	,56
	uppera2	-,03	,22	1,00	-,69	,62
	mida2	-,33	,22	,86	-,99	,31

A Gabriel Post Hoc Test uncovered a resemblance among individual groups from distinct proficiency levels. The table above indicates that all groups exhibited this error type, with no significant difference in the mean numbers to identify the specific group causing the variation.

3.4.2. Preposition Omission

The participants produced the following instances of preposition omission errors:

He smiled me. (smiled at me)
I looked the results. (looked at the results)
Some people waited the concert. (waited for the concert)
I listened Metallica song. (listen to Metallica song)
He shared it the social media. (shared on the social media)

Table 13.

One-way Anova Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2,93	5	,58	,33	,88
Within Groups	425,96	246	1,73		
Total	428,90	251			

The statistical analysis conducted through One-way Anova revealed no significant difference among groups (F (5,246) = .33, p = .88 > .05) regarding Preposition Omission Errors.

Table 14.

Descriptive Statistics of Preposition Omission Errors

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
upperb1	29	1,10	1,93	,35	,37	1,84	0	10
midb1	46	,98	1,35	,20	,58	1,38	0	5
lowerb1	48	,92	1,44	,20	,50	1,34	0	8
uppera2	43	,91	,99	,15	,60	1,21	0	5
mida2	44	,89	1,08	,16	,56	1,22	0	3
lowera2	42	,71	1,08	,16	,38	1,05	0	4
Total	252	,91	1,30	,08	,75	1,07	0	10

Descriptive statistics indicate that every group in the study exhibited Preposition Omission Errors. Mean differences were distributed in alignment with proficiency levels. Specifically, Class Upper B1 had the highest mean (1.10), while this error occurred least frequently in Lower A2 (.71). Thus, it is evident that mean differences increase with advancing proficiency levels, signifying that higher proficiency levels result in more errors.

Table 15.

Multiple Comparisons of Preposition Omission Errors

(I) class	(J) class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
upperb1	midb1	,12	,31	1,00	-,79	1,04
	lowerb1	,18	,30	1,00	-,72	1,09
	uppera2	,19	,31	1,00	-,73	1,13
	mida2	,21	,31	1,00	-,71	1,14
	lowera2	,38	,31	,97	-,55	1,32
midb1	upperb1	-,12	,31	1,00	-1,04	,79
	lowerb1	,06	,27	1,00	-,74	,86
	uppera2	,07	,27	1,00	-,75	,90
	mida2	,09	,27	1,00	-,73	,91
	lowera2	,26	,28	,99	-,57	1,09
lowerb1	upperb1	-,18	,30	1,00	-1,09	,72
	midb1	-,06	,27	1,00	-,86	,74
	uppera2	,01	,27	1,00	-,81	,83
	mida2	,03	,27	1,00	-,78	,84
	lowera2	,20	,27	1,00	-,62	1,02
uppera2	upperb1	-,19	,31	1,00	-1,13	,73
	midb1	-,07	,27	1,00	-,90	,75
	lowerb1	-,01	,27	1,00	-,83	,81
	mida2	,02	,28	1,00	-,81	,85
	lowera2	,19	,28	1,00	-,65	1,04
mida2	upperb1	-,21	,31	1,00	-1,14	,71
	midb1	-,09	,27	1,00	-,91	,73
	lowerb1	-,03	,27	1,00	-,84	,78
	uppera2	-,02	,28	1,00	-,85	,81
	lowera2	,17	,28	1,00	-,67	1,01
lowera2	upperb1	-,38	,31	,97	-1,32	,55
	midb1	-,26	,28	,99	-1,09	,57
	lowerb1	-,20	,27	1,00	-1,02	,62
	uppera2	-,19	,28	1,00	-1,04	,65
	mida2	-,17	,28	1,00	-1,01	,67

The multiple comparisons test for Preposition Omission indicated that there were no significant differences among groups. As per the table, this error type was observed in all groups, but none of them emerged as significantly distinct within the participant components.

3.4.3. Preposition Misuse

The examples of prepositional misuse consist of the instances below:

I started university at Ankara. (in)

I fell in love to her. (with)

She was dead in 8th April. (on)

Table 16.

One-way Anova Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16,63	5	3,32	2,43	,03
Within Groups	336,63	246	1,36		
Total	353,27	251			

The One-way Anova Test asserted a significant difference among groups (F (5,246) = 2.43, p = .03 < .05) concerning the dependent variable of Preposition Misuse Errors.

Table 17.

Descriptive Statistics of Preposition Misuse Errors

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
upperb1	29	1,10	1,291	,240	,61	1,59	0	4
midb1	46	,78	1,073	,158	,46	1,10	0	3
lowerb1	48	,75	1,896	,274	,20	1,30	0	11
uppera2	43	,70	,860	,131	,43	,96	0	3
mida2	44	,48	,792	,119	,24	,72	0	3
lowera2	42	,21	,520	,080	,05	,38	0	2
Total	252	,65	1,186	,075	,50	,80	0	11

As indicated in the above table, preposition misuse errors were present in every group. The mean differences for Preposition Misuse Errors were systematically distributed based on proficiency levels. Upper B1 exhibited the highest frequency of this error (1.10), and the mean difference gradually decreased to Lower A2 (.21). Once again, it is evident that the number of means increases with advancing proficiency levels.

Table 18.

Multiple Comparisons of Preposition Misuse Errors

(I) class	(J) class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
	midb1	,32	,27	,98	-,49	1,14
	lowerb1	,33	,27	,96	-,45	1,16
upperb1	uppera2	,40	,28	,90	-,42	1,23
	mida2	,62	,28	,31	-,20	1,45
	lowera2	,88*	,28	,02	,06	1,72
	upperb1	-,32	,27	,98	-1,14	,49
	lowerb1	,03	,24	1,00	-,68	,75
midb1	uppera2	,08	,24	1,00	-,65	,82
	mida2	,30	,24	,97	-,42	1,03
	lowera2	,56	,25	,29	-,17	1,31
	upperb1	-,35	,27	,96	-1,16	,45
	midb1	-,03	,24	1,00	-,75	,68
lowerb1	uppera2	,05	,24	1,00	-,67	,78
	mida2	,27	,24	,98	-,45	,99
	lowera2	,53	,24	,37	-,19	1,27
	upperb1	-,40	,28	,90	-1,23	,42
	midb1	-,08	,24	1,00	-,82	,65
uppera2	lowerb1	-,05	,24	1,00	-,78	,67
	mida2	,22	,25	,99	-,52	,96
	lowera2	,48	,25	,58	-,27	1,23
	upperb1	-,62	,28	,31	-1,45	,20
	midb1	-,30	,24	,97	-1,03	,42
mida2	lowerb1	-,27	,24	,98	-,99	,45
	uppera2	-,22	,25	,99	-,96	,52
	lowera2	,26	,25	,99	-,48	1,01
	upperb1	-,88*	,28	,02	-1,72	-,06
	midb1	-,56	,25	,29	-1,31	,17
lowera2	lowerb1	-,53	,24	,37	-1,27	,19
	uppera2	-,48	,25	,58	-1,23	,27
	mida2	-,26	,25	,99	-1,01	,48

*. The mean difference is significant at the 0.05 level.

The multiple comparisons test indicated that only Upper B1 and Lower A2 classes displayed a statistically significant difference (p=.02<.05) regarding Preposition Misuse Errors. The remaining classes exhibited similar means. Notably, there was a high resemblance in the

comparison of Mid B1, Lower B1, and Upper A2 (1.00). In essence, these results demonstrate a rational distribution among groups, highlighting a distinction between the highest and least proficient proficiency levels.

For many second language (L2) students, learning prepositions can be challenging. In Turkish, there is a suffix that is equivalent to the English prepositions at, in, and on. This specific preposition is spelled differently in various contexts to match the sound that precedes the addition. For example, ev (house/home) and evde (in the house or at home); araba (car) and arabada (in the car); mutfak (kitchen) and mutfakta (in the kitchen); tuvalet (bathroom) and tuvalette (in the bathroom) (Erkaya, 2012).

Henceforth, when Turkish speakers are learning English prepositions such as at, in, and on, they often become confused and struggle to determine when to use them. In the current study, participants either omitted prepositions entirely or used incorrect ones.

4. Findings

In response to the query, "What categories of interlingual errors do English as a Foreign Language (EFL) learners typically commit in their written compositions?", it can be stated that students often make errors in word choice, verb tense, pluralization, as well as in preposition addition, omission, and misuse. Among various types of errors in the written materials of 252 students, word choice errors exhibit the highest frequency, totaling 531 instances. Following this, preposition omission errors occur 241 times, while preposition addition errors account for 154 occurrences. Additionally, there are 152 cases of preposition misuse, resulting in a total of 547 prepositional errors. In terms of grammatical errors, there are 126 instances of pluralization errors and 75 occurrences of verb tense errors, making up a total of 201 grammatical errors. Analyzing the overall error distribution, word choice errors constitute 41.51% of the total, emphasizing their significant prevalence and serving as the primary focus of the study. Preposition omission comprises 18.84%, preposition addition represents 12.08%, preposition misuse accounts for 11.88%, pluralization forms 9.85%, and verb tense errors present only 5.86% of the total number of errors.

Regarding the second question concerning the sources of errors, it can be asserted that the primary origin of the errors detected in students' writings is interlingual errors. While there are some intralingual errors, the primary emphasis is on interlingual transfer effects in students'

written works. The predominant majority of errors result from mother tongue interference. Out of the 1279 errors of various types, all were attributed to interlingual transfer, underscoring the need for continued exposure to the second language under the guidance of knowledgeable instructors to mitigate these errors.

As for the third question, "In what manner can these errors be categorized?" a systematic procedure was devised to meet the study's requirements. An Error Code List was compiled based on these studies, and subsequently, each of the 252 written pieces was meticulously analyzed, with errors identified and marked using a predetermined color code. Following this extensive and meticulous preparation phase, errors were categorized into three primary classifications: grammatical, lexical, and prepositional errors. Grammatical errors encompass subdivisions such as pluralization and verb tense. Prepositional errors include preposition addition, preposition omission, and preposition misuse.

Addressing the fourth question regarding the influence of mother tongue interference on English usage among EFL learners at various proficiency levels (Pre-intermediate, Intermediate, and Upper-intermediate), a prevalent notion suggests that heightened exposure to the second language diminishes interlingual transfer errors while amplifying intralingual errors. However, this study challenges this belief, indicating that such a trend is not consistently evident across all error types and proficiency levels.

In seeking to address the fifth research question "What strategies can be employed to mitigate the impact of mother tongue interference?", researchers' experiences and relevant literature may provide valuable insights into practical solutions for this discourse.

Considering that learners face challenges in various aspects of sentence structure, it is vital to reassess language instruction methods and the teacher's focus on enhancing students' awareness to generate accurate and effectively communicated written pieces. Educators commonly recognize that motivation is a potent asset, regardless of the availability of excellent resources and texts. Students can acquire knowledge only when sufficiently motivated to do so. Achieving this involves creating engaging and stimulating activities that tap into and encourage the students' inherent motivation. A needs analysis remains consistently crucial in the instructional process to identify the appropriate remedy and the suitable tactics and approaches to be applied.

Instructors should implement a systematic approach to error methodology. Simply recognizing common student difficulties is inadequate; it is vital to assess these challenges for targeted emphasis in remedial instruction. Without this, issues will persist, hindering learners from producing written pieces free of numerous grammatical errors. Hence, prioritizing error repair and offering substantial feedback is crucial. Redirecting students' attention to distinguish between Turkish and English is essential, and they should face more challenges in the target language. Specifically, increased practice exercises focusing on essential structures can familiarize them, enabling appropriate use in their written outputs.

Noted for his extensive contributions to the study of mother tongue interference, Corder (1982:1) outlines two key justifications for investigating students' errors. The first, a pedagogical justification, emphasizes the necessity of a thorough understanding of error nature before implementing an effective strategy for error elimination. The second, a theoretical justification, posits that analyzing students' errors is integral to a comprehensive study of their language, crucial for understanding the language acquisition process. This information is essential for shaping informed recommendations to enhance language education materials and methodologies.

Acknowledging the structural and communicative differences between the first and second languages is paramount when constructing sentences in a second language, as emphasized by Odlin (1989:177). This recognition significantly contributes to the process of learning and acquiring a second language.

Given the aforementioned arguments, it is recognized that the outcomes of this study can be advantageous for the education and learning process. Consequently, this research aims to offer valuable suggestions derived from the sample data findings to enhance the acquisition of the target language.

5. Discussion

The current research corroborates the findings of Darus and Subramaniam's (2009) study. Kırkgöz (2009) also identified errors in the use of prepositions in students' essays, and the errors were of the same type as those found by the researchers in the present paper: addition of a preposition, omission of a preposition, and misuse of a preposition. Kırkgöz's (2009) example was as follows: "Suzanne is on downstairs." Since in Turkish a suffix is added to the word

"downstairs," which becomes "aşağıda" (with "da" being the suffix equivalent to at, in, and on), the students may have thought in their native language and translated into English, resulting in the omission of the preposition.

Masangya and Lozada's (2009) findings are further substantiated by the current research. The researchers affirmed the difficulty students faced in learning second language (L2) prepositions. They observed that the highest number of errors committed by their participants was in the use of prepositions, which accounted for a significant portion of the entire study. Thus, Masangya and Lozada (2009) attributed students' confusion to the abundance of prepositions in English.

Moreover, the findings of this research accord with those of Rocha Erkaya (2012) in that word choice was overwhelmingly the most common and significant error, leading to frequent misunderstandings. She addressed both local and global errors and their impact on the flow of communication, along with L1 interference arising from cross-semantic differences.

The study findings align with those of Alhaysony (2012) regarding prepositional errors, where errors occurred due to both L1 interference (interlingual) and L2 features (intralingual), with omission errors constituting a significant part of the error data.

Nevertheless, the research findings also reveal differences with some prior studies, such as Mahmoodzadeh (2012), where the subjects in question made errors related to misusing and repetition of prepositions more frequently than errors associated with the omission of prepositions when translating from Persian into English. This study identified preposition errors as a common type of error.

This research's findings also differ from those of Mungungu (2010), where spelling and tense errors were identified as the most common errors in the three languages under investigation. However, in this study, Verb Tense was observed to have a low frequency and occurrence.

Corder (1982:8) contends that achieving complete mastery of a target language is highly likely if learners are sufficiently motivated. In this context, participants are expected to have the necessary motivation as they must attain a specified level of language proficiency to continue their education. These interference errors can be viewed as a significant step in language acquisition that is subject to modification and improvement. Explicitly teaching the language

plays a vital role in enhancing students' awareness of specific areas, as indicated by interference research. However, the prevailing approach in foreign language teaching is Communicative Language Teaching (CLT), which prioritizes interaction and considers conveying meaning as the primary goal in acquiring a foreign language. This emphasis on message conveyance may lead to structure-related errors influenced by the learner's first language (L1).

Corder (1982: 99) asserts that when a student is compelled to communicate, they will draw upon their existing knowledge of etymology to enhance successful communication. If they lack sufficient knowledge of the second language (L2) for effective communication, they may resort to using their first language (L1) or any other known language to compensate, borrowing or adapting linguistic elements. This practice may lead to a lack of emphasis on the grammatical and syntactic aspects of the second language. Considering the detrimental effects of current testing practices, it becomes imperative to enhance students' understanding of second language structures to mitigate interference errors impacting Turkish language grammar. In addition to explicit instruction, developing "meta-phonetic mindfulness," which involves a conscious awareness of L2 structures (Tat, 2013), is also crucial.

As per Jarvis (2009), meta-semantic mindfulness empowers students to discern distinctions between languages, enabling them to identify the features of a second language (L2) through their understanding of their first language (L1). This practice aids in fostering the capacity to deduce meanings of unfamiliar words, thereby refining language skills and minimizing the chances of errors related to transfer.

Apart from its impact on grammar and syntax, explicit instruction is also deemed advantageous for vocabulary learning. In line with Stenson (1983), when students grasp the similarities and distinctions between two languages concerning phonology, cognates, false friends, and other facets, their awareness can be heightened. Consequently, the potential for negative transfer occurring can be reduced.

Moreover, it is essential to furnish students with authentic materials that immerse them in the genuine language, promoting the implicit acquisition of L2 vocabulary and other linguistic structures. Identifying students with effective strategies, like thinking in the target language rather than relying on translation, is crucial (Brown, 1994:27). This approach is expected to eliminate errors induced by transfer.

Bhela (1999:29) asserts that employing a tailored learning program for each learner proves advantageous in facilitating the learning and instructional process. This approach permits focused attention on specific areas and facilitates the customization of teaching methods and materials to cater to individual student needs. According to Odlin (1989:162), course books tailored for a particular group of learners should be structured to include explicit explanations that compare the two languages.

Yet, crafting such books may pose difficulties when classes include students with varied L1 backgrounds. In such cases, Odlin (1989) recommends employing bilingual dictionaries alongside the assistance of a teacher well-versed in cross-linguistic awareness and the associated challenges.

In conclusion, having a deep understanding of interference and employing effective strategies to counter its impact empowers educators to anticipate and prevent undesirable transfer more effectively. Therefore, instructors must undergo proper training to efficiently assist students in acquiring the target language, as previously highlighted.

6. Conclusion

The study aimed to identify common errors in written compositions by learners, focusing on word choice, verb tense, pluralization, and preposition errors. It found that word choice errors were widespread across all proficiency levels, with higher proficiency classes exhibiting higher frequencies. This suggests a potential inverse relationship between word choice errors and proficiency levels. The study speculated that time constraints and the pressure to meet word count targets may contribute to these errors, as learners prioritize quantity over accuracy.

Verb tense errors were present in all groups, with higher proficiency classes showing more instances. This could be attributed to the complexity of tense usage in longer essays, where higher proficiency learners need to navigate a broader spectrum of verb tense forms. Pluralization errors also increased with proficiency level, indicating a pattern of learners making more errors as their English proficiency improves, possibly due to interlingual transfer from their native language.

Preposition errors were observed in all groups, with higher proficiency classes exhibiting more instances. This could be influenced by the learners' reliance on their native language's

preposition usage. The study emphasized the importance of formal instruction in reducing transfer errors and highlighted the challenges faced by Turkish learners due to differences between Turkish and English grammar and syntax.

The study involved a specific number of participants and was conducted within a limited scope. While the findings offer valuable insights into error patterns among Turkish-speaking students, the generalizability of the results may be limited due to the relatively small sample size and narrow focus.

As for the limitations of the study, the examination duration for each class varied, potentially influencing the students' ability to review and correct errors. For instance, the shorter duration allotted to B1 classes may have hindered students' capacity to contemplate accurate English equivalents, leading to a higher frequency of errors.

The requirement for essays to fall within specific word count ranges could have impacted students' priorities during composition. Students may have focused on meeting the word range rather than prioritizing error correction and structural perfection, potentially skewing the error frequencies observed.

The study acknowledges the influence of learners' native language, particularly in instances of negative transfer. However, the depth of exploration into the specific mechanisms of interlingual transfer and its impact on error occurrence may be limited.

While the study identified common error types such as word choice, verb tense, pluralization, and preposition errors, it may not have comprehensively examined all potential error categories present in learners' compositions.

The study was conducted as a one-time analysis, providing a snapshot of error frequencies among learners at specific proficiency levels. Longitudinal data tracking the progression of error patterns over time could offer deeper insights into learners' language development and error correction strategies.

The study suggests avenues for future research, including the exploration of specific error categories and the effectiveness of formal instruction in reducing transfer errors. However, additional research is warranted to address these areas comprehensively.

To conclude, while the study provides valuable insights into error patterns among Turkish-speaking learners, it is essential to acknowledge these limitations when interpreting the findings and to consider them as avenues for future research endeavors.

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ITALL

Research Article

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The Relationship Between Reading and Mathematics Achievement: Findings from Meta-Analysis

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Abstract

This meta-analysis study aims to analyse the findings of quantitative studies examining the relationship between reading skills and mathematics achievement. Articles discussing the relationship between reading skills and mathematics achievement in the education field constitute this study's data source. Data from 13 studies and 397882 students were combined. The Difference in Standardized Means was used to calculate the effect size in the meta-analysis. Quantitative data such as correlation, t-value, p-value, mean, standard deviation and sample size were obtained from each study. Inter-coder reliability was ensured by receiving a 92% agreement rate with two independent coders. Meta-analysis was performed with Comprehensive Meta-Analysis software, and both fixed and random effects models were examined. Heterogeneity in effect sizes was determined by Q and I2 analyses. Publication bias was tested with four different methods. The results underline a strong link between reading and math achievement. However, the data analysis reveals heterogeneity, suggesting a potential complexity in this relationship and that the influence of various factors may vary. The study found no statistically significant differences between subgroups. Moderators such as education level, geographical location and type of research did not significantly affect the relationship between reading and math achievement. This suggests that the relationship between reading and math achievement is generally consistent across different groups. This meta-analysis of the relationship between reading and math achievement has critical educational practice and policy implications.

Keywords: Reading, Mathematics, Achievement, Meta-analysis

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Okumak ve Matematik Başarısı Arasındaki İlişki: Meta Analizden Bulgular

Özet

Bu meta-analiz çalışması, okuma becerileri ile matematik başarısı arasındaki ilişkiyi inceleyen nicel araştırmaların bulgularını analiz etmeyi amaçlamaktadır. Eğitim alanında okuma becerileri ile matematik başarısı arasındaki ilişkiyi inceleyen makaleler bu çalışmanın veri kaynağını oluşturmaktadır. Toplam 13 çalışma ve 397882 öğrenciden elde edilen veriler birleştirilmiştir. Meta analizde etki büyüklüğünü hesaplamak için Standartlaştırılmış Ortalamalardaki Fark kullanılmıştır. Her çalışmadan korelasyon, t-değeri, p-değeri, ortalama, standart sapma ve örneklem büyüklüğü gibi nicel veriler elde edilmiştir. İki bağımsız kodlayıcı ile %92 uyum oranı elde edilerek kodlayıcılar arası güvenilirlik sağlanmıştır. Meta-analiz Comprehensive Meta-Analysis yazılımı ile gerçekleştirilmiş ve hem sabit hem de rastgele etkiler modelleri incelenmiştir. Etki büyüklüklerindeki heterojenlik Q ve I2 analizleri ile belirlenmiştir. Yayın yanlılığı dört farklı yöntemle test edilmiştir. Sonuçlar, okuma ve matematik başarısı arasında güçlü bir bağlantı olduğunun altını çizmektedir. Bununla birlikte, veri analizi heterojenliği ortaya koyarak bu ilişkide potansiyel bir karmaşıklığa ve çeşitli faktörlerin etkisinin değişebileceğine işaret etmektedir. Analiz, alt gruplar arasında istatistiksel olarak anlamlı farklılıklar bulmamıştır. Eğitim seviyesi, coğrafi konum ve araştırma türü gibi moderatörler okuma ve matematik başarısı arasındaki ilişkiyi önemli ölçüde etkilememiştir. Bu da okuma ve matematik başarısı arasındaki ilişkinin farklı gruplar arasında genel olarak tutarlı olduğunu göstermektedir. Okuma ve matematik başarısı arasındaki ilişkinin bu meta-analizi, önemli eğitim uygulamaları ve politika çıkarımlarına sahiptir.

Anahtar Kelimeler: Okuma, Matematik, Başarı, Meta-analiz

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1. Introduction

Reading and mathematics skills are determining factors in individuals' academic achievement. Understanding and analysing the relationship between these two domains is a complex problem educators and researchers face. However, in recent years, the impact of reading skills on students' mathematics performance has become an essential topic of discussion among educational researchers and policymakers. This topic is of particular importance as it has significant implications for curriculum design, instructional strategies, and student assessment in both reading and mathematics (Ertürk Kara, 2019; Karakuş Aktan et al., 2021; Pala & Sağlam, 2019).

Educational achievement is a multifaceted concept encompassing various aspects of a student's academic performance. It is often measured by basic skills such as reading and mathematics. Reading, for instance, is not confined to language and literature courses but permeates other disciplines, including mathematics (Snow & Sweet, 2003). Mathematics achievement, on the other hand, reflects students' ability to think analytically, solve problems, and make logical inferences (National Mathematics Advisory Panel, 2008). The intricate relationship between these two essential skills has long been a fascinating and challenging area of educational research.

Reading skill involves students' understanding, interpreting and evaluating written materials. This skill directly affects students' access to information, learning processes and academic achievement (Guthrie & Wigfield, 2000). Students with high reading skills are more successful in various disciplines (Cunningham & Stanovich, 1997). Reading also plays a vital role in understanding and solving mathematical problems. In particular, word problems require students to use their reading skills to understand and apply mathematical concepts (Vilenius-Tuohimaa et. al., 2008). Mathematics is a fundamental discipline that develops students' analytical and logical thinking skills. Mathematical achievement predicts students' future academic and professional success (Geary, 2011). Students who excel in mathematics often have better problem-solving skills and scientific thinking abilities (Rittle-Johnson & Schneider, 2015). However, mathematical success is broader than numerical abilities; linguistic skills also play an essential role. Students must have strong reading skills to correctly understand and solve mathematical problems (LeFevre et al., 2010).

The relationship between reading skills and mathematics achievement has been extensively studied in educational research, and the findings have significant practical implications. The strong relationship between these two skills provides essential insights into how reading skills can positively influence mathematics performance. Research consistently shows that students with higher reading skills excel in mathematics (Purpura et. al., 2011). Particularly in word problems, reading comprehension skills are crucial for correctly understanding and solving the problem (Fuchs et al., 2006).

Although studies examining the relationship between reading and mathematics are usually conducted as correlational studies, such studies have some limitations. Although correlational studies help determine the relationship between two variables, they may need to provide more information about the generalizability and consistency of these relationships (Salkind, 2010). The findings of a single study may need to be consistent with other studies due to sample size, methodological differences, or contextual factors (Cooper, 2010). This can make assessing the relationship between reading and mathematics difficult.

The purpose of this meta-analysis was not just to review the existing literature examining the relationship between reading and mathematics achievement but also to provide a robust assessment of the strength and consistency of this link. The meta-analysis method, which combines data from different studies, ensures the validity and generalizability of our conclusions (Borenstein et. al., 2009). This study aims to contribute significantly to developing reading and mathematics education strategies for educators and policymakers.

1.1. Reading Skills and Mathematics Achievement

Reading skills can directly affect students' ability to understand and solve math problems. Research shows that students with higher reading skills understand and solve math problems better (Smith & Johnson, 2019).

Studies examining the impact of reading skills on mathematics performance can generally be categorised under two main headings: reading comprehension and vocabulary knowledge. Reading comprehension helps students correctly interpret math problems and develop solution strategies (Fuchs et al., 2019). For example, a study by O'Reilly and McNamara (2007) showed that improved reading comprehension skills increase students' capacity to solve math problems.

Vocabulary knowledge also has a significant impact on math performance. Familiarity with math terms helps students understand problems more quickly and accurately (Hiebert & LeFevre, 2017). Moreover, improving reading skills enables students to better understand mathematical terms and concepts, positively affecting their problem-solving skills (Kintsch & Greeno, 1985).

In conclusion, the findings in the literature demonstrate the direct and indirect effects of reading skills on mathematics performance. This underscores the importance of improving reading skills for language learning and overall academic achievement (Booth & Thomas, 2020; Smith, 2021). These insights provide a clear roadmap for educators and policymakers, empowering them to implement effective strategies that can significantly enhance students' competencies in both reading and mathematics.

Reading skills can directly affect students' ability to understand and solve math problems. Research shows that students with higher reading skills understand and solve math problems better (Smith & Johnson, 2019). Studies examining the impact of reading skills on mathematics performance can generally be categorised under two main headings: reading comprehension and vocabulary knowledge. Reading comprehension helps students correctly interpret math problems and develop solution strategies (Fuchs et al., 2019). For example, a study by O'Reilly and McNamara (2007) showed that improved reading comprehension skills increase students' capacity to solve math problems. Students with high reading comprehension skills can analyse problems better and develop more effective strategies in the solution process.

Vocabulary knowledge also has a significant impact on math performance. Familiarity with math terms helps students understand problems more quickly and accurately (Hiebert & LeFevre, 2017). Moreover, developing reading skills enables students to better understand mathematical terms and concepts, positively affecting their problem-solving skills (Kintsch & Greeno, 1985). In particular, understanding the terms and symbols used in mathematical language plays a critical role in problem-solving. In this context, reading skills are fundamental for students to understand and apply mathematical concepts.

Reading skills also contribute to the development of critical thinking and analytical skills. Critical thinking supports the logical reasoning processes for solving mathematical problems (Booth & Thomas, 2020). As students learn to evaluate texts critically, they can develop a deeper

understanding of mathematical concepts. This suggests that reading skills contribute to text analysis and the strengthening of mathematical thought processes. Moreover, reading skills also enhance interaction with other disciplines. For example, understanding scientific and technical texts can help connect mathematical concepts to real-world applications (Smith, 2021). This improves students' ability to use mathematical thinking in various contexts.

Strong reading skills reduce students' cognitive load when solving math problems. When they understand the text part of the problem with less effort, students can focus more of their mental resources on the problem-solving process (Sweller et. al., 2011). This suggests that improving reading skills is essential in enhancing students' overall academic performance. Thus, this interrelationship between reading skills and mathematics achievement requires educators to adopt holistic approaches to increase students' competencies in both domains.

Regarding educational strategies, educators play a crucial role in creating integrated educational programs that develop reading and mathematics skills together. Such programs not only strengthen students in both areas but also highlight the integral role of educators in their learning journey (Booth & Thomas, 2020). Educators should teach specific reading strategies to students, empowering them to tackle math problems effectively. These strategies include underlining important information, taking notes, and summarising texts (Fuchs et al., 2019). Educators should encourage students to learn and actively use mathematical terms in mathematics lessons. Activities and games can significantly improve vocabulary knowledge (Hiebert & LeFevre, 2017).

This study is of significant importance as it aims to analyse the findings obtained from quantitative studies in the literature on the relationship between reading skills and mathematics achievement. The following questions were sought to be answered, highlighting the relevance and significance of this research.

1. Does reading skill affect mathematics achievement?
2. Does the effect of reading skills on mathematics achievement differ according to moderator variables?

2. Method

The method of this research is meta-analysis. Meta-analysis can be defined as statistical synthesis and interpretation based on the quantitative findings of different studies on the same subject (Cumming, 2012; Ellis, 2012; Petticrew & Roberts, 2006). In this meta-analyzed study, the data obtained from the students were accessed. Publication bias analyses were conducted within the scope of reliability studies. Predetermined analysis procedures statistically processed these data, and the results were synthesised.

2.1. Selecting and coding the data (studies)

In the meta-analysis, articles on the relationship between reading skills and mathematics achievement in the field of education are the data source of this study. These were excluded from the scope. Because they did not undergo a severe peer review. The keywords "reading", "mathematics", and "achievement" were used in the search. EBSCO and Google academic search engines were used, and many databases were accessed. As a result of the search, 1690 studies that met the inclusion criteria from 2013 to 2024 (April) were reached. Of these studies, 13 were included in the meta-analysis because they met the inclusion criteria. Data from 13 studies and 397882 students were combined. The inclusion procedure is shown in the PRISMA flowchart below (Figure 1).

Studies to be included in the meta-analysis;

- Studies published between 2013-2024 (April),

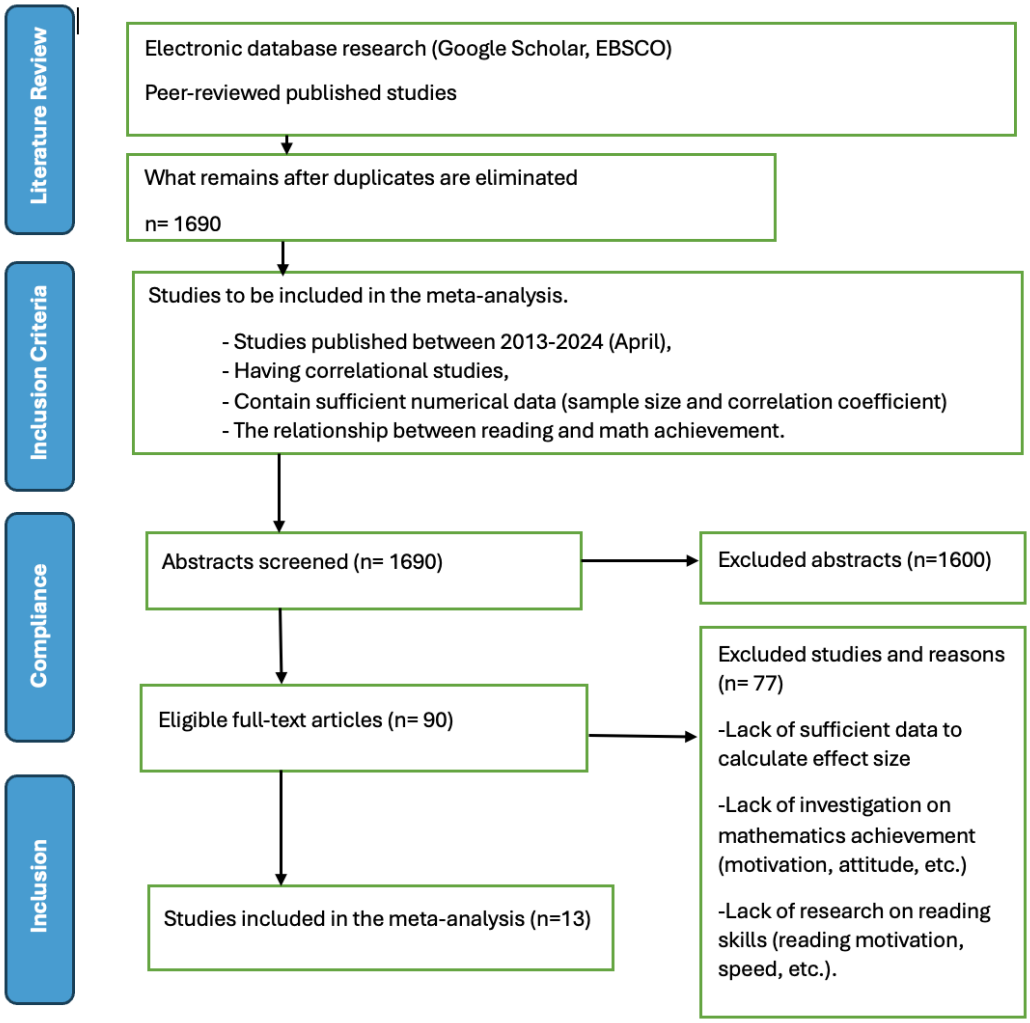
- Having correlational studies,

- Contain sufficient numerical data (sample size and correlation coefficient)

- It should be about the relationship between reading and math achievement.

Figure 1

PRISMA Flowchart



2.2. Coding the Studies, Reliability of the Coding Process

This study used the Difference in Standardized Means to calculate the effect size in meta-analysis. Quantitative data such as r, t, p values, mean and standard deviation values and sample size were obtained from each study to calculate the Difference in Standardized Means and reach possible moderators. Inter-coder reliability was ensured with two independent coders. According to the Cohen Kappa reliability analysis, an excellent agreement was observed with a rate of 0.92.

2.3. Meta-Analysis Procedure and Publication Bias

This study calculated effect size with Comprehensive Meta-Analysis (Version 2.0) software. Calculations were made in fixed and random effects models. However, random effects model is recommended for meta-analysis studies in social sciences (Cumming, 2012). Heterogeneity of effect sizes was determined by Q and I2 analysis. Publication bias was tested using four methods: Classic fail-safe N Egger Regression Test, Berg and Mazumdar Rank Correlation.

3. Result

3.1. Publication Bias Findings

Table 1

Results of Reliability Tests Representing the Probability of Publication Bias

Classic fail-safe N	Egger's test	Berg & Mazumdar Rank Correlation test
p = 0.000	p = 0.37	p = 0.123
We need to find 7749 non-significant studies for the p-value to exceed 0.05.	Since p> 0.05, it can be said that there is no publication bias.	Since p> 0.05, it can be said that there is no publication bias.

In meta-analyses, the possibility of publication bias cannot be ignored. The aim is to reach a general conclusion by combining the results of many different studies. Conducting publication bias analyses is a critical step in meta-analyses. This process can provide a different perspective from the reality in the literature, potentially preventing the dissemination of incorrect conclusions. Ensure the results are objective and reliable (Rothstein et al., 2005). According to Table 1, the Orwin Protected N Number, a statistical measure used to estimate the number of studies needed to change a meta-analysis finding, is 7749. This number is approximately 546 times more than 13 studies. However, 13 studies are all the studies that could be reached according to the inclusion criteria among the studies conducted in Turkey for this research question. The fact that it was impossible to get 7749 studies other than these shows no publication bias in this meta-analysis. The fact that the results of Egger's test (p = 0.37) and Rank Correlation test (Begg's test, p = 0.123), which are other publication bias tests, were not significant, were accepted as other indicators that there was no publication bias in this meta-analysis study.

Table 2

Standardized effect sizes included

Model	Study name	Outcome	Statistics for each study							Fisher's Z and 95% CI
			Fisher's Z	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	-1,00 -0,50 0,00 0,50 1,00
	Habók et.	Ortaokul	0,215	0,022	0,000	0,172	0,259	9,737	0,000	
	Hassinger-D	Okuloncesi	0,369	0,098	0,010	0,177	0,561	3,762	0,000	
	Shin et. al.,	İlkokul	0,618	0,020	0,000	0,579	0,657	31,006	0,000	
	Ten Braak	Okuloncesi	0,811	0,071	0,005	0,672	0,949	11,466	0,000	
	Adelson et.	Lise	1,510	0,005	0,000	1,501	1,520	308,524	0,000	
	Barnard-Bra	İlkokul	0,497	0,007	0,000	0,484	0,511	72,761	0,000	
	Schöber et,.	Ortaokul	0,950	0,025	0,001	0,901	1,000	37,948	0,000	
	Masci, et.	Ortaokul	0,891	0,002	0,000	0,887	0,895	419,452	0,000	
	Watts et.	İlkokul	0,693	0,027	0,001	0,640	0,746	25,553	0,000	
	Chu et. al.,	Okuloncesi	0,758	0,102	0,010	0,559	0,957	7,467	0,000	
	Zhu, 2022	Ortaokul	1,528	0,009	0,000	1,510	1,545	167,715	0,000	
	You et. al.,	Ortaokul	0,590	0,013	0,000	0,565	0,615	46,558	0,000	
	Korpershoe	Lise	0,332	0,024	0,001	0,285	0,379	13,870	0,000	
Fixed			0,955	0,002	0,000	0,951	0,958	533,858	0,000	
Random			0,753	0,115	0,013	0,527	0,979	6,529	0,000	

When Table 2 is examined, it is seen that the standardised effect sizes in 13 studies are between 0.215 and 1.528. There is no statistically significant difference in all studies. The studies have confidence intervals ranging between 0.007 and 0.102.

Table 3

Average effect size

Model	**Average Effect Size (EB)**							**Heterogeneity**		
	k	ES	S.H.	Lower limit	Upper limit	Z	P	Q	sd	p
Fixed	13	0.955	0.002	0.951	0.958	533.858	0.000	252.255	2	0.000
Random	13	0.753	0.115	0.527	0.979	6.529	0.000			

Average Effect Size Value d=0.20 for small effect; d=0.40 for medium effect; d=0.60 for significant impact (Hattie, 2008).*

According to the data in the studies included in the meta-analysis, the effect size (in terms of Pearson r) was calculated as .955 according to the fixed effect model and .753 according to the random effects model. When the data were subjected to a heterogeneity test, the Q(sd=12) statistic value was calculated as 252.255 ($p<0.01$). The fact that the Q value obtained exceeds the value read from the chi-square table at I2 degrees of freedom and .05 confidence level (sd I2, X2 (.05) = 21.026) indicates that the data are heterogeneous. Another method used to determine heterogeneity is calculating the I2 percentile value. The I2 value calculated from the data is 99.95%. This value indicates a high level of heterogeneity. The estimated average effect size value indicates a significant effect according to Hattie's (2008) classification.

Table 4

Analog ANOVA (Level of Education)

		Average Effect Size (ES)							Heterogeneity		
	Category	k	ES	S.H.	Lower limit	Upper limit	Z	P	Q	sd	p
Level of Education	Kindergarten	2	0.601	0.061	0.481	0.721	9.820	0.000	1.860	3	0.602
	Primary School	3	0.921	0.589	-0.234	2.076	1.563	0.118			
	Middle School	3	0.650	0.137	0.382	0.919	4.744	0.000			
	High School	5	0.835	0.175	0.492	1.179	4.766	0.000			

According to the mixed effects model, the chi-square value was 3 with 7.815 degrees of freedom, and the p-value was 0.602. In this case, there is no statistically significant difference between the subgroups. It is necessary to use the mixed-effects model and report accordingly since the analyses in which we investigated the source of variance between groups were conducted. The education level variable was analysed, and the findings of the analogue ANOVA analyses are presented in Table 4. The average effect size and confidence interval values in Table 4 are reported by converting them into Pearson correlation units.

Table 5

Analog ANOVA (Continent)

		Average Effect Size (ES)							Heterogeneity		
	Category	k	ES	S.H.	Lower limit	Upper limit	Z	P	Q	sd	p
Continent	America	6	0.742	0.276	0.201	1.283	2.689	0.007	0.749	2	0.688
	Asia	2	1.059	0.469	0.140	1.977	2.259	0.024			
	Europe	5	0.639	0.164	0.318	0.960	3.898	0.000			

According to the mixed effects model, the chi-square value was 2 with 5.991 degrees of freedom, and the p-value was 0.688. In this case, there is no statistically significant difference between the subgroups. It is necessary to use the mixed-effects model and report accordingly since we are conducting analyses to investigate the source of variance between groups. The continent variable was analysed, and the findings of the analogue ANOVA analyses are presented in Table 5. The average effect size and confidence interval values in Table 5 are reported by converting them into Pearson correlation units.

Table 6

Analog ANOVA (Type of Research)

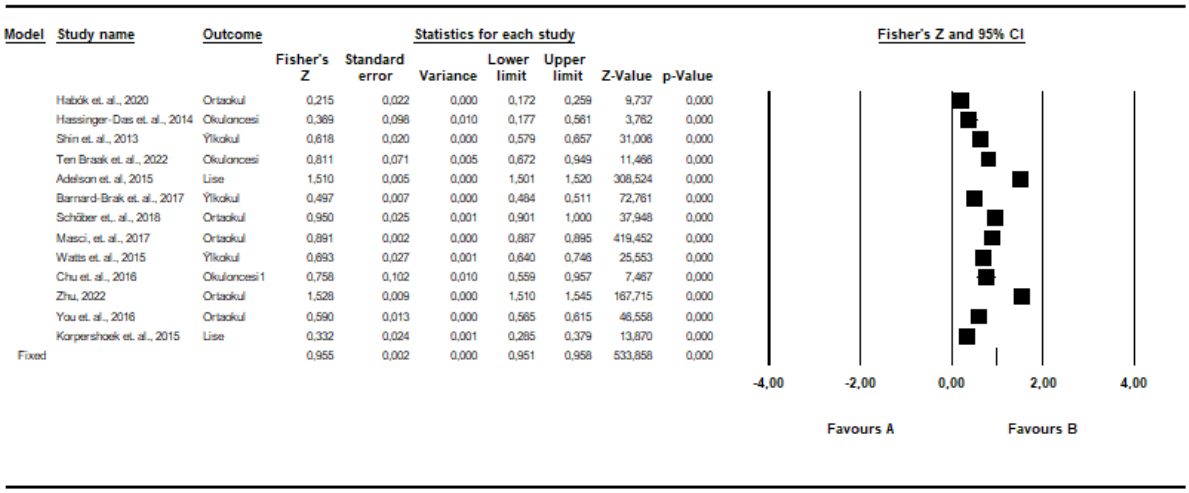
		Average Effect Size (ES)							Heterogeneity		
	Category	k	ES	S.H.	Lower limit	Upper limit	Z	P	Q	sd	p
Type of Research	Longitudinal	6	0.682	0.111	0.464	0.900	6.135	0.000	0.345	1	0.557
	Cross-sectional	7	0.812	0.191	0.438	1.186	4.252	0.000			

According to the mixed effects model, the chi-square value was 1 with 3.841 degrees of freedom, and the p-value was 0.557. In this case, there is no statistically significant difference between the subgroups. It is necessary to use the mixed-effects model and report accordingly since the analysis in which we investigated the source of variance between groups was conducted. The research type variable was analysed, and the findings of the analogue ANOVA analyses are presented in Table 6. The average effect size and confidence interval values in Table 6 are reported by converting them into Pearson correlation units.

The forest plot showing the distribution of the effect size values of the studies within the scope of the research according to the random effects model is given in Graph 1.

Graph 1

Forest Graph



Graph 1 shows that the result is statistically significant according to the random effects model (d = 0.955 [-0.215; 1.528] p = 0.000) and a substantial effect according to Cohen.

4. Discussion and Conclusion

This meta-analysis delves into the relationship between reading and math achievement. The findings underscore a robust connection between the two. However, the data analysis reveals heterogeneity, suggesting a potential complexity in this relationship, with the influence of various factors possibly varying.

On the other hand, no statistically significant differences were found in the analysis between subgroups. Moderators such as educational level, geographical location, and research type did not significantly affect the relationship between reading and mathematics achievement. This suggests that the relationship between reading and math achievement is generally consistent across different groups.

The study broadly evaluates the relationship between reading and mathematics achievement and reveals a strong and consistent link between these two skill areas. The findings align with the results of similar studies in the literature. For example, Vukovic and Siegel (2010) reported that students with reading difficulties also had math difficulties. Similarly, in their meta-analysis, Nelson and Harwood (2011) showed that students with learning disabilities significantly lagged behind their peers in reading and math achievement. These findings indicate that reading and math skills are closely interrelated.

In addition, a review study by Raghubar, Barnes, and Hecht (2010) focuses on the cognitive mechanisms that explain the relationship between reading and mathematics. According to this study, verbal-linguistic skills (e.g., vocabulary and language comprehension) are essential in developing mathematical problem-solving and computational skills. Therefore, the cognitive processes linking reading and mathematics achievement should be examined more deeply. These processes may include transferring language skills to mathematical problem-solving, using reading comprehension strategies in mathematical texts, and integrating verbal and non-verbal information in mathematical tasks. On the other hand, the heterogeneity observed in this meta-analysis suggests that the relationship between reading and mathematics achievement may be complex and multifaceted. Various demographic, socio-cultural and instructional factors may affect this relationship. For example, students' differences, such as age, gender, socioeconomic status, the school district, teachers' qualifications, and instructional methods, may shape the link between reading and mathematics achievement.

This meta-analysis confirms a strong and consistent relationship between reading and mathematics achievement. However, further exploration of the cognitive mechanisms and contextual factors underpinning this relationship is required. Educators and researchers must adopt holistic approaches to foster students' development of both reading and mathematics skills. The heterogeneity between studies and subgroups also signals the need for more research to comprehend the relationship between reading and math achievement fully.

These findings on how reading and mathematics skills influence each other should be seen as important information that can guide the development of teaching approaches and curricula and better unlock students' academic potential.

4.1. Implications of Research

The results of this meta-analysis have important implications for educational practice and policy. First, emphasising the solid and consistent relationship between reading and mathematics achievement shows that educators must holistically support these two skill areas. Reading and mathematics skills should be considered to influence each other mutually, and curricula and interventions should be designed to cover both areas.

Second, a deeper examination of the cognitive mechanisms underlying the relationship between reading and mathematics achievement may contribute to developing instructional methods. For example, understanding the impact of verbal-linguistic skills on mathematical problem-solving may allow for the design of more effective interventions to identify and address students' difficulties in both reading and mathematics.

Furthermore, examining the role of various individual and contextual factors in this relationship may allow the development of interventions specific to student profiles and learning environments. Thus, more sensitive approaches can be adapted to the needs of students with different demographic, socioeconomic and cultural characteristics.

4.2. Limitations and Suggestion

Some limitations of this study and suggestions for future research are presented below:

- The meta-analysis method of the study could not fully explain the heterogeneity arising from the methodological differences of the individual studies. In the future, more comprehensive

studies using qualitative research methods may contribute to a deeper understanding of the relationship between reading and mathematics achievement.

- In the current study, moderator analyses were limited, and the role of student-, teacher-, and school-level factors needed to be adequately examined. Considering these contextual variables in future research is essential, as they can significantly influence reading and mathematics achievement.

- The study's cross-sectional design did not allow for examining the developmental relationship between reading and math skills. The urgency and importance of conducting longitudinal studies to reveal the dynamic changes in the interaction between these two skill areas over time cannot be emphasised enough.

- The study needed to adequately discuss the cognitive processes underlying the relationship between reading and math achievement. Future research should address the impact of language skills on math performance in more detail, specifically focusing on the role of vocabulary acquisition and comprehension in mathematical problem-solving.

5. References

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Research Article

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Psychometric Properties of the Turkish Version of the Algorithmic Media Content Awareness (AMCA) Scale

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Abstract

Given the rapid technological advancements, there is an increasing need for users to acquire new skills, particularly in the realm of algorithmic awareness. This study aims to adapt and validate the Algorithmic Media Content Awareness Scale (AMCA), developed by Zarouali et al. (2021), to the Turkish context and to test its validity and reliability. The original scale is a 5-point Likert type measure consisting of 13 items with four factors in English. Participants included 414 undergraduate students from various faculties of a state university in Türkiye, selected through convenience sampling during the spring term of 2022-2023. The study employed confirmatory factor analysis (CFA) to assess the scale's construct validity and utilized Cronbach's alpha to examine reliability. The CFA results revealed a good model fit for the proposed four-factor structure ($\chi 2/df$ = 2.902, CFI = .95, GFI = .939, TLI =.93, RMR = .035, SRMR = .047, RMSEA = .068). Reliability coefficients ranged from .74 to. 81 across the factors, with an overall alpha of .90, indicating high reliability. The item-total correlation analysis revealed that all items significantly contributed to the measure. Additionally, both convergent and discriminant validity were found to be satisfactory. Consequently, all evidence suggests that the Turkish version of the AMCA scale is a valid and reliable tool for assessing algorithmic literacy among undergraduate students, contributing significantly to the field of media literacy research.

Keywords: Algorithms, algorithmic awareness, Scale adaptation, Scale validation

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Algoritmik Medya İçerik Farkındalık (AMİF) Ölçeğinin Türkçe Versiyonunun Psikometrik Özellikleri

Özet

Hızlı teknolojik gelişmelerle birlikte, kullanıcıların özellikle algoritmik farkındalık alanında yeni beceriler kazanmalarına duyulan ihtiyaç giderek artmaktadır. Bu çalışma, Zarouali ve arkadaşlarının (2021) geliştirdiği Algoritmik Medya İçerik Farkındalık Ölçeği'nin (AMİF) Türkçeye uyarlanmasını ve geçerlik ile güvenirliğinin test edilmesini hedeflemektedir. Orijinal ölçek, İngilizce olarak 13 madde ve dört faktör içeren 5'li Likert tipi bir ölçektir. Araştırmaya, 2022-2023 bahar döneminde, kolay örnekleme yöntemiyle seçilen bir devlet üniversitesinin çeşitli fakültelerinden 414 lisans öğrencisi katılmıştır. Ölçeğin yapısal geçerliliğini belirlemek için doğrulayıcı faktör analizi (DFA) kullanılmış, güvenilirliğini test etmek için ise Cronbach alfa değerleri kontrol edilmiştir. DFA sonuçları, dört faktörlü yapının iyi bir model uyumu sergilediğini göstermiştir ($\chi 2/df$ = 2.902, CFI = .95, GFI = .939, TLI = .93, RMR = .035, SRMR = .047, RMSEA = .068). Güvenilirlik katsayıları, faktörlerde .74 ile .81 arasında değişirken, genel alpha .90 olarak yüksek bir güvenilirlik göstermiştir. Madde-toplam korelasyon analizi, tüm maddelerin ölçeğe önemli bir katkıda bulunduğunu göstermiştir. Ayrıca hem yakınsak hem de ayırıcı geçerlilik yeterli düzeydedir. Sonuç olarak, Türkçe AMİF ölçeği, lisans öğrencilerinin algoritmik okuryazarlığını ölçmede geçerli ve güvenilir bir araçtır ve medya okuryazarlığı araştırmalarına da katkı sunma potansiyeli vardır.

Anahtar Kelimeler: Algoritmalar, Algoritmik farkındalık, Ölçek uyarlama, Ölçek doğrulama

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1. Introduction

Rapid developments in technology have provided numerous advantages, accompanied by new challenges that demand the acquisition of novel skills by users. In this era, individuals must be aware of various literacies, such as new media literacy, digital literacy, technology literacy, digital competencies, and many more. The prevalence of social network sites and recent developments have elevated the role of algorithms in our lives, influencing how we interact, consume information, and make decisions (Wilson, 2019). Algorithms are everywhere, influencing every facet of life domains, and their impact is contingent on decisions made in their social use. When anticipating our actions or preferences, algorithmic inferences can be remarkably accurate to the extent that they occasionally appear to possess a deeper understanding of us than we have of ourselves, or even before we realize certain aspects (Krassman, 2020). In this current digital age, we are constantly exposed to algorithmically selected content, including social media feeds, recommendations, and personalized search results. Algorithms make decisions influenced by user behavior and impact knowledge building as they confine individuals with algorithmic filtering. Given their pivotal role in personalization and content curation (Gillespie, 2014), individuals must improve their understanding of how algorithms operate, including interpreting algorithmic outputs or adapting to technological changes (Shin et al., 2022).

Recent educational research emphasizes how software not only gathers information about human behavior but also predicts our actions (Perrotta & Selwyn, 2020), necessitating an awareness of algorithms. The term "algorithmic awareness" is described as “knowing that a dynamic system is in place that can personalize and customize the information that a user sees or hears” (Hargittai et al., 2020, p. 771). The literature highlights several concerns related to algorithms, which may be the main reason that requires users to be algorithmically aware. The first issue is that algorithms have the power to limit our access to knowledge, necessitating individuals to develop proactive skills to effectively navigate algorithms. This limitation is related to the content filtering mechanism, which directly affects user inputs to offer personalized recommendations or newsfeed. Being aware of filtering has been a critical element that shapes users’ actions on online platforms (Bucher, 2017). The second concern is associated with privacy issues, as algorithms utilize enormous amounts of personal data to collect information and present relevant content to users (Araujo et al., 2020; Thurman et al., 2018).

Some individuals perceive this in a negative way and develop a more negative attitude toward technology. Furthermore, another concern exists related to the digital divide, which encompasses varying levels of algorithmic awareness (Gran et al., 2021; Just & Latzer, 2017). With these concerns, it can be inferred that algorithms restrict our exposure to diverse information, potentially resulting in biased algorithmic decision-making. Thus, our decision mechanism is unintentionally affected and limited by channels that are beyond our control.

The concerns outlined above have necessitated the need for research studies to enhance individuals' understanding of algorithms, a crucial element of internet infrastructure, and their profound impact on users' online search experiences (Beer, 2017; García-Orosa et al., 2023; Kitchin, 2017; Latzer & Festic, 2019). One group of those studies has investigated individuals' algorithmic awareness, aiming to understand whether people know that the digital content they access is algorithmically filtered or not (Eslami et al., 2015; Klawitter & Hargittai, 2018; Proferes, 2017; Swart, 2021; Zarouali et al., 2021). The other group of studies focused on educational interventions aimed at enhancing users' algorithmic awareness (Jacques et al., 2020; Swart, 2021). A notable contribution to the literature comes from the study conducted by Eslami et al. (2015), who observed users' reactions upon discovering the algorithmic management of their Facebook news feed. The findings of the study showed that participants feel surprised or frustrated when updates from their friends or families are omitted from the feed. On the other hand, most of them are unaware of the fact that their Facebook's news feed is curated by an algorithm. In another study, interviews with entrepreneurs were conducted to understand their understanding of algorithms impacting sales (Klawitter & Hargittai, 2018). The results revealed varied levels of algorithmic skills among participants, emphasizing the necessity for algorithmic awareness. Despite being aware of the impact of algorithms on online viability, only a few of them have implemented strategies to optimize their content to reach potential customers.

Existing studies show that there is a pervasive lack of algorithmic awareness among several groups of people, including students, workers, and others, despite the high number of social media or Internet usage rates. Additionally, these studies collectively contribute to the growing body of knowledge in terms of algorithmic awareness that shapes human digital experiences. There is a need to explore the functionality of algorithms and how they impact the overall experience of individuals. It can be concluded that algorithmic awareness is a critical aspect

that should be gained by individuals. Recognizing its critical importance, researchers have found it necessary to explore algorithmic media context awareness on a valid and reliable scale.

Zarouali et al. (2021) introduced the Algorithmic Media Content Awareness Scale (AMCA-scale) to systematically measure algorithmic awareness. This scale, validated with strong psychometric properties, measures users' awareness across four dimensions, which are content filtering, automated decision-making, human-algorithm interplay, and ethical considerations. The AMCA-scale emerges as a valuable contribution, providing scholars with a reliable tool to investigate algorithmic awareness in online platforms. The current study aimed to adapt the scale developed by Zarouali et al. (2021) to the Turkish context and establish a valid and reliable measurement tool, given the significance of possessing algorithmic readiness and the absence of such a scale in Turkish literature. Within the growing prevalence of social media and the Internet, this study introduces a scale designed to measure users' algorithmic media content awareness. In today's digital age, where communication is predominantly conducted online, the importance of this scale is heightened due to its numerous benefits. By using this scale, researchers can measure users' algorithmic awareness, fostering a deeper understanding of the complex interaction between individuals and the algorithms shaping their online experiences. This valuable information not only contributes to the academic discourse but also has practical implications for digital literacy initiatives and media literacy education. Comprehensive research initiatives can be started to enhance users' conscious social media and Internet use and equip them with a thorough understanding of algorithmic media content awareness. Thus, users can improve their skills and knowledge necessary for navigating the digital landscape. Based on its purpose, the current study is guided by the following research question:

- How valid and reliable are the psychometric properties of the Turkish version of the AMCA scale?

2. Method

This study employs a descriptive and cross-sectional design.

2.1. Participants and Procedure

The data collection period spanned from February to September 2023, and it involved undergraduate students from a state university in Türkiye. The surveys for the study were created using Google Forms and shared with participants through convenience sampling.

Unlike random or stratified sampling methods, convenience sampling does not allow for comprehensive generalizations about a population (Creswell, 2012). Participants were notified that they had the option to withdraw from the study at any point while completing the online questionnaire. To maintain data quality, the electronic questionnaire was set to accept only complete submissions, limiting one response per student. Of the 419 collected responses, 5 were excluded due to lack of consent, resulting in a final sample of 414 participants for the analysis. Approvals to carry out the study were obtained from the relevant university's Research and Ethics Committee (February 3, 2023; Approval no. 571441).

2.2. Measures

2.2.1. Personal information

The questionnaire comprised demographic information such as gender, age, Grade Point Average (GPA), grade level, and faculty. It also contained questions about students' previous education in computer and technology-related courses, daily Internet use, and Internet Use Patterns categorized into academic, social, and recreational Internet use hours.

2.2.2. Algorithmic media content awareness scale

The original scale, developed by Zarouali et al. (2021), aims to measure people's awareness of how algorithms influence media content on digital platforms. Zarouali et al. (2021) suggest that this scale has the potential to evaluate a groups' "algorithmic literacy"- an individual's understanding of algorithms' roles and outcomes in media. The AMCA scale includes 13 items with four dimensions. Each dimension, along with explanations and sample items, is provided in Table1.

Table 1.

Dimensions, Explanations, and Sample Items of the AMCA scale

Dimensions – no. of items	Explanation	Sample item
Content filtering (FIL/ 4-item)	It reflects the users' recognition that algorithms tailor media content based on individual online data.	"Algorithms are used to show someone else sees different [media content] than I get to see on [platform name]".
Automated decision-making (ADM/ 3-item)	Awareness that algorithms autonomously decide the media content displayed.	Algorithms do not require human judgments in deciding which [media content] to show me on [platform name].
Human-algorithm interplay (HAI/ 3-item)	Understanding that user behavior influences algorithmic content suggestions made by the algorithms.	The [media content] that algorithms recommend to me on [platform name] depend on my online behavioral data.
Ethical considerations (ETC/ 3-item)	Recognizing potential biases and ethical dilemmas in algorithm-recommended content.	The [media content] that algorithms recommend to me on [platform name] can be subjected to human biases such as prejudices and stereotypes.

The AMCA scale uses a 5-point Likert scale ranging from 1 (not at all aware) to 5 (completely aware). Cronbach alpha values of four dimensions indicate a good internal consistency. The reliability coefficients lie between .89 and .92. This research focuses on adapting this scale into Turkish context.

2.3. Translation Procedure

We began translating the scale with a thorough assessment of the items for cultural suitability, guided by Merenda's (2006) framework. Accordingly, three steps were followed to achieve item and test equivalence. The initial step involves a comprehensive review of the AMCA items and response scales, assessing them from emic (culture-specific) and etic (universal) perspectives. This preliminary analysis is crucial for identifying any culturally bound content that may not translate directly across cultures. Following this, two translators with proficiency in both the original and target languages translated the scale into Turkish. They were followed by a pair of translators who back translated this Turkish version into the source language. We compared the back-translation to the original to ensure accuracy in the final Turkish version. During the translation of the scale, discrepancies in the equivalence of translations for idioms such as "human judgments" (item 6), and "prejudices and stereotypes" (item 12) were identified. This aligns with Merenda's observation that certain items may not seamlessly transfer across

cultural contexts without undergoing necessary adjustments or even replacement. To navigate this issue, three expert reviewers—a linguist and two measurement specialists—carefully evaluated these idioms, thereby ensuring a more accurate translation. The consensus among these experts confirmed the items' content validity as well. After the final step, Merenda (2006) emphasizes the significance of language equivalence and references Sireci (2005), who recommends testing both language versions with bilingual subjects proficient in both languages to mitigate 'language group' effects. However, as mentioned by Cha et al. (2007), there is no gold standard, meaning a universally preferred method, for scale translation due to variations in research contexts, such as the accessibility and availability of bilingual participants. Given these constraints, our study faced challenges in implementing this specific aspect of the process, primarily due to difficulties in finding bilingual participants for our sample. In addition, before finalizing the instrument, cognitive interviews were carried out with an expert in computer science and seven students across various faculties to assess the face validity of the scale. The objective was to uncover potential errors in responses and to delve into the reasons behind these errors on the scale (Willis, 2004). Based on these findings, the researchers implemented minor adjustments to several items.

2.4. Data Analysis

Descriptive statistical methods were employed to outline the attributes of the entire sample. The validity of the study was verified through three distinct approaches: construct, convergent, and discriminant validity. For evaluating construct validity, Confirmatory Factor Analysis (CFA) was applied. Before conducting CFA, certain assumptions such as sample size adequacy, normality, and outlier detection were thoroughly examined. By checking univariate and multivariate outliers, a total of six outliers were identified and subsequently excluded from the analysis. The sample size was deemed adequate for the analysis, substantially meeting the 1:10 thumb rule with 13 items and 408 participants. This size falls within the suggested range of 260 to 420 participants, based on the guideline that the sample size should be 10 to 20 times the number of survey items (Andrew et al., 2010; Kline, 2015).

Univariate normality was confirmed through the assessment of skewness and kurtosis values, alongside visual inspection of histogram and Q-Q plots. A second-order CFA was performed, as in the original research, where the four factors can operate both as distinct scales and

collectively as a comprehensive overarching meaningful scale. CFA was carried out utilizing the maximum likelihood estimation method. The reliability of the Turkish version of the AMCA scale was evaluated through Cronbach' alpha coefficient. Item-total correlations were observed to assess item homogeneity. All statistical analyses were conducted using IBM SPSS 28 and IBM AMOS 20.

3. Result

3.1. Descriptive Statistics

The sample consisted of 414 undergraduate students from various faculties at a public university in Türkiye, representing all grade levels. Among them, 306 (73.9%) of them were female and 108 of them (26.1%) were male. The mean age of the total sample was 21.50 (SD= 5.14), ranging from 18 to 65. The largest group within the sample was the juniors, with 157 students (37.9%), followed by sophomores and freshmen, with 97 (23.4%) and 88 (21.3%) respectively. Seniors accounted for 72 students (17.4%). GPA of the students, excluding freshmen who did not yet have a GPA, exhibited a mean value of 3.02 (SD = .37), with a range from 1.72 to 3.81. The mean of daily Internet use was found to be 5.31 (SD = 2.73) ranging from a minimum of 0.6 hour to a maximum of 20 hours. In relation to Internet usage patterns among participants, the data revealed varying trends across different purposes. The academic-related Internet usage had a mean of 2.29 hours (SD = 1.67), spanning a range from no usage to 9 hours. Social Internet use had a slightly higher mean of 3.30 hours (SD = 2.27), with the range also varying from no usage to a high of 20 hours. Lastly, recreational Internet use showed a mean of 1.94 hours (SD = 1.55), extending from no usage to 13 hours. The survey also explored students' previous education in computer and technology-related courses, with a majority (259) indicating no prior courses, while 155 affirmed having taken such courses. Of those who had taken relevant courses, 95 reported these were part of the university curriculum, 39 had taken extracurricular private courses outside the university, and 21 participated in both types of courses. This demographic and academic profile provides a detailed snapshot of the students' engagement with digital technologies and their educational backgrounds in computing and technology, shown in Table 2.

Table 2.

Characteristics of the Sample (N = 414)

Variable	f	%		
Gender				
Female	306	73.9		
Male	108	26.1		
Study Year				
Freshman	88	21.3		
Sophomore	97	23.4		
Junior	157	37.9		
Senior	72	17.4		
Have you received any courses on computers, various technologies, or software before?				
Yes	155	37.4		
No	259	62.6		
If yes, these courses were…				
Within university	95	22.9		
Outside the university	39	9.4		
Both of them	21	5.1		
	M	**SD**	**Min**	**Max**
Age	21.5024	5.137	18.0	65.0
GPA (excluding freshman n = 326)	3.0161	.37047	1.72	3.81
Daily Internet Use	5.3138	2.72656	0.6	20.0
Internet Use Patterns				
Academic Internet Use	2.2783	1.67143	0.0	9.0
Social Internet Use	3.3007	2.27381	0.0	20.0
Recreational Internet Use	1.9372	1.54602	0.0	13.0

Note. f: Frequency, %: Percentage, M: Mean; SD: Standard Deviation; Min: Minimum; Max: Maximum

3.2. Validity and Reliability

3.2.1. Construct validity – Confirmatory factor analysis

CFA was conducted on the AMCA scale using the remaining data, comprising 408 students, to validate the proposed four-factor structure. The selected fit indices for evaluating the measurement model included the chi-squared divided by the degree of freedom ($\chi 2/df$), the comparative fit index (CFI), the goodness of fit index (GFI), the Tucker–Lewis index (TLI), the root mean square residual (RMR), the standardized root mean squared residual (SRMR) and the root mean squared error of approximation (RMSEA). As seen in Table 3, the fit indices revealed a good fit to the data ($\chi 2/df = 2.902$, CFI = .95, GFI = .944, TLI = .939, RMR = .033, SRMR

= .0466, RMSEA = .068) with no modifications made to the model. The CFI, GFI, and TLI indices should possess a value of at least .90, which is considered acceptable, and .95 and above is considered a perfect fit (Hu & Bentler, 1999). Furthermore, RMSEA, RMR, and SRMR values less than .05 indicate an excellent fit, while values ranging from .05 to .08 are good and acceptable (Browne & Cudeck, 1993). Values of χ^2/df less than 3 are typically seen as indicative of a good fit, while those less than 5 are deemed acceptable (Kline, 2011).

Table 3.

Results of the Selected Fit Indices for the Model Based on CFA

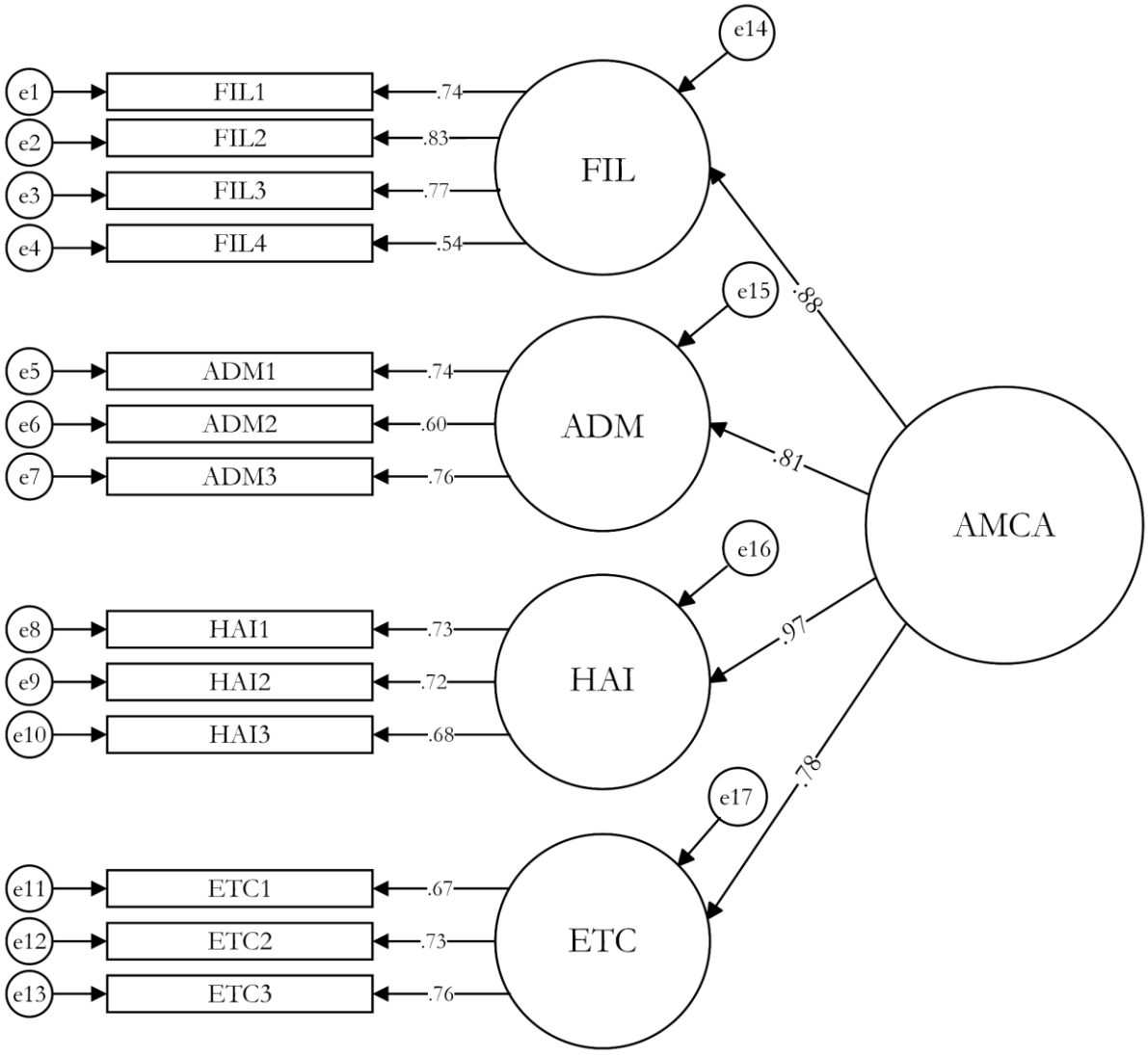
	χ2/df	**CFI**	**GFI**	**TLI**	**RMR**	**SRMR**	**RMSEA**
AMCA	2.902	.95	.939	.933	.035	.0466	.068
Decision	*Good*	*Perfect*	*Good*	*Good*	*Perfect*	*Perfect*	*Good*

Note. χ2: Chi-squared; df: Degree of freedom; CFI: Comparative fit index; GF: Goodness of fit index; TLI: Tucker–Lewis's index; RMR: Root mean square residual; SRMR: Standardized root mean squared residual (SRMR); RMSEA: Root Mean squared error of approximation

The factor loadings of the items ranged between .54 and .83, which are greater than .40 as recommended by Stevens (2002). The Figure 1 showed a second-order CFA model of the translated version of the AMCA scale below.

Fig. 1

Second-order measurement model of the Turkish version of AMCA-scale



3.2.2. Convergent and discriminant validity

Convergent validity: All standardized loadings should surpass .5, proving good reliability (Hair et al., 2010), and average variance extracted (AVE) should be above .5, demonstrating sufficient convergent validity (Fornell & Larcker, 1981). The findings from the present study corroborated the convergent validity as all factor loadings and AVE values surpassed the .5 benchmark.

Table 4.

Measurement Model

Construct	*L* Interval	AVE	CR	α
FIL	.54 – .83	.61	.82	.81
ADM	.60 – .76	.50	.74	.74
HAI	.68 – .73	.51	.75	.76
ETC	.67 - .76	.52	.76	.77

Note. L: Factor Loadings; AVE: Average Variance Extracted; CR: Composite Reliability; α: Cronbach's alpha

Discriminant validity: The square root of AVE should exceed the inter-construct correlations to ascertain a satisfactory level of discriminant validity and should also be higher than .5 (Fornell & Larcker, 1981). As illustrated in Table 5, the square root of AVE values for each construct were higher than the correlation coefficients and the threshold of .5, thereby validating the discriminant validity.

Table 5.

Discriminant Validity for the Measurement Model

	FIL	ADM	HAI	ETC
FIL	**(.787)**	-	-	-
ADM	.602	**(.683)**	-	-
HAI	.669	.577	**(.704)**	-
ETC	.520	.491	.581	**(.718)**

*Note. *The values in parentheses are the square roots of AVE*

3.2.3. Reliability and item homogeneity

Fornell and Larcker (1981) established that a Cronbach's Alpha (α) value above .7 indicates good reliability, and a Composite Reliability (CR) score above .7 suggests acceptable internal consistency. For the Turkish version of the AMCA scale, α values across various dimensions ranged from .74 to .81, with the overall α value reaching .90, as detailed in Table 6. Additionally, CR values for each dimension surpassed the .7 threshold, confirming adequate reliability of the constructs, as shown in Table 4.

Table 6.

Item Homogeneity of Each Item of the Turkish Version of AMCA Scale

Factors	Item	Correlation coefficient of item-subscale	Alpha coefficient if item deleted	Alpha coefficient
Content filtering	1	.633	.737	.81
	2	.709	.702	
	3	.671	.723	
	4	.463	.826	
Automated decision-making	5	.594	.617	.74
	6	.511	.716	
	7	.591	.625	
Human-algorithm interplay	8	.538	.720	.76
	9	.603	.620	
	10	.587	.676	
Ethical considerations	11	.585	.700	.77
	12	.626	.653	
	13	.582	.702	
Overall score				.90

Item homogeneity, which measures the consistency among items within a subscale by calculating the Pearson correlation coefficient between each item and its subscale, was analyzed. Mason et al. (2021) notes that a correlation coefficient above .30 denotes item homogeneity, leading to the exclusion of items with coefficients below this value. Our item-total correlation analysis revealed that all items had correlation coefficients greater than .30, ensuring their sufficient contribution to the overall measure, as indicated in Table 6.

4. Discussion

This current study presents a valid and reliable scale that can be implemented in studies to measure the algorithmic awareness of users. Within the study, the Algorithmic Media Content Awareness Scale, originally developed by Zarouali et al. (2021), was adapted into Turkish. This scale can be used to determine the algorithmic literacy of users, which is related to their understanding of algorithms. The scale has 13 items and four dimensions: content filtering, automated decision-making, human-algorithm interplay, and ethical considerations. Considering the increasing rates of online environments and social media tools in every aspect of life, this scale has a contribution to the field, both in an academic context and in other social contexts. The Cronbach alpha values of the dimensions range between .89 and .92, indicating a good value (Cortina, 1993). The study showed that the construct validity of the scale was ensured, and based on the results, AMCA was found to be linguistically equivalent, valid, and reliable for measuring the algorithmic awareness of Turkish users. Although initially designed

for use at the undergraduate level, the scale can be applied to individuals irrespective of their academic standing.

The studies in the literature point to the increasing importance of users' algorithmic awareness, as algorithms have the capability to shape users' behaviors in online environments and impact their decisions (Cohen, 2018; Gran et al., 2021; Shin et al., 2022). The first factor, content filtering, consists of 4 items and is associated with users' recognition of algorithms customizing media content based on individual online data. Recent research has concentrated on algorithmic filtering, elucidating its societal impact on users, and also examining how the collection of personal information influences their experiences on online platforms (de Groot et al., 2023; Light et al., 2016). Additionally, studies indicate that users are unaware online platforms employ filtering for their newsfeeds (Eslami et al., 2015; Smith, 2018).

The second factor, automated decision-making, comprises 3 items and is linked to users' awareness that algorithms independently determine the displayed media content. As emphasized in the literature, understanding how online platforms make automated decisions is a crucial aspect (Shin et al., 2022). This issue is becoming more prevalent and automated with the increasing use of online platforms, involving aspects like creating personalized advertisements and recommendations. Studies have shown that users still may not comprehend that online platforms like Netflix, Facebook, and Instagram utilize algorithms to provide suggestions (Gran et al., 2021).

The third factor, human-algorithm interplay, comprises 3 items and is associated with users' comprehension of their behaviors that influence algorithmic content suggestions. As explored in the literature, the content presented to users and the aspects of content filtering are not solely linked to algorithmic logic but are also shaped by users' behaviors (Wilson, 2019). Understanding this issue is crucial for algorithmic awareness, as it enables users to consciously make choices while using online platforms and anticipate content based on their actions (Gillespie, 2014).

The fourth factor, ethical considerations, comprises 3 items related to recognizing potential biases and ethical dilemmas in algorithm-recommended content. The literature highlights various ethical considerations arising from content curated by algorithms, such as privacy risks (Araujo et al., 2020; Thurman et al., 2018), a lack of transparency (Zerilli et al., 2019), or biased

algorithmic decision-making (Zarsky, 2016). Being algorithmically literate is also associated with being aware of these concerns that are closely related to ethical issues. Users should understand that algorithmic content may carry potential bias and cannot be classified as neutral (Zarouali et al., 2021). To address these concerns, individuals should understand that algorithms shape our access to information, and we should be aware of the potential impact of algorithmic filtering.

4.1. Conclusion and Suggestions

The Algorithmic Media Content Awareness Scale was adapted to Turkish through a systematic approach, comprising 13 items and a four-factor structure. Recognizing the increasing prevalence of social media and online platforms in today's world, it becomes evident that enhancing algorithmic literacy is crucial. Developing a valid and reliable tool for determining users' algorithmic awareness in online environments is valuable. Researchers can use this scale to investigate the algorithmic literacy of individuals. Furthermore, it can also serve as a means to explore strategies for improving participants' algorithmic literacy levels.

This study has some limitations that should be noted. The current study was limited to undergraduate students from only one university. Future studies can involve users from diverse educational backgrounds and different universities, encompassing students with various cultural backgrounds. Additionally, including potential variables in comparative studies can be considered. Moreover, research can explore the associated factors that may impact users' algorithmic awareness levels. In the digital era, the effective utilization of online platforms depends on how users comprehend them. Understanding the levels of algorithmic awareness among users is critical to ensuring their effective use of online platforms.

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APPENDIX A

Table A1.

The AMCA Scale Items

Factor Name	Number of item	Original Item (EN)	Turkish Version Items
Content filtering (İçerik filtreleme)	1	Algorithms are used to recommend [media content] to me on [platform name]	1. Algoritmalar sosyal medyada bana içerik önermek için kullanılır.
	2	Algorithms are used to prioritize certain [media content] above others	2. Algoritmalar sosyal medyada belirli içerikleri ön plana çıkarmak için kullanılır.
	3	Algorithms are used to tailor certain [media content] to me on [platform name]	3. Algoritmalar sosyal medyada belirli içerikleri bana uygun/çekici hale getirmek için kullanılır.
	4	Algorithms are used to show someone else see different [media content] than I get to see on [platform name]	4. Algoritmalar sosyal medyada başkalarına benim gördüğümden farklı içerikleri göstermek için kullanılır.
Automated decision-making (Otomatik karar verme)	5	Algorithms are used to show me [media content] on [platform name] based on automated decisions	5. Algoritmalar sosyal medyada hangi içeriği göreceğim konusunda otomatik kararlar verir.
	6	Algorithms do not require human judgments in deciding which [media content] to show me on [platform name]	6. Algoritmalar sosyal medyada bana hangi içeriği göstereceğine insan müdahalesi olmaksızın karar verir.
	7	Algorithms make automated decisions on what [media content] I get to see on [platform name]	7. Algoritmalar bana sosyal medyada otomatik karara dayalı içerikleri göstermek için kullanılır.
Human-algorithm interplay (İnsan-algoritma etkileşimi)	8	The [media content] that algorithms recommend to me on [platform name] depend on my online on that platform.	8. Algoritmalar sosyal medyada -online- bulunmama bağlı olarak bana içerikler önerir.
	9	The [media content] that algorithms recommend to me on [platform name] depend on my online behavioral data	9. Algoritmalar sosyal medyada online hareketlerimden (benim sunduklarım dışında) elde ettiği verilerime bakarak bana içerikler önerir.
	10	The [media content] that algorithms recommend to me on [platform name] depend on the data that I make available online	10. Algoritmalar sosyal medyada online olarak sunduğum/paylaştığım verilerime bakarak bana içerikler önerir.
Ethical considerations	11	It is not always transparent why algorithms decide to show me certain [media content] on [platform name]	11. Algoritmalar sosyal medyada hangi içeriklerin gösterileceği konusundan her zaman şeffaf değildir.

(Etik konular)	12	The [media content] that algorithms recommend to me on [platform name] can be subjected to human biases such as prejudices and stereotypes	12. Algoritmaların sosyal medyada bana önerdiği içerikler taraflı olabilir.
	13	Algorithms use my personal data to recommend certain [media content] on [platform name], and this has consequences for my online privacy	13. Algoritmalar sosyal medyada bana belirli içerikleri önermek için kişisel verilerimi kullanır ve bu online gizliliğim/mahremiyetim açısından bazı sonuçlar doğurur.