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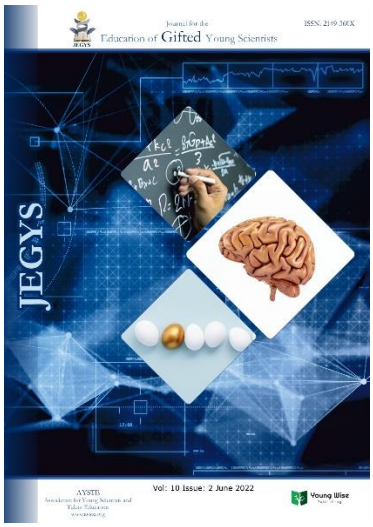

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From the Editor: What should we understand from the concept of gifted young scientists education?

Abstract
I wrote the article to understand the concept of "Gifted Young Scientist Education". Because there are questions about the scope of JEGYS. The concept of "Gifted Young Scientist Education" should be deeply understood for the problem of which basic perspectives the coverage area will be presented. JEGYS, where you can find preliminary research on the practices of the future education, continues to maintain its privileged position with a brand new concept.
Keywords:
Gifted young scientists education, Scope of JEGYS, EPGBU Model, Education of the Future

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"Science education" is now obsolete and is looking for a way out. The signs of this are that he now has to create concepts and study areas such as STEM, the Nature of Science. However, rest assured that neither STEM nor the Nature of Science fields of study are suited to the education and understanding of ordinary students. An academic who is involved in teaching with students can easily understand that these two fields of study are for gifted children.

I am the editor of JEGYS and taught science for ten years. The last three years have been spent with gifted children. Then, I applied the EPGBU model for gifted children in the academic field for 5-6 years at the university. Raising scientists can be a goal. Many countries should strengthen their scientist training policies in order to maintain their claim to be developed countries. However, the concept of raising scientists will no longer exist.

It will be replaced by the concept of "Young Scientist Education" first, and then the concept of "Gifted Young Scientists Education". Why?

Because education for gifted children will be shorter and product creation will accelerate. We will begin to see scientists who are gifted, young and dynamic at a very young age.

JEGYS is the scientific platform where this ideal is discussed. The scope of JEGYS is not just science education, because young scientists can be in any discipline, even in the arts, sports, leadership. These children should be educated as if the master and doctorate programs of universities were adapted 10 years ago.

Now we invite all our colleagues who follow us to the wide platform of JEGYS. You can submit your articles from all fields of educational sciences, psychology, social sciences and health sciences. Our main point of view should be how the accelerated education of the future should be and how we can turn highly productive children into scientists.

We have prepared our summer issue with 13 articles for you to read. I would like to thank all our team, authors, referees and editors for their efforts. I know you don't read much from the editorial, but I have to write it and I have to explain it over and over. JEGYS is an academic journal with spirit, goals, future and charisma.We would like to thank all authors, editors, referees and readers who contributed to the spring issue of 2022.
Best regards

Dr. Hasan Said Tortop
Editor-in-Chief of the JEGYS

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Research Article

E-tutors' instructional strategies in teaching the design process in virtual classroom: A case in an Open Distance eLearning (ODeL) environment

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Abstract

The technology curriculum is positioned to have the same status as those in mathematics and science curricula. This existence is supplied as a means of advancing knowledge and contributing to key insights into the subject's design process curriculum, particularly in the context of an ODeL. Innovative instructional methodologies are better positioned to develop design process knowledge within the needs of the ODeL environment to meet this requirement. "How did the e-tutors' gained pedagogical knowledge effect the students' learning of the design process?" was studied as a question to help the inquiry get more important insights. This work used a quantitative way to answer the main research question by allowing students to describe how they believe their e-tutor abilities to select instructional tactics to teach the design process. The quantitative data was employed as a scope and depth of comprehension and confirmation of the data gathered in the quantitative approach. Three hundred fifty postgraduate students were chosen from a year module of a degree as a sample. The instructional tactics of the e-tutors in teaching the design process in the virtual classroom were evaluated through an online survey. In the results of the study, in virtual classroom settings, e-tutors were found to have less ability to innovate and employ a broad educational style. It can be recommended to use an alternative model of e-tutor appointments instead of using the existing.

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Introduction

Developed a model by Nelson and Stolterman (2014) and Plattner et al. (2012) on important functions performed by designers quite some time ago. Nelson and Stolterman (2014) proposed a design process model that included five stages: desire, interpretation and measurement, imagination and communication, judgement, composing, and connecting. Plattner et al. (2012), on the other hand, advocated investigating, defining, making, communicating, and evaluating as steps in the design process. The stages assert what is known as IDMEC from Plattner et al. (2012) about the design process, despite the fact that the two concepts are recognized differently. Figure 1 depicts the pictorial representation in this study. As a result, the steps proposed by Plattner et al (2012) will be examined in order to gain a better knowledge of how instructional tactics enhance the design process in an ODeL environment. The design process has established itself as a prominent component of a number of themes that have gotten a lot of critical attention, particularly in the ODeL setting. The extra focus is necessary since it advances a key goal of building future entrepreneurial education for students in the ODeL setting. The concept of entrepreneurship education, which is closely linked to another widely held belief in the development of students' employable skills. After Covid-19, Kamat

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(2021) sounds heroic because it changed a lot of the status quo. At the same time, it is credited in one of the goals for the curriculum in the Curriculum and Assessment Policy Statement (CAPS), (2011), from which this study is conceptualized. Despite this, according to Herwin et al. (2021), learning organization during the Covid-19 pandemic has become a severe challenge in the learning activities itself, necessitating teachers to develop novel instructional strategies to ensure that learning activities go smoothly (Adeoye, 2020; Al-Hunaiyyan & Alhajri, 2021).

Instructional tactics relating to the presentation of learning for the design process are particularly significant since they stay at the heart of the process even when provided at a distance. This is because Syaharuddin et al. (2021) feel that such tactics aid students by allowing them to continue studying while in a virtual environment. With that in mind, Iorait and Guleviiut (2021) feel that ODeL institutions still have a responsibility to provide possibilities for entrepreneurs to innovate and build secure innovations through the design process. Instructional techniques are a critical component in establishing entrepreneurial skills for design process students in virtual classrooms, as discussed in this research. This may be the case because Johann et al. (2020) argue that when design process education is incorporated into the design process education system, design process, which is also relevant in the context of entrepreneurship education, becomes a very important tool for developing entrepreneurial skills.

What is known about the design process from literature would serve as a foundation for publicizing entrepreneurial education. The design process is seen as a significant accomplishment that has resulted in a slew of new studies (Clarke, 2020; Kelly & Goro, 2021) that have anchored conversations in the field with topics in a curriculum that are as important as those in Mathematics and Sciences. Because the curriculum has the same status as the two courses, there is the possibility of differences arising when a teacher offers activities based on tactics that have no bearing on the fulfillment of preset learning objectives. Herwin and his colleagues (2021). What is stated here contributes to the ongoing arguments concerning the optimal tactics for teaching the design process, particularly in a virtual environment. Surur et al. defined strategies as "unique patterns or combinations of diverse learning activities carried out by teachers and students to attain goals that are a key component of learning success" (2020). As more teachers in an ODeL setting begin to educate about real-world chances and skills as efficient tactics, special patterns efficacy may mean more hands-on learning. Gabrielsson & Hägg (2020). Given the current discussion regarding techniques that are relevant to how the design process functions as distant learning, the question of how the design process is known from literature is critical.

Over time, one has been aware of a persistent dilemma arising from the divergent conceptions of the design process. Baldauf (2021) and Kelly and Gero (2021) supplied some literature that led to a widespread agreement on the concept. Because it was not conceptualized in the setting of South African schools, what has been widely publicized and accepted about the concept from the mentioned literature is problematic for this paper.

Where design process is a widely proposed in reiterative steps of: Investigate, Design, Make, Evaluate and Communicate (Department of Basic Education, 2011). The pictorial representation is depicted as figure 1 below.

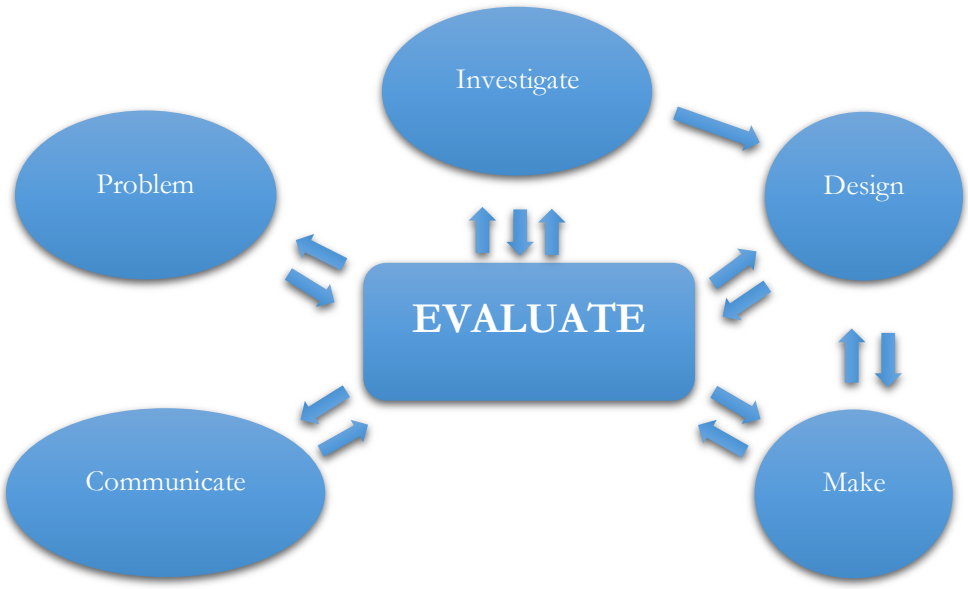

Figure 1
IDMEC Process Skills Adapted From the Department of Basic Education (2011)

The reiterative steps as proposed in the above diagram will form the basis to be considered as instructional skills for the paper. Then, an understanding of what is understood about the concept narrows into the defined strategies envisaged about the design process skills.

Theoretical Framework for the Paper

This study is based on George Siemens' connectivism (2005), in which students who are taught by e-tutors take advantage of technological opportunities. Cognitive presence, social presence, and teacher presence are the three demands of being an e-tutor, according to the theory. Within the three, this study focuses on teacher presence because it necessitates the employment of instructional strategies that provide students with high-quality online learning experiences. Students are provided with strategies to investigate ways in which they can independently explore approaches to become independent users in this manner.

Literature Review

For this paper, two goals were set. As a result, the issue of e-tutors' ability to select instructional techniques for the design process became more prominent, and its importance was heightened to the point where an objective one was developed to further such an understanding. The distinctiveness explains that the Technology curriculum is taught differently than the mainstream disciplines, particularly Mathematics and Science, and that the topic does not follow the commonly accepted teaching techniques. The design process should then become a logical process governed by rules and processes, particularly when selecting and employing methodologies that help students comprehend the design process. As a result, e-tutors who are responsible with overseeing the design process must possess talents that will benefit students, particularly in terms of instructional skill selection and application. According to Van Diggelen et al. (2021), e-tutors are expected to select teaching and learning methodologies that support students in becoming creative and innovative thinkers and possessing relevant skills to conceptualize the design process. This concept is significant because Orbey and Erdogdu (2020) argued that the design process is a creative activity with some idiosyncrasies, such as intuition and logic, and that their roles in the design process are to demonstrate that they can work together to solve design challenges. Another piece of advice for selecting the methodologies needed for the conceptualization of the design process is to think about tactile design epistemology and hands-on kinesthetics knowledge learning.

The use of diverse teaching methodologies for the design process, including epistemological and kinesthetic knowledge approaches, has been a source of heated discussion among proponents of the design process. The approaches have not been restricted and limited to the fore stated, as these arguments have shown. That is why, for this study, the content method is adopted, as it has increased in popularity as a major foundational and widely accepted teaching strategy central to the design process. The content approach, according to Mann et al. (2020), is concerned with the selection of abilities that play a crucial role in how information delivery is approached. In figure 1 of IDMEC process skills, what is highlighted in Mann et al. (2020) has already garnered some attention. Each skill in the IDMEC process diagram represents a teaching strategy in and of itself. For example, Han et al. (2021) used research skill to tell members about the product's requirements, which is likened to some as a means of exerting collective wisdom.

In Han et al. (2021), the design team of students achieved positive outcomes about collectively brainstorming for solutions with an end product of an agreement based on the selection, and combination of various product solutions. Jones et al. (2019) found that teachers with cumulative knowledge of perfected techniques to teaching the subject of the design process found power in collaborative learning. Reports in (Han et al. 2021; Mann et al. 2020) were watered down by reports in (Han et al. 2021; Mann et al. 2020; Lie et al. 2019; Mesutoglu et al. 2021; Trauth et al. 2018). Their published findings that consistently revealed certain flaws in the content approach. Their findings garnered a lot of attention, indicating that content was a hot topic, and that there were some design issues when using the content approach because teachers did not revisit the various design processes after their first brainstorming. At the same time, Mesutoglu and Baran (2021) reported that teachers had difficulty recognizing and explaining the producing and process of solving the design process in a group in a collaborative set up.

The paper's second goal was to see how well e-tutors might use instructional tactics to educate the design process. The literature was used to investigate and predict how this goal would evolve based on the concept that the act of planning strategies entails complicated mental and behavioral activities in order to achieve instructional objectives. When it comes to selecting instructional tactics, e-tutors should attempt to address problems and anticipate what students will need to know about the design process. E-tutors should take on the role of ambassadors, guiding students through the curriculum design process using instructional methodologies that are based on current standards (VanTassel-Baska & Baska, 2021). According to Kuba et al. (2021) e-tutors can teach the design process of coherence,

in which students in group settings learn better when irrelevant aspects are removed, and signaling, in which students learn better when important information is highlighted in a group.

A body of literature has arisen that offers recommendations for teaching strategies, with a focus on the use of strategies in the design process. According to a report Trilles (2021), there were favorable responses from the students who reported that the teaching tactics utilized in their virtual classrooms were viewed at an exceptional level by the students. At the same time, Krishnan et al. (2021) findings showed that students in flipped classes had stronger interaction with ways for becoming self-reliant. The findings of Krishnan et al. (2021) and Trilles (2021) were augmented by new findings that were consistent with those of (Ebner et al. 2020; Wang and Zhu, 2019), who reported that the used innovative pedagogical strategies contained more elements of active learning as they became more student-centered. In contrast to the findings of other studies (Ebner et al. 2020; Krishnan et al. 2021; Trilles, 2021; Wang and Zhu, 2019). Wahab & Iskandar's (2020) findings revealed that students struggled with the tactics used, making it difficult for teachers to organize a good virtual learning experience. Sukardi et al. (2020) also observed that teachers were having difficulties with their new teaching strategies that would innovate for basic principles for teaching curriculum of specific subject, such as the design process content.

Problem of the Study

Research objectives are to assess e-tutors' abilities to select approaches which assist students to conceptualize the design process and to determine the e-ability tutors to use instructional strategies to teach the design process. For this aim, it can be creating a research question as below;

- How did the e-tutors' acquired pedagogical knowledge influence the students' learning of design process?

Method

Research Design

This work used a quantitative way to answer the main research question by allowing students to describe how they believe their e-tutor abilities to select instructional tactics to teach the design process. The quantitative data was employed as a scope and depth of comprehension and confirmation of the data gathered in the quantitative approach (Bryman, 2012). The research design arose from the selection of the e-tutors who would tutor the students digitally as part of the program. They were chosen since it was assumed that they knew more about the module. The policy dictated that all of the e-tutors (N=5) be chosen in accordance with the policy. The Likert Scale was employed, and participants were asked to complete a questionnaire that asked them to answer five questions (SA means Strongly Agree, then A means Agree, N means Neutral, SD means Strongly Agree and D means Disagree). To collect and analyze data, this paper used a pragmatic research strategy and an exploratory mixed method design approach (Bryman 2012; Creswell, 2008; Greene, 2007). Pragmatists believe that truth is 'what works,' and that the researcher has a greater say in how the results are interpreted (Creswell, 2008).

Participants

A total of 350 students enrolled in a module took part in this study. Their primary objective was to provide extensive accounts based on a qualitative study of the ways their e-tutors use to educate the design process. E-tutors clarified and attempted to defend views that offered information from the students on their selection, usage, and general applicability of their techniques during the teaching of the design process in the second thorough reports not in any other of preference.

Table 1

Structures of the Participants

		f	%
Gender			
	Male	167	47.7
	Female	183	52.3
Age			
	19-45 years	160	45.7
	45-55 years	120	34.3
	55+ years	70	20
Total		100	100

Table 1 explains the profiles of the participants. Participants of the were males (47%) and were females (52.3%). Their ages range from 19-45 and their actual number was 160 which is about 45.7%. Those who were between the

ages of 45-55 were 120 which is about 34.3% of the participants. Lastly, those who were 55 years and above were 70 and this is about 20% of the total participants.

Research Instruments

A senior professor at the university ensured the reliability and validity of the scale, which was developed from the TPACK instrument. To satisfy the paper's objectives, data was collected utilizing a questionnaire-based study instrument devised by the paper's researcher. The measure has five Likert Scale items, with SA indicating Strongly Agree, A indicating Agree, N indicating Neutral, SD indicating Strongly Agree, and D indicating Disagree. Students' perceptions of their e-tutors in relation to their design process approaches were gathered using an instrument questionnaire. The first instrument for my PhD program was improved and expanded into the Technological Pedagogical and Content Knowledge Questionnaire Protocol (TPACK). For the sake of this article, the same instrument was further tweaked and improved to better suit the function for which it was designed. This method included pre-testing the questionnaire for reliability through piloting, as well as ensuring that the answers collected from the questionnaire were correct and that they were used appropriately (validity). As a result, despite some criticism, the researcher believes it was successful in acting as a practical and helpful instrument for data gathering purposes for this project.

Data Analysis

A descriptive data was obtained from a data set from a survey questionnaire. Three tables were used to clarify specific aspects about instructional strategies that the e-tutors employ during their teaching of the design process in a virtual environment. Table 1 examined e-tutors' abilities to select best approaches for students to conceptualize the design stage of the design process. The second clarity in the paper was collected from Table 2 about the abilities of e-tutors to adapt their teaching styles which to suit the students' learning of the design process. Table 3 which was the final for the paper established the e-tutor abilities to use a wide range of teaching approaches in a virtual classroom setting for the design process.

Results

The following research question was formulated for the paper content. "How did the e-tutors' acquired pedagogical knowledge influence the students' learning of the design process?". From the main research question, two objectives were set for the paper: to assess e-tutors' abilities to select approaches which assist students to conceptualize the design process; to determine the e-ability tutors to use instructional strategies to teach the design process. Results of table 1 were the first to consider advancing insights to the item which was formulated about the objective 1.

Table 2

e-tutors' Familiarity for Approaches which Best Explain How to Conceptualize the Design Process in a Virtual Classroom.

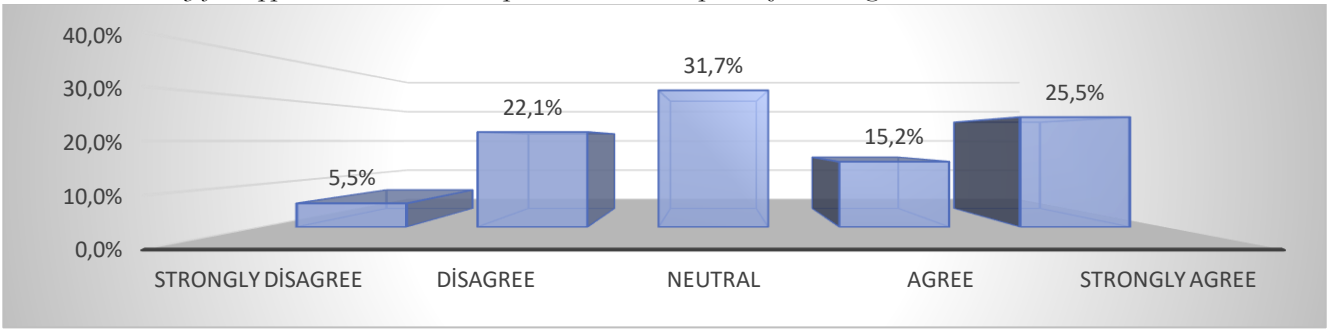

Table 2 illustrates the responses to a question asking students if their e-tutors had any familiar techniques to explaining how to envision the design process in a virtual classroom. According to the data, 40.7 percent of students strongly agreed or agreed that their e-tutors are not knowledgeable with employing proper online tactics that best explain the design process. The fact that 31.7 percent of the students were ambivalent towards the notion suggests something else. The percentage of those who strongly disagreed and disagreed was 27.6%. This suggests that e-tutors perform below average in terms of using online tactics to communicate common understandings about the design process, particularly to students in an ODeL environment. In terms of the goal for this section of the paper, it appears that e-tutors have not developed techniques that could help them influence the inconsistent data concerning their tactics.

Table 3

The Abilities of e-tutors to Adapt Teaching Styles to Suit the Students' Virtual Learning Needs of the Design Process

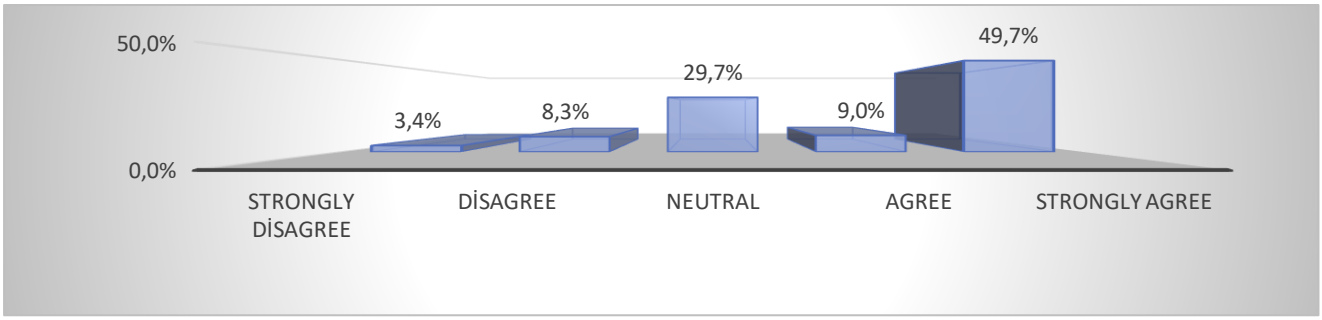

Table 3 displays the results from online students who commented on their e-tutors' ability to alter teaching techniques to meet their design learning goals. According to the table, 58.7% of students strongly agreed or agreed that their e-tutors were capable of adapting their teaching techniques to meet the learning needs necessary for the design process topic. There were 29.7% of individuals who expressed indifference about the construct that was developed about their e-tutors. At the same time, those who strongly disagreed and disagreed accounted for 11,7% of the total, implying that their opinions had less of an impact on the construct established for the research. Based on these submissions, it appears that the e-tutors perform admirably in terms of the construct. Positive performance through techniques by e-tutors provides students with a conceptual comprehension of the fundamental material of the design process, with great certainty based on what has been conclusive proof.

Table 4

The e-tutor Abilities to Use a Wide Range of Teaching Approaches in a Virtual Classroom Setting for the Design Process

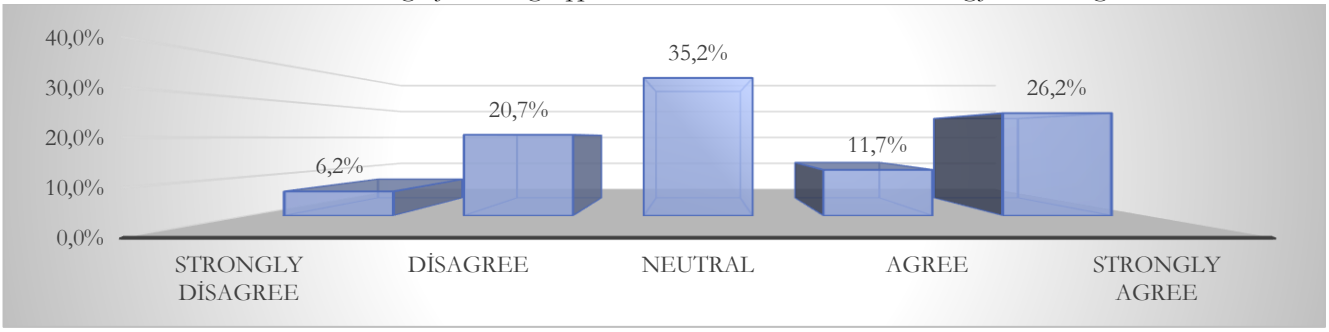

Table 4 illustrates the responses to a question asking students if their e-tutors might use a variety of teaching methods in a virtual classroom setting. According to the table, 37.9% of the students highly agreed or agreed that their e-tutors were capable of using a variety of teaching styles in a virtual classroom setting intended for the design process. This suggests that the e-tutors lacked the necessary teaching skills to deliver the design process in an ODeL context. According to another estimate, 35,2 percent stated that they were unconcerned about the construct. Those who disagreed or strongly disagreed with their e-tutor abilities of possession to a wide range of teaching approaches in a virtual classroom setting for the design process made up the final cohort of submissions, accounting for 26.9% of those who did not positively defend their e-tutor abilities of possession to a wide range of teaching approaches in a virtual classroom setting for the design process. In this section of the research, an inference was taken that e-tutors have been found to have less ability to apply a wide range of teaching styles in a virtual classroom context.

Table 5

Items for the Design Process

Likert scale %	SA	A	N	SD	D	Total
My e-tutors possess familiar approaches which best explain how to conceptualize the design process in a virtual classroom	25.5	15.2	31.7	5.5	22.1	100
My e-tutors have abilities to adapt teaching styles that suit their learning needs of the design process.	49.7	9.0	29.7	3.4	8.3	100
e-tutors have potentialities to use a wide range of teaching approaches in a virtual classroom setting	26.2	11.7	35.2	6.2	20.7	100

SA: Strongly agree **A**: Agree **N**: Neutrol **SD**: Strongly disagree **D**: Disagree

Most of the participants believe that their e tutors possess knowledge about the design process (40%) and 31,7% were undecided and 27,6% of the same participants disagreed. 58.7% of the participants said that their e-tutors have

abilities to adapt teaching styles that suit their learning needs of the design process. 29.7% of the same participants were undecided. Only 11.7% of the respondents agreed that e-tutors have abilities to adapt their teaching styles that suit the students' learning needs of the design process. 37.9% of the participants were of the view that e-tutors do not have potentialities to use a wide range of teaching approaches in a virtual classroom setting. 35.2% of the same respondents were unsure if the participants were able to use a wide range of teaching approaches. 26.9% of the same participants agreed that the e-tutors could use a wide range of teaching methods.

Discussions

The development of this work was guided by two goals. This debate is based on a construct to determine whether students' tutors had familiar techniques that best explained how to envision the design process in a virtual classroom from a section of Table 1. The discussion that follows is based on a significant value placed on the paper's first objective. It has been discovered that e-tutors perform below average in terms of choosing online tactics to communicate common understandings about the design process, particularly to students in an ODeL setting. The findings were consistent with previous publications (Lie et al. 2019; Trauth et al. 2018), which stated that several design issues were encountered because the teachers did not review the numerous design processes after their initial brainstorming for teaching strategies. These findings matched those of Mesutoglu and Baran (2021), who found that teachers in a collaborative setting had trouble detecting, explaining, and producing effective instructional strategies for the process of solving the design process in a group. In light of these changes, it is deduced that students' techniques did not target the special demands of a virtual environment in relation to instructor presence inside Connectivism. Another implication is that the cohort of students tutored by the sample e-tutors would not be able to meet the cognitive demands associated with Connectivism. In terms of the IDMEC abilities that were desired for the design process (see Figure 1), students would be disadvantaged from the benefits of such skills in their careers as students and as teachers who must instruct students after completing their teacher trainings.

Another piece of evidence from Table 2 reveals that there were favourable results based on a construct that was designed to determine their e-tutors' ability to adjust teaching techniques to meet their design learning needs. According to the construct report, there has been positive progress in the field of the topic, and the design process has been fully investigated as a curriculum to be taught. This supports what was previously said by VanTassel-Baska & Baska (2021) that the ambassadorial duties of e-tutors in leading students through the design process curriculum by employing instructional strategies that were prepared based on current standards. Similarly, in Trilles (2021) study, students replied positively, indicating that the teaching tactics used in the virtual sessions were outstanding and beneficial to their learning of the design process. The skills diagram 1 of IDMEC also revealed scientific proof, adding to the favourable outcomes that have been raised about the design process. The evidence for teaching approaches skills was examined in this research, and it was shown to be conclusive that virtual students gain from e-tutors' techniques. In terms of the theoretical framework that was constructed for the paper, it can be said with certainty that students who receive instruction with tactics that target the virtual environment experience some type of cognitive presence and instructor presence.

The last Table 3, which was created for this paper's talks, was able to provide some direction for the development of the construct that was discussed in this part. Its goal was for the virtual students to see if e-tutors could teach the design process content using a variety of teaching methods. The less favourable results acquired about the construct lead to the conclusion that e-tutors have been discovered to have a limited ability to apply a variety of teaching ways for topic knowledge during the design process. The results were less good in comparison to the preceding account given regarding the IDMEC skills figure1 of the design process, which was admired as a teaching strategy for this paper arrangement. It was shown that e-tutors were unable to provide a conceptual understanding of the design process that could be examined in the context of how teaching tactics were used. Furthermore, the theoretical framework, which was created to determine how the unique aspect of the design process is determined, came to the conclusion that the cognitive presence part of the framework had no accomplishment. The findings were bolstered by a review of the literature. Wahab and Iskandar (2020) observed fewer good outcomes, stating that students struggled with the tactics used and that it became a difficulty for teachers to organize effective virtual learning experiences. Sukardi et al. (2020) discovered that teachers had difficulties with IDMEC teaching strategies that would innovate for basic concepts for teaching the design process content curriculum.

Talent development is very important in universities. Starting in kindergarten, institutions are supposed to identify and nurture potential in pupils. To recognize talent in students, schools and colleges must go beyond programming to transform mindsets and provide learning opportunities for educators and families. This holistic

approach to giftedness development in children must adopt an ecological system-based view on the development of giftedness in students, especially understanding the interaction of systems such as families and teachers (Frazier-Goatley, Adelson, & Snyder, 2022, p.116). Though secular definitions of giftedness differ, most incorporate the idea of high performance or achievement in each discipline, according to Mofield & Mofield (2022, pp. 80-81). Students with gifts and talents perform -or have the potential to perform- at greater levels in one or more domains than students of same age, experience, and environment. They will need to change their educational experiences in order to learn and reach their full potential. Students with abilities and talents come from many walks of life, including all racial, ethnic, and cultural groups, as well as all socioeconomic levels. To reach their full potential, they must have ample access to relevant learning opportunities. They may also suffer from learning and processing issues that necessitate specialist attention and accommodations. As a result, kids require assistance and supervision in order to grow socially, emotionally, and academically. The talent development paradigm has gained traction in the field of gifted education as a model for developing the strengths and talents of gifted students and students with high potential, such as those who may not be formally identified as intellectually gifted per se but who exhibit propensities and high performance in a variety of domains (Mofield & Mofield, 2022, p.81). The first step in creating talent is to evaluate the current condition of each university's Generation Z students, including their personalities and knowledge backgrounds, and to identify any existing talent training issues relating to student capabilities. The second stage should be to identify the training goals for strengthening transdisciplinary and big data thinking skills in institutions. The third phase is for universities to build a new talent development model for its students, which should involve encouraging innovation in the classroom, multidisciplinary education, personality development, and industry-education integration (Mo, 2022, p.4). Spies, Schauer and Pfeiffer (2022, p.2) discovered that giftedness is made up of three components: noncognitive personality traits (achievement motivation, striving for cognition, self-concept, and so on), giftedness factors (intelligence, creativity, psychomotor skills, and so on), and environmental characteristics (parents' educational level, number of siblings, critical life events, and so on).

Conclusion

How did the e-tutors' acquired pedagogical knowledge effect the students' learning of the design process was presented as a significant topical study issue? Further talks for the article were sparked by two aims. Less desirable outcomes resulted as a result of the first objective, which was to analyze e-tutors' abilities to identify ways that help students conceive the design process. To recognize talent in students, schools and universities ought to go beyond providing programs to transform mindsets and provide learning opportunities for teachers and families of the students. The way e-tutors chose online tactics to explain common understandings about the design process in an ODeL environment was found to be less than average. The extent to which this result is comprehended cannot be justified in order to address the enormous challenges linked with the tactics that can be investigated to teach the design process. Given the IDMEC skills diagram 1 that was chosen for the paper, it can be deduced that the most admired design process techniques were lost due to the e-tutors' overall failure to regard the IDMEC skills as important to the design process. Furthermore, within Connectivism, the theoretical framework did not include doses of excellence connected with cognitive presence, which targets autonomous online students and e-tutor presence. The presence of an e-tutor attests to the notion that such an e-tutor is capable of explaining the changing nature of the design process curriculum to students, as well as clarifying numerous parts of the curriculum. In the literature, the concept of entrepreneurship education, which was another widely believed approach of preparing students for employment, was discussed. Kamat (2021), made a minor contribution and had no impact that would persuade policymakers to promote entrepreneurship education in the design process. It can also be argued that students who were taught according to Van Diggelen et al. (2021) would not become creative and innovative thinkers and would lack the necessary abilities to conceive the design process as a result of the e-tutors' tactics. It's possible that part of the rationale is related to what was reported by Lie et al. (2019), Mesutoglu and Baran, (2021), Trauth et al. (2018). Teachers had difficulty detecting and explaining the producing and process of solving the design process in a group, according to (Lie et al. 2019; Trauth et al. 2018). As a result, students in such e-tutors' classes would miss out on the tactile design process epistemology and the hands-on kinesthetics aspect of knowledge during their learning.

In terms of the paper's construct, it reported fewer good outcomes, stating that e-tutors were found to have insufficient abilities to employ a wide range of teaching methodologies for topic knowledge for the design process. This story stems from a second goal, which was to examine the tutors' capacity to apply instructional strategies to teach the design process using e-ability. The findings about the construct confirmed more insights that were already available in literature (Sukardi et al. 2020; Wahab & Iskandar, 2020) whose findings were about students who had

difficulties with the strategies that were used, as well as teachers who found it difficult to organize positive virtual learning activities from the strategies that they chose to deliver the virtual design process curriculum. Another study by the same this study, Sukardi et al. (2020) found that teachers had difficulties with their new teaching strategies, which hampered their ability to innovate and resulted in fewer opportunities for students to gain a better understanding of the fundamental principles that were specified for the design process curricula. According to additional research, VanTassel-Baska & Baska, (2021), e-tutors' ambassadorial duties to guide students through the design process curriculum were based on less effective use of instructional strategies that were not established based on current standards. As things stand, another widely held view of student capacity building in the direction of employability, Kamat (2021) cannot be considered significant because students who were tutored were not helped by the strategies used to appreciate the extent to which knowledge for the design process can shape their future careers. During the process of developing knowledge with the use of instructional methodologies, the reiterative phases of the IDMEC skills set for the design process were lost in translation. This goal is furthered by a contribution to the theory (Connectivism) that the presence of an e-tutor had a lower impact on students who were exposed to different teaching methods. Further contributions to the hypothesis that there was no aspect of cognitive presence were discovered, which may illuminate for improved insights into design process methods from the e-tutors. Universities must prioritize multidisciplinary education, personality development, and industry-education integration in order to construct a new talent development model for its students, which should include fostering creativity in the classroom.

Recommendations

There is an indication that e-tutors have not developed techniques that could positively affect the contradicting findings about their tactics, which was set as the first objective for this section of the paper.

These data imply that the e-tutors perceive the first training as beneficial, but that there is a general lack of understanding of how their educational efficacies may be demonstrated to support their claims. In this section of the research, an inference was taken that e-tutors have been found to have less ability to apply a wide range of teaching styles in a virtual classroom context. Students with gifts and talents should be accommodated in schools irrespective of their racial, ethnic, and cultural groups, and socioeconomic status. They should be assisted and supervised to develop them socially, emotionally, and academically.

Limitations of the Study

This study was conducted in an ODeL university with a student population of 300,000 students worldwide. This study focused on 350 postgraduate students who registered for a module (n=500) out of the total student population, which proved to be a limitation. Another disadvantage was that the same ODeL institution positioned its qualifications across seven colleges and institutions, despite the fact that this article is focused on a single college. Despite the fact that departments teach a variety of modules, the fact that this article focused on only one institution and one module within a department certainly added to the limitation. The institutional professional plan for e-tutors provides for e-tutors across the institution, colleges, and departments, which might be considered a large number of e-tutors and result in a limitation in this study because only five e-tutors participated. Because it was created and used as a practical tool for a certain goal, an instrument became a limitation. The document then contained a list of limits, with no indication that the paper would be given little weight or authority. Finally, it is necessary to investigate these limitations in order to avoid generalizing the findings and to pay attention to them so that they may be applied to other investigations.

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Research Article

Investigation of the relationship between Androgen Receptor Gene CAG Repeat Polymorphisms and Turkish gifted students' science attitudes[1]

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Abstract

This study aims to examine the AR gene CAG polymorphisms of gifted students, and to determine whether there is a relationship between this gene region and students' attitudes towards science. The research was conducted with randomly selected gifted students (N = 100) and normally developing students (N = 100) studying at the 5th grade level in Kocaeli, Turkey during the 2017-2018 and 2018-2019 school years. In order to determine students' attitudes towards science, science and technology lesson attitude scale was applied. According to the results of the study, while there was no significant difference in terms of "enjoyment" and "social content of science" from the science and technology lesson attitude scale factors, it was found that there was a statistically significant difference in favor of gifted students from the "scale total scores" and "desire to learn" factors ($p<0,05$). In the genetic dimension of the study, no statistically significant difference was found between the two groups in AR gene CAG polymorphisms. In the whole sample, there was no significant relationship between the AR gene CAG polymorphisms and the "scale total score" values.

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Introduction

Giftedness and Genetics

Gifted people have achieved great success throughout history. People who provide important developments in technical, scientific and social fields in societies are those who have superior brainpower (Çağlar, 2004). Specially gifted students show interest in different subjects compared to their peers and have a desire for detailed learning with a sense of curiosity (Taber, 2017). But the question is "Does being gifted always positively affect the attitude towards science?" Is it determined solely by IQ score, or can it be supported by genetic factors?" Thinking that cognitive abilities and intelligence are due to the best versions of genes, researchers have found a different sequence on the long arm of chromosome 6 than other humans (Asbury and Plomin, 2016). They noted that this sequence in the middle of the IGF2R gene differs in intelligent children. The existence of intelligence genes indicates that an inherited link between the IQ value and the genes (Ridley, 1999). Although different variations of intelligence affect the interests, skills, and

[1] For the AR gene CAG repeat polymorphisms of the sample groups in the study, the permission of Kocaeli University Faculty of Medicine 2017/375 KÜ GOKAEK Non-Interventional Ethics Committee was obtained. Later, the approval of the Ministry of Education and the Governorship was obtained, dated 30.04.2018 and numbered 99332089-605.01-E.8616597. Then, the study was carried out by obtaining permission from parents and students. This study was supported by Kocaeli University Scientific Research Projects Unit (2018-105).

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attitudes of individuals in different areas, individuals with high IQ levels are defined as gifted. It is a simple approach to identify students with standardized test scores who can be described as gifted in the field of science (Taber, 2017). Science education has an important place in mental field education. The interests, desires, curiosity, and research feelings of gifted children in the field of science are signs of their future success (Tereci et al. 2008). However, in Turkey, there are only studies that examine the science attitudes of gifted students in terms of students 'gender, educational areas, class levels, and families' education level (Tereci et al. 2008).

Genetic differences seen in a population with a frequency higher than 1% are expressed as polymorphism. Polymorphisms are not causes of disease, but may be causes of susceptibility to disease. There are many genetic polymorphism studies conducted in diseases such as phenylketonuria, Alzheimer's, Prader-Willi Syndrome, William's syndrome, Down Syndrome, schizophrenia, psychosis, autism, dementia. Compilation studies based on intelligence focused on genetic polymorphisms in these diseases and mostly studied on the 2q, 6p, 7, 21, 22, X chromosomes. There are very few studies on genetic polymorphisms in intellectually gifted children (Celec et al. 2013; Durdiakova et al. 2013).

Celec et al. (2013) examined the polymorphisms in the Androgen Receptor (AR), Estrogen receptor (ESR), Sex Hormone Binding Globulin (SHBG) genes of (Intellectually gifted children) special talents between 2013-2015, and statistically significant results were determined. It was found by the same researchers that there was a significant decrease in the number of AR gene CAG repeats in children with special abilities (Intellectually gifted children).

The AR gene is a 10667 base pair gene with 8 exons on the Xq12 chromosome (URL1; URL2). It corresponds to a protein consisting of 920 amino acids (URL3). This gene is a hormonally regulated transcription factor that mediates a wide variety of biological processes (Liao et al. 2003). The functional polymorphism of the AR gene is known to have a higher DNA binding activity resulting in a stronger androgen signaling of shorter alleles. As the number of CAG repeats increases, the transcriptional activity of the androgen receptor functions as a transcription regulator (Celec et al., 2013). In two studies, the relationship between CAG polymorphism and cognitive abilities was examined, and it was reported that fewer CAG repeats will show a stronger androgen signal (Celec et al. 2013; Durdiakova et al. 2013).

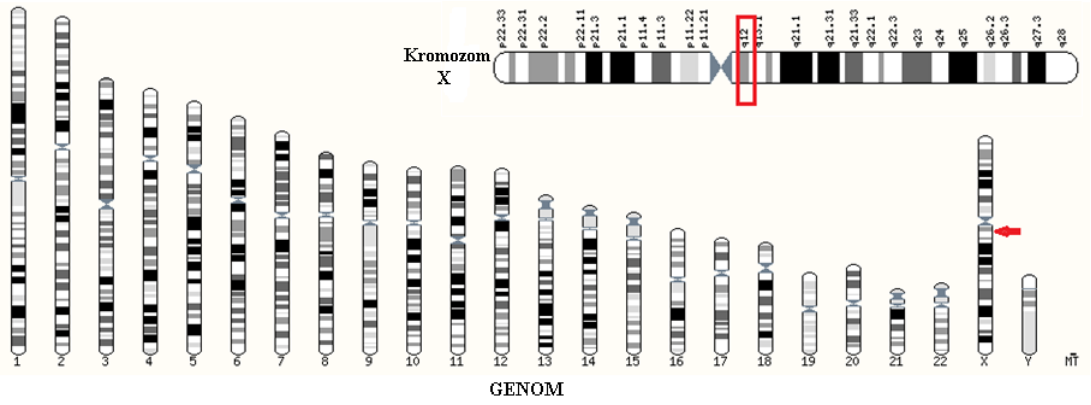

Photo 1

Location of the Androgen Receptor Gene in Human Genome (URL4)

Giftedness and Science Attitude

Studies on special talents and their attitudes towards science were examined. Among these studies, Tereci et al. (2008), a study on the gender, education levels, fields of education, educational status of the family and science attitude of the primary and middle school level students with special abilities who are studying at the Science and Art Center (SAC); (Orbay et al. 2010), the study examining the relationship between the gender, class levels, family education status and attitude towards science of gifted students attending SAC; the study by Keser and Kalender (2016) in which the attitudes towards the science of the students who continue the "support education program", "individual abilities noticeable program" and "special skills program" in SAC; and the study by Camcı Erdoğan (2013), in which the attitudes towards science were analyzed, with the sample of 11 specially gifted female students; draw the attention.

Within the world literature; Harty and Beall (1984), examined the attitudes towards the science of 25 gifted and 25 normally developing students at 5th grade in Indiana; Al-Hemaisan (1985) conducted on science achievement, attitudes toward, learning motivation, and divergent creativity on academically gifted or non-gifted male students in a middle school in Saudi Arabia; Afro-American middle school students' attitudes towards science were investigated by Yong in (1992); Caleon and Subramaniam (2008) investigated the attitudes towards science in terms of enjoying science, career preference and social content, with groups of students with medium, above-medium intelligence and

special talent; Bo-eul and Chi-soon (2014) compared between gifted and general elementry school students' scientific attidues and deree of satisfaction about school science lessonss of science in South Korea; studies appear before us.

In the studies conducted in SAC, it is seen that gifted students attending different stages of primary education are compared within their own sub-groups, generally examined in terms of their gender, family education status and their attitudes towards science, and studied with small samples. Similar to our work in the world, Harty and Beall's (1984) article appears, but it is seen that a very small sample is used.

Photo 2

Gifted Students in Science Acitivity Environment

Problem of Study

This research objective is to determine whether there is a relationship between this gene region and the attitude towards science by examining the attitudes of gifted students towards science and the AR gene CAG repeat polymorphisms in Kocaeli. This study is the first study in Turkey in which attitudes towards science and genetic research were carried out on gifted students, and it is thought that it will guide those who want to do research in this field in the future.

Materials and Methods

Research Design

This study was carried out by using the relational survey model in order to investigate the AR gene CAG repeat polymorphisms of gifted and normally developing students and to determine its relationship with their attitudes towards science. Survey models are research approaches that aim to describe a past or present situation as it exists. The event, individual or objects subject to the study are tried to be defined as they are (Karasar, 2007).

Participants

The research was conducted in Kocaeli province borders in 2017-2018 and 2018-2019 academic years. The study group consisted of 100 students randomly selected at the 5th-grade level and 100 students with normal development, a total of 200 students. The identification of gifted students was carried out by the Guidance Research Center (GRC), a department administered by Ministry National Education, with the WISC-R intelligence test, and those with an IQ level of 120 and above were included in the study.

Data Collection Tools

The study was conducted with two different data collection tools. These are:

Science and Technology Lesson Attitude Scale

The "Science and Technology Course Attitude Scale", which was developed, validity and reliability tests was done by Yaşar and Anagün (2009), was applied to 100 students with special talent and 100 students with normal development.

For 5th grade students, each item was evaluated with the five-point Likert scale, which is expressed as Strongly agree (5), Agree (4), Neither agree nor disagree (3), Disagree (2), Strongly disagree (1).

Data entries were made as positive sentences were valued from 5 to 1, negative sentences from 1 to 5. It was assumed that the students participating in the study behaved sincerely and objectively while answering the data collection tools. The highest 95 points indicate the most positive attitudes and the lowest 19 points indicate the most negative attitudes. Neither agree nor disagree option expresses neutral attitudes with an unknown direction. Scores below 57 points towards negative attitudes, scores above 57 points towards positive attitudes.

The five-point Likert-type Science and Technology Course Attitude Scale, developed by Yaşar and Anagün (2009), consisting of 19 items and three factors, was used to determine students' attitudes towards science. The validity and reliability studies of the scale were conducted on 849 fifth-grade students randomly selected in Eskişehir city center. Cronbach's alpha reliability coefficient was 0.89, KMO Barlett coefficient for structure validity was 0.3. As a result of the factor analysis, it was observed that the scale was gathered in three factors. The factors were named as pleasure, desire to learn and social content of science based on the literature (Yaşar and Anagün, 2009). The total Cronbach's alpha reliability coefficient of the scale for the sampling (N = 200) was calculated as 0.867.

Genetic Analysis

DNA Isolation, Polymerase Chain Reaction and DNA Sequence Analysis

In children in the 5th grade, 200 µl of saliva fluid was collected in sterile tubes 30 minutes after cleaning the mouth and teeth with a disposable toothbrush from 200 individuals, including 100 experiments (diagnosed with special talent) and 100 controls (with normal development). Saliva samples were kept in cold containers until they were brought to the laboratory for DNA isolation.

DNA isolation was performed using the EURx GeneMATRIX Tissue & Bacterial DNA Purification Kit (Gdansk Poland, Cat no. E3551) following the procedures recommended by the company. Primers for AR gene CAG repeat polymorphism were as follows: 5'-GCGCGAAGTGATCCAGAAC-3' (forward) ve 5'-CTCATCCAGGACCAGGTAGC-3' (reverse) (Durdiakova et al., 2013). 5x FIREPol Master Mix (Solis BioDyne) was used to prepare the PCR reaction mixture. PCR reaction mix 5x Master Mix: 6µl, 10 µM primer (sense): 0.5 µl, 10 µM primer (antisense): 0.5 µl Mold DNA: 2 µl were used. Bidistillated water was added to 30 µl for the PCR mixture of the gene region. PCR steps were involved: 4 min at 94°C (pre-denaturation), 35 cycles at 94°C for 45 s (denaturation), 45 s at 59,5 °C (annealing), 45 s at 72°C (extension), and 10 min at 72°C (final extension). The amplified AR gene CAG repeat polymorphism PCR products were then for 30 minutes at 100 volts in 1,5% agarose gel electrophoresis and visualized with a UV transilluminator by using Safe-T staining (ethidium bromide alternative).

PCR products were purified by the BM Lab in accordance with the kit procedures used with the ExoSAP-ITTM PCR Product Cleanup Reagent (Thermo Fisher Scientific, USA) purification enzyme. Sequence analysis was performed by using sense and antisense primers of the purified PCR products of the AR gene CAG repeat polymorphism. For the Sanger sequencing, the ABI 3730XL Sanger sequencing device (Applied Biosystems, Foster City, CA) and the BigDye Terminator v3.1 Cycle Sequencing Kit were used in the Macrogen Netherlands laboratory. Genotypes were determined by displaying with the chromas 2.6.6 program for the CAG repeat numbers of the AR gene.

Analysis of Data

Power analysis was performed using the G * Power 3.1.9.4 program to determine the sample number of the study. The study conducted by Celec et al. in (2013) on AR gene CAG repeat polymorphisms of specially gifted children was examined. The sample size they used in this study was found to be alpha = 0.05 and 1-Beta = 0.98 as a result of the power analysis performed by considering N1 = 67 (control) and N2 = 95 (experimental group). When the 1-Beta value was examined, it was seen that the total sample size of the study (N = 200) was a good value.

SPSS 22.0 software was used for statistical analysis. Kolmogorov-Smirnov test was conducted to look for the normal distribution of the numbers of AR gene CAG repeat polymorphism between the experimental and control groups. Then, the non-parametric test, Mann-Whitney U (M-W) Test was applied. The average of ranks and totals of ranks were determined and analysis was made at the level of p = 0.05.

Kolmogorov-Smirnov test was used for the normal distribution of the science lesson attitude scale according to the intelligence level. The numbers of AR gene CAG repeats of specially gifted and normally developing students were grouped and compared statistically with the total scores of the scale. For this, Celec et al. (2013), the CAG numbers were divided into 3 groups as 16-20, 21-24, and those containing 25 or more numbers. The groups are named as "CAG16-20, CAG21-24, and CAG25-". The Scale Code is divided into two groups as “19-56 and 57-95”, since scores above 57 points towards positive attitudes and scores below 57 for negative attitudes. Then, binary logistic regression was performed to determine the relationship between scale total score values and the number of AR gene CAG repeats and to calculate the risk ratios (odds ratios) at 95% confidence interval (CI).

Ethics Committee Approval

For the AR gene CAG repeat polymorphisms of the sample groups in the study, the permission of Kocaeli University Faculty of Medicine 2017/375 KÜ GOKAEK Non-Interventional Ethics Committee was obtained. Later, the approval of the Ministry of Education and the Governorship was obtained, dated 30.04.2018 and numbered 99332089-605.01-E.8616597. Then, the study was carried out by obtaining permission from parents and students. This study was supported by Kocaeli University Scientific Research Projects Unit (2018-105).

Results

In the first dimension of the study, which was conducted on two groups of students studying in the 5th grade with gifted sturdent and showing normal development, the groups were examined in terms of attitudes towards science. In the second dimension, genetic research was conducted and it was investigated whether there is a statistically significant difference between the groups in terms of the number of AR gene CAG repeats.

The results of the research regarding the science attitude scale applied to the gifted and normally developing groups are shown in Table 1.

Table 1
Mann-Whitney U (M-W) Test Results in terms of Factors of Science and Technology Course Attitude Scale of Students with Special Abilities (Gifted) and Normal Development

Factors	Group (n)	Rank Avg.	Rank Sum.	Median Value	Mean ± sd	U	p
Factor 1	Gifted (100)	100.72	10072	36	34.44±6.14	4978	0.957
	Normally developing (100)	100.28	10028	36	34.14±6.33		
Factor 2	Gifted (100)	114.32	11431.5	33	31.44±3.96	3618.5	**0.001***
	Normally developing (100)	86.69	8668.5	30	27.02±8.40		
Factor 3	Gifted (100)	100.05	10004.5	18	17.60±2.90	4954.5	0.909
	Normally developing (100)	100.96	10095.5	18	17.45±3.13		
(Scale Total)$_n$	Gifted (100)	110.3	11029.5	87	83.48±11.69	4020.5	**0.017***
	Normally developing (100)	90.71	9070.5	82.5	78.61±14.18		

Avg.: Avarage; sd: standard deviation; *statistically significant when p <0.05.

When Table 1 was examined, no statistically significant difference was found between the results of the gifted students and the students with normal development in terms of Factor 1 "enjoyment" and Factor 3 "social content of science" scores (U = 4978.00, p = 0.957 and U = 4954.50, p = 0.909 respectively). When factor 2 was analyzed in terms of "desire to learn" scores, it was observed that there was a statistically significant difference between the two groups (U = 3618.50, p = 0.001). While the factor 2 mean scores were 31.44 in the gifted group, it was 27.02 in the normally developing group; It is seen in Table 1 that the median values are 33.00 and 30.00, respectively. Considering the mean rank, it is understood that the attitudes of the gifted students are higher in terms of factor 2 than the students with normal development.

Table 1 shows that there is a statistically significant difference when gifted students and students with normal development are examined in terms of scale total scores (U = 4020.50, p = 0.017). While the mean of the total scores of the scale was 83.48, the average of the total scores of the students with normal development was 78.61. The median for gifted students was 87.00, while the median for students of normal development was 82.50. Considering the mean rank, it is understood that gifted students have higher attitudes towards science than students with normal development.

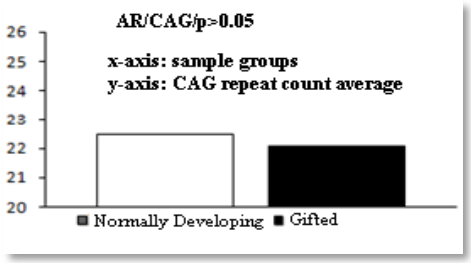

Figure 1
Bar Graph Showing the Average Number of AR Gene CAG Repeats in Individuals with Normal Development and Special Talents (Gifted)

Table 2
Findings Related to the Differences between the AR gene CAG Repeat Numbers of Gifted and Normally Developing Students

Group		Rank Avg.	Rank Sum.	Median Value	AR (CAG)$_n$ Avg.± sd		
Gifted	89	89.75	7987.50	22.00	22.45±2.98	3982.50	.302
Normally Developing	98	97.86	9590.50	22.00	22.07±2.91		

Avg.: Avarage; sd: standard deviation; *statistically significant when p <0.05

In the genetic dimension of the research; despite the repetition of the experiments, samples that were thought to be contaminated due to the problems experienced while taking samples or during laboratory experiments were not included in the study, and therefore, the study continued with 89 students with special talents and 98 students with normal development (Table 2). When Table 2 and Figure 1 are examined, it was found that there was no statistically significant difference between the group with special talents and the group with normal development (p = 0.302) and the median value was 22.00 in both groups.

Table 3

Frequency Distribution of Gifted and Normally Developing Students in terms of AR Gene CAG Repeat Polymorphisms

AR gene CAG Repeats	Gifted N=89 (%)	Normally Developing N=98 (%)	Total N=187 (%)
16-20	24 (27)	19 (19)	43 (23)
21-25	58 (65)	69 (70)	127 (68)
26-35	7 (8)	10 (11)	17 (9)

Table 4

Dual Logistic Regression Results Showing the Relationship between the Number of AR Gene CAG Repeats and the Total Scores of the Scale Towards Science and Technology Lesson Attitude

AR-CAG(n)	Scale Code (19-56) n=12 (%)	Scale Code (57-95) n=175 (%)	Crude values		Adjust values (Gender, intelligence level, number of siblings)	
			p value	OR (CI %95)	p value	OR (CI %95)
AR-CAG$_{16-20}$	2 (17)	41 (23)	-	-	-	-
AR-CAG$_{21-24}$	9 (75)	105 (60)	0.781	0.707 (0.061-8.168)	0.414	0.496 (0.093-2.662)
AR-CAG$_{25-}$	1 (8)	29 (17)	0.397	0.402 (0.049-3.307)	0.728	1.573 (0.122-20.219)

*statistically significant when p <0.05

The frequency of the AR gene CAG repeats in both groups was examined (Table 3). In total, students with 21-25 CAG repeats in the AR gene constitute 68% of our study sample, 16-20 CAG repeats constitute 23%, and students with a CAG repeat number between 26 and 35 are 9% of our study sample. Based on this, it was examined whether there was a relationship between the CAG repetition numbers and the scale total score values for science attitude. The related binary logistic regression analysis results are shown in Table 4. Scores below 57 points towards negative attitudes, scores above 57 points towards positive attitudes. The neutral score that can be obtained by the student who uses the expression "Neither agree nor disagree (3)" in all items of the science and technology lesson attitude scale was used as the threshold value. When Table 5 was examined, a statistically significant result could not be obtained in the analysis performed considering variables such as gender, intelligence level, and number of siblings, as well as between the number of CAG repetitions and scale total score values (p> 0.05).

Discussion

Every activity students do by putting themselves in the shoes of scientists and the experiments they carry out in the laboratory environment encourage them to have a positive attitude towards science. As a result of the diagnosis of gifted children, the difficulties students experience while adapting to the role assigned to them and the changes in their mood and environment, could affect the children. The problem of self-confidence in learning and developing science processes in science, combined with the daily challenges they face in class, can cause children to create prejudices against science. Difficulties of given science learning tasks can affect the social, psychological, and emotional dynamics of children. The experiences and these dynamics of normally developing children will not be the same. However, if the same conditions, environment, and experience are provided, similar results can be obtained in terms of attitudes.

Items in factor 1 measure students' ability to enjoy science and technology lesson. When the results were examined, there was no difference between the two groups of students in terms of enjoying science lessons. Orbay et al. (2010), in a study they conducted, investigated the attitudes of gifted students attending the science and arts center in Amasya towards science depending on variables such as their gender, education areas, class levels, and educational status of families. There was no statistically significant difference between the specified variables and gifted students' attitudes towards science.

In a study conducted by Cürebal (2004), it was reported that the 8th grade students' scores were higher than the 9th and 11th grade students' scores among the academic grade levels in terms of the factor of enjoying science lesson, and this difference was found to be statistically significant. It was stated by the same researcher that the science lesson in 8th grade is a lesson in which the most interesting and entertaining subjects are included. In our study, we found that there was no significant difference between two groups with the same grade level (5th grade) in terms of enjoying science lesson, that the same science course subjects were taught in formal education institutions, and at the same time, students were supported with concrete experiments and activities. It is thought that every student can enjoy science lessons regardless of their intelligence level. In a study conducted by Yong on African-American middle school

students, it was observed that students perceived science as interesting, entertaining, and enjoyed attending science classes (Yong, 1992).

Keser and Kalender (2016), in their study in terms of the attitudes towards the science of students who attend the "support education program", "individual abilities awareness program" and "special abilities program" in SACs where gifted students are educated, "special skills program" found a statistically significant difference between continuing students and those who attended the "support education program". They stated that the attitude scale scores of the students who attended the "special skills program" were higher than the scores of the other students, and they attributed these students to their intense desire to learn, their orientation to activities, experiences, and even branches in line with their interests. The fact that there is a significant difference between the results of gifted students and students with normal development in terms of Factor 2 "desire to learn" scores in our study ($U = 3618.50$, $p = 0.001$) is in parallel with the studies of Keser and Kalender (2016). It is known that individuals with special talent have high motivation and focus power in the field they are interested in (Akça et al. 2018). This result supports the curiosity of gifted individuals and their desire to learn by asking too many questions.

In our study, in terms of "Social Content of Science" (Factor 3) scores, no statistically significant difference was found between the results of gifted students and students with normal development (Table 1, $U = 4954.50$, $p = 0.909$). Caleon and Subramaniam (2008), analyzed the groups' attitudes towards science in terms of social content in their study, in which the sample was composed of average, above average and gifted students in terms of intelligence levels, and they did not find a statistically significant difference between the attitudes of above-average and gifted students.

In the study conducted by Cürebal (2004) in terms of the "Social Content of Science" factor in a total of 163 gifted students at four different grades (eight, high school preparatory, nine and eleventh grades), no statistically significant difference was found.

Harty and Beall (1984), in their study in Indiana, examined the attitudes of 5th-grade students with special ability (25) and normal development (25) towards science, and in terms of scale total scores, there was a slightly positive attitude among the gifted students between the two groups. Although they have a tendency to exhibit, they could not detect a statistically significant difference. Although there is a similar study with this study, the results obtained are different. Its; It is thought that it may arise from differences such as sample size, population, education system, curriculum contents, intelligence diagnosis methods, socioeconomic level, and technology. The sample size is 4 times the research done in Indiana. Harty and Beall (1984), used the "Iowa Tests of Basic Skills" (Hieronymus, Lindquist, and Hoover, 1979) tests for general abilities and the "Cognitive Abilities Test" (Thorndike and Hagen, 1979) tests for cognitive abilities. The same researchers thought that the procedures for selecting gifted students were not done correctly at that time.

Tereci et al. (2008), in a study by the gifted primary education I. and II. It has been observed that there is no significant difference between the total science attitude scores of the level students according to their gender, education levels, education fields, and educational status of the family. In this study, the sample group consists of gifted children and normally developing students. When the attitudes of individuals at normal development level and individuals with special talent are compared to science, it is seen in Table 1 that the scale average scores of the gifted individuals are higher in terms of the total scores of the science and technology lesson attitude scale. According to this research, it can be stated that gifted students have positive attitudes towards science. As a matter of fact, Tereci et al. (2008) states that students' attitude to the lesson will affect their success and participation rates. In the study of Camcı Erdoğan (2013), the sample of which was composed of 11 gifted female students, the attitude towards science was examined and it was stated that the students showed high attitudes in terms of scale total scores. Caleon and Subramaniam (2008), in their study with average, above average, and gifted student groups in terms of intelligence levels; Attitudes towards science were investigated in terms of enjoyment of science, career choice, and social content, and all attitude subscales gave significant results in terms of scale total scores. The study of Caleon and Subramaniam (2008), in which the attitude towards science is examined, supports the results of the scale total scores analysis of this research.

The relationship between the number of CAG repeats in exon 1 of the Androgen Receptor gene and the transcriptional activity of the androgen receptor is inverse. The higher the number of CAG repeats, the lower the transcriptional activity of the androgen receptor. Shorter alleles generate stronger androgen signaling and display higher DNA binding activity (Ding et al. 2004).

Celec et al. (2013), conducted a research on boys between the ages of 14-15 in Bratislava. They were "gifted" ($n = 95$-gifted boys, IQ = 143.2 ± 9.6) and control ($n = 67$, IQ = 112.5 ± 14, 8), performed DNA isolation by taking intraoral epithelium samples from the group. Then they studied 6 single nucleotide polymorphisms consisting of

different gene regions and CAG repeat polymorphism located in the exon 1 region of the AR gene. Although there was a small difference between the two groups in terms of CAG repeat numbers, they found a statistically significant result ($p<0.03$). Celec et al. (2013), no statistically significant result was found between the AR gene CAG repeat polymorphism between the "gifted" and "normally developing" groups (Table 2, Graphic 2, $p = 0.302$). This may be due to the differences in the distribution of polymorphisms between populations. For example, Ryk et al. (2011), reported that the eNOS gene -786> C promoter polymorphism in the Swedish population would increase 3 times more in bladder cancer patients, but in a similar study conducted in the Turkish population, it was observed that there was no statistically significant difference (Polat et al. 2016).

When the relationship between the number of all AR gene CAG repeats in both groups (Table 3) and the scale total score values for science attitude was examined (Table 4), there was a statistically significant difference between the number of AR gene CAG repeats and the scale total score values in attitude towards science (Table 4). No result was obtained. Similarly, a statistically significant result was not obtained in the analysis performed by adding the AR gene to CAG repeat numbers in variables such as gender, intelligence level, and number of siblings.

According to Asbury and Plomin, according to the information obtained from twin studies, there is a definite component between mathematics ability and genetics. Low mathematical ability may be affected by the same genes that affect normal variations in ability (Asbury and Plomin, 2016). While the intelligence level of twins is 20% similar in the mother's womb, the intelligence levels of non-twin siblings show a 5% similarity rate. The common point reached as a result of the studies is that approximately 50% of the IQ level is determined by inheritance, less than 5% is shaped by the environment shared with siblings - the family. No information has been found in the literature regarding the relationship between the gene and interest in science. In future studies, the interest in science, science ability, and different gene regions can be examined and contribution to the literature can be made.

Conclusion and Suggestions

It is very important to direct students to educational strategies that will enable them to become individuals who adopt a creative thinking style that can go beyond certain patterns and can use their potential at the top level. By developing multiple skill areas, the interests of students should be determined, and studies should be carried out to improve the skills of individuals who show high success in science.

As a result, according to the science and technology lesson attitude scale data in this study, no significant difference was found between gifted students and students with normal development in terms of the factors of enjoyment of science and the social content of science. A statistically significant difference was found in favor of special talents in terms of learning desire and scale total scores. In the genetic analysis, no statistically significant difference was found in AR gene CAG repeat polymorphisms between the two groups of students and their attitudes towards science.

In Turkey, no evidence of any genetic polymorphisms sample of the work created by the gifted children. There are only a few studies on this subject in the world. This study is the first genetic study conducted with gifted individuals in Turkish society.

In addition, it is the first study in which attitudes towards genetics and science were examined together. Studies on science ability and genetics will close the gap in the literature. Researchers interested in this field may be advised to study ESR2, SHBG, CYP19A1, CYP19A1, ESR1, SRD5A2 gene, that are thought to be related to intelligence, in a larger sample including parents or twins. In the future, revealing the genetic profiles of individuals with special talents in various societies and evaluating them by using both intelligence tests and genetic information may lead to new researches in this field.

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Compliance with Ethical Standarts

Conflict of interest. The authors declare that they have no conflict of interest. ***Statement of compliance with standarts of research involving humans as subjects.*** All applicable international, national, and/ or institutional guidelines for non-invasive clinical studies were followed.

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Research Article

Digital immigrants, digital natives and digital learners: Where are we now?

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Abstract

Students' competencies in clinical practice is vital in health sciences. Clinical simulation is one approach used to support students' learning in clinical practice. There is a lack of research on clinical simulation in acupuncture programmes in the African context. This paper explored the experiences of students' views towards clinical simulation in the acupuncture programme to strengthen clinical teaching using the Technological Pedagogical Content Knowledge Framework as a theoretical lens. A qualitative research approach with an interpretivist paradigm was adopted. A single case study design was selected. Six undergraduate students voluntarily agreed to participate. The data were analysed inductively using the thematic analysis approach. Findings revealed that students were optimistic about clinical simulation because it assisted them in their practice. The findings highlighted students' views regarding the lack of knowledge and skills among instructors and poor infrastructure. The study also found that students gained more confidence in the clinical simulation since they were aware that the patients are not harmed. It is recommended that clinical simulation should be included and standardised in the acupuncture curriculum. To improve clinical simulation, the authors recommended that clinical simulations should be carefully planned and coordinated; training facilities needed upgrading to accommodate Covid-19 regulations and a detailed handbook on clinical simulation should be developed to standardise the simulation process.

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Introduction

"limiting screen time" is considered, among many parents, a necessary educational tool aimed to help their children learn. This punishment is quite popular among many parents – whether their children ae gifted or not. Parents are also quite sure, most of the time, that this punishment is "for the child's own good", as it helps any child to learn better, complete school tasks, including homework and preparing for tests, as well as reading. Parents usually believe that limiting computer time helps getting enough sleeping time, adopt healthier life style, including eating well, socializing, doing sports, and leaving home for outdoor activities. In many families "screen prevention" is considered the only effective punishment. Parents is these families explain this situation saying: "the child does not care about any other punishment, but not being able to use their smartphone for one single day makes them crazy".

On the other hand, computers have been a useful – unavoidable mean for learning in all developed countries for at least two decades. This tendency has been intensified since the beginning of 2020, when the covid-19 pandemic has forced many educational systems, even those who had series objections against "learning by computers", to transfer to online learning. Furthermore, educational gaps among the "more digital" and less digital" countries, cultures and societies have been substantially increased during the last two years. For many students, especially those from high SES, online learning opened new opportunities for deep learning, subject- and even grade skipping, early entrance to university, accelerated learning while still in high- and even grade-school, better preparing for contests, Olympiads and other competitions, and easier access to them as they all transferred to online events. Individual learning of any

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preferred subject, in one's own pace, has also increased as more and more online opportunities opened, and the gifted have been the first school population to adopt them.

This allegedly contradiction, between the positive and the negative aspect of th accelerated digitalization due to the covid-19 pandemic has aroused serious issues for parents of the gifted. This keynote is to shed some light on the issue of parenting gifted children who have been born into the "computer era" and how the covid-19 pandemic influenced it. It is also to discuss already-existing beliefs, world-views and values of digital immigrant parents with those of their native digital children.

Short History of Digital General Gap Digital Native Children Versus Digital-Immigrant Parents

More than a quarter of a century ago, Tunbridge (1995) had wrote about digital natives versus digital immigrants: "[…] generally speaking, at this stage, if you're over 25, you're an immigrant. If you're under 25 you're closer to being a native, in terms of understanding what it is having a real basic sense of it" (p. 2). Six years later, with the publication of the two-part Prensky (2001a,b) article "digital natives, digital immigrants" these terms have become accepted by the scientific community as differentiating between those who use computers for work, leisure and entertainment, education, communication and everyday tasks, and those who do not (e.g. Creighton, 2018; Goodson, Knobel, et al., 2002; Lankshear & Bigum, 1999; Rakhmawati, & Kusuma, 2015; Rodley, 2005; Rowan, Knobel, et al., 2000; Selwyn, 2009; Tapscott, 1998, 2009).

As times passes the population living in our modern world without using screens on a daily basis becomes smaller every day. However, there is still a difference, between digital natives, who prefer using their mobile telephone, their desktop- or their portable computer as their preferred tool for ALL tasks, and digital immigrants, who also use them, but prefer not to when possible. This second group if far from being homogenous; it includes people who would use the phone, even when it takes a longer time, for payments, setting appointments, etc., and others who will still prefer reading from actual books, for example, even though they are very good at all practical, everyday possibilities the computer offers. Those belonging to the second group use also, in many cases, telephones for actual conversations, being used to listen to others, feeling the other even when not seeing them; shops – for "the experience of shopping", and some even like the chatting with the cashier at the supermarket from time to time even though they are quite good at using the automatic cashier that scans their groceries. Digital immigrants tend also to ask their children, or their grandchildren, for help when having "problems with the computer". Some of them do not even try to solve "computer-problems" on their own, even when they are quite good with other machines or home instruments...

But apparently the time of the massive use of "digital natives" and digital immigrants" has also almost passed, as even before the covid-19 pandemic started more and more natives "joined the club". Thus, many new terms have been suggested. "Digital learner" has been probably the most successful one (e.g. Bennett, Maton, & Kervin, 2008; Gallardo-Echenique, et al., 2015; Rapetti, & Cantoni, 2010), maybe because it suggests a process rather than a rigid situation – a learner is improving when time passes, and so is the level of digitalization of everybody who becomes more and more fluent in "the world of screens". There has also been an understanding that though chronological age has some correlation to the level of digitalization (e.g. Gallardo-Echenique et al., 2015; Palfrey, & Gasser, 2008), its relevant is not that important, as had been first suggested. They argue that "digital native"]is a social and not a generational issue (e.g. Bullen & Morgan, 2011; Bullen, Morgan, & Qayyum, 2011; Rapetti & Cantoni, 2010). Bullen and colleagues (ibid) concluded that there was no empirical basis for the notion of "digital native". According to them, this term could have been used for classifying of social class which might have had influence on educational issues. Corona-time had indeed strengthen their claim as it showed that educational gaps have widened mainly due to differences in access to digital means.

Using the term "digital learner" switched the focus from just age to characteristics such as level of computer-expertise, intensity of computer-using, or the time-duration spent at the computer for various purposes, such as work, play, or social communication (Czerniewicz, & Brown, 2012; Gallardo-Echenique et al., 2015; Palfrey, & Gasser, 2008). The main argument for this claim has been the fact that chronological age might influence digital literacy, but it is just one single factor among many who have an impact on the ability of any individual to "fit in", to be a part of the digital world.

Thus, it can be concluded, that while the terms "digital immigrants" and digital natives" have served us in the 90ies and into the first decade of the 21st century, "digital literacy" is a more proper name for now, but will probably in use just for a limited time in the future. "Digital literacy" has many definitions. For example: According to Pangrazio (2016), it consists of three elements: the ability to take ideological and digital concerns into consideration while adopting the person's affective response; the ability to cope with collective concerns about inequalities and translating them to individual practices, and the ability to nurture technical expertise and knowledge in the service of critical

thinking. Pangrazio et al. (2020) have discovered that the meaning of "digital literacy" was different in three countries: Australia, Sweden, and Argentina.

The term "digital literacy" started being used almost simultaneously by many organizations, educational systems, business and professional organizations and political individuals representing a variety of institutions: state, city/municipal, or world-wide. For example: ALSC: Association for Library Service for Children (1999/2004) had used it in the context of Media Mentorship in Libraries Serving Youth, aimed to "help support children's librarians in their role as media mentor to children and their families. […] children require mediated and guided experiences with digital media for the experiences to translate into positive and productive *digital literacy skills*" [my italics – H.D.]. Another example is the work of Seglem (2009), which was called: It's like having a library, and you don't get to go. Educators negotiating boundaries when working with new literacies. Libraries helped man people have access to all written documents; screens have made it possible for everybody to be more literate by increasing access to ALL kinds of information and data.

Teaching Computer Science in School: The Education System is Chasing Its Own Tail

Computer science is a comparatively new school subject. But unlike basic subjects, which all students, gifted, slow or in-between must learn in order to improve their knowledge, understanding and achievements, very often gifted and high-ability students had a better understanding of than their teachers. This has been the situation until 2019; the covid-19 pandemic has showed it clearly, exposing the fact that many teachers had serious problems switching to distant-teaching, many students became in charge of handling the difficulties caused by their teachers lack of digital skills, and subsequently many parents became aware of the fact that both their demand in participating in the zoom-learning in general and in computer science classes in particular did not make so much sense any longer. The issue of parents and teachers' authority regarding school work became a very serious one.

Here is an example of the influence of digital literacy on gifted Israeli students due to the covid-19 pandemic and its consequences on their parents.

Israel is justifiably known as "the start-up nation" (e.g. Senor, & Singer, 2011; Yerman, 2019). On the other hand, the achievements of Israeli children in all international examinations – in mathematics, science and literacy has been gradually deteriorated since 1963/4, when it had the best scores among the 12 developed countries participating in the first TIMSS test until the last PISA 2018 (e.g. David, 2008, 2014, 2015, 2020). This deterioration goes along with the Jaffe-Hoffman (2021) estimation that about a half of Israeli children, mostly Ultra-Orthodox and Arab, get third-world education. The digital gap is responsible for a large part of this situation, but the fact that many teachers have not accepted to any university contributes to it as well (Ben-David, 2021).

But while both sub-populations, Arabs and Ultra-Orthodox could have made a substantial progress during the covid-19 lockdowns (e.g. Cohen & Scheer, 2020), parents of Ultra-Orthodox gifted children have had a greater problem, as many of them objected to e-learning (e.g. Rosenberg et al., 2021). Many Ultra-Orthodox schools who objected to using computers transferred to teaching by telephone, but this has limited the possibilities of individual learning, or learning at one's own pace, which is necessary for the gifted. In addition to these problems common to all the gifted who had not access to available computers gifted children – especially girls – in the Ultra-Orthodox community had in many cases home responsibilities both in the everyday household and in taking care of their younger siblings, which was a necessary task in families with an average of 7.1 children, more than twice as the average Israeli family (Cahaner & Malach, 2019). Larger families are positively related to poorer computer availability (Rabinovitz, 2020). In a reality of negative correlation between the family size and the income level (Sheva, 2021), the children most suffering were both raised in larger- and lower SES families. The gifted, more mature child in such families suffered mostly during the covid-19 crisis.

Covid-19 and the Gifted: Literature Review

The literature about the impact of the covid-19 pandemic on gifted education is very poor. It consists mainly of two parts: quantitative and mixed studies done in several Muslim countries or countries with either a majority of Muslims, such as Albania (Hyseni Duraku, & Hoxha, in press) or Saudi Arabia (Aboud, 2021). Other studies done in the US had focused on the emotional effects of the pandemic (e.g. Amend et al., 2020; Support for gifted learners at home during covid-19, 2021). There is quite a number of American studies on distant learning for the gifted, but almost all of them had been done before the covid-19 pandemic emerged into our life (e.g. Olszewski-Kubilius, & Corwith, 2010; Potts, 2019; Ravaglia et al., 1995; Thomson, 2010; Wallace, 2005, 2009). The one that was completed during the pandemic (Hawthorne, 2020) was designed before the beginning of the pandemic, and the burst of the covid-19 influenced it mainly y worsening the connectivity of the internet due to massive use when lockdown started.

The Influence of the Covid-19 Pandemic on Higher Education in Israel and the Opening of New Opportunities for a Fast Academic Track for the Gifted

Towards the beginning of the 2021/22 school year almost all higher education institutions reported about sharp increase in the number of new candidates (Frenkel, 2020). As three was a substantial decrease of available jobs and the "traditional" "big tour" of the Israeli who has just finished her or his obligatory military service, the option of higher education became more popular. Another reason for the increase or candidates who have registered to higher education institutes, for example, about 35% at the Tel Aviv University (ibid), has been the change in the acceptance policies, that enabled acceptance relying solely on the matriculation certificate without having to take the psychometric examination (Trabelsi Hadad, 2020).

These changes opened new opportunities to many gifted children, and parents of gifted, who had, until the burst of the pandemic, trusted the "system" and did not look at early entrance to higher education as an option for their children, had changed their mind because of the long lockdowns, the boredom of learning by zoom, the inability of their children to participate in afternoon extra-curricular activities, and the understanding that when the education system fails to supply the needs of all students, their children were to suffer more due to thei more needs, more extensive learning, and their ability to learn without school intervention. In addition, while the Israeli Open University had always offered online classes and excellent written materials, practically all universities followed it and thus it physical access to higher education institutions were not necessary any longer for more than a year, which made it much easier for young gifted students. Thus, the open university in Israel reported of a 30% increase in the number of school age students between the 2019/20 and 2021/2022 school-years (Klein, 2021). There were reports about similar increase elsewhere (e. g.

However, other studies dealing with the influence of e-learning on gifted students reveal a different picture. For example, the results of Aboud's (2021) study on 30 gifted students in Saudi Arabia and 15 of their parents were that both outcomes were negative. The parents felt a heavier psychological burden because of school closures and isolation, and home conflicts increased. The children experienced sleep disorders, depression, isolation, frustration, and loss of motivation. Most gifted students were not satisfied with their e-learning either, experienced it as inefficient and lacking in effectiveness and connections. Similar findings were found in study of 20 gifted students and 10 of their parents in Albania (Hyseni Duraku, & Hoxha, 2021). In my opinion such outcomes point at the fact that during "normal" school time, namely, before the beginning of the covid-19 pandemic, schools were doing quite a good job supplying the need of the gifted. In addition, the results can indicate that teachers and schools in general were not well prepared for e-learning, and the problems gifted children experienced during e-learning, such as inexperienced teachers, lack of computers, maybe lack of privacy at their own homes and at their teachers' might have also contributed to their negative experience of e-learning. A similar influence of e-learning was observed in all students – gifted or non-gifted, school-age or those learning in higher education institutes. For example: in Jordan, university students from remote and disadvantaged areas had to overcome substantial challenges, such as technological accessibility, poor internet connectivity, and harsh study environments (Alsoud, & Harasis, 2021).

When inequity of education grows, gifted education and emotional support for the gifted are pushed away

Resources for Educators & Parents During COVID-19

Note: When you click on the titles/articles, you can redirect to the relevant site

https://www.nagc.org/resources-publications/resources/resources-educators-parents-during-covid-19
National association for Gifted Children:
NAGC seeks to provide information to educators, parents, caregivers, and mental health providers who are supporting gifted children during this unprecedented time. NAGC has turned to trusted partners, such as state gifted associations, publishing partners, and/or leaders within the gifted community, for recommended resources. However, the information provided here, except those resources published by NAGC, have not been vetted by the association, nor should they be viewed as an endorsement or as approved by NAGC. *Updated 6/1/20*
Free Webinars & Live Chats
COVID-19 Research

Teaching Online: Best Practices, Technology & Tools
https://www.nagc.org/teaching-online-best-practices-technology-tools
Online teaching: Best practices
What are best practices in remote learning? How can the new *NAGC PreK-12 Gifted Programming Standards* be applied to online education? These resources provide administrators and educators research-based frameworks in determining policies, protocols, and tools for serving gifted students during this sudden shift from classroom to at-home learning. *Updated 5/8/20*

107 Free E-Learning Tools for Teachers in the Digital Classroom. More than 100 open source and free e-learning/online tools to help teachers keep students engaged.

Best Practices for Teaching Online. Laurel Springs School has more than 150 teachers and almost 30 years of distance learning experience as a school. During this COVID-19 pandemic, the school offers a best practices guide on what works when trying to engage students online and know how to create an atmosphere of communication conducive to the online world.

Ditch that Textbook Digital Summit. Professional development for gifted educators! 50+ presentations from a free, online virtual conference for educators by educators. Includes dozens of speakers from all walks of education, printable PDF notes from each session, and loads of resources. Topics range from pedagogy to technology to problem-based learning and creativity. Recommended by Dina Brulles, Interim Governance Secretary, NAGC Board of Directors.
EdPuzzle. This tools allows teachers to incorporate the use of video in lesson plans. Find a video, add questions, and assign it to your class. Provides analytics to measure comprehension, engagement, and accountability. Also, be sure to check out their "Teaching Today" blog that includes "The Best Teacher Podcasts," which includes great tips you can use in your classroom today, interviews with experts, and more.

Making a Sudden Transition to Teaching Online: Suggestions and Resources. SAGE Publishing has drawn from its large body of published and peer-reviewed research to offer these resources from various journals—free of charge through April 30—to serve teachers and students around the world.

Online and virtual learning research, from the *Gifted Child Quarterly* archives:
Edinger, M. J. (2017). Online Teacher Professional Development for Gifted Education: Examining the Impact of a New Pedagogical Model. *Gifted Child Quarterly*, *61*(4), 300–312.
Potts, J. A. (2019). Profoundly Gifted Students' Perceptions of Virtual Classrooms. *Gifted Child Quarterly*, *63*(1), 58–80.
Stoeger, H., Hopp, M., & Ziegler, A. (2017). Online Mentoring as an Extracurricular Measure to Encourage Talented Girls in STEM (Science, Technology, Engineering, and Mathematics): An Empirical Study of One-on-One Versus Group Mentoring. *Gifted Child Quarterly*, *61*(3), 239–249.

QM Emergency Remote Instruction Checklist (K–12 Education). This checklist from Quality Matters is a tiered list of considerations, tips, and actionable strategies to enact during an institutional move to temporary remote instruction of classroom-based courses.

QM Emergency Remote Instruction Checklist Explained. This 3-minute video explains how higher education and K-12 checklists can assist educators as a job aid when moving to remote instruction in an emergency.

Remote Teaching Solutions. To help educators navigate the challenge of transitioning to teaching online, SAGE Publishing is offering free access to various resources—such as eTextbooks, Learning Management System resources, SAGE Vantage Courseware, and publication articles—that can aid in setting up and managing online courses quickly and successfully.

Renzulli Learning Free Subscription. In response to the COVID-19 situation, through the end of the 2019-20 school year, Renzulli Learning is offering free access to its platform that provides schools a remote learning solution to support students while they are homebound.

The Art of Instruction: TIPS for Taking Your Course Online. Lyn Fairchild Hawks, director for curriculum and instruction for Duke TIP's distance learning programs, offers best practices in planning and delivery of online instruction.

PreK-12 Enrichment & Educational Resources

Social-Emotional Support
https://www.nagc.org/social-emotional-support
As COVID-19 forces us to face new norms like social distancing, remote learning, and shelter-in-place orders, gifted children may exhibit increased anxiety, sadness, intense feelings, and out-of-the-ordinary behavior. These resources offer parents and educators strategies for talking with gifted children about COVID-19 and in helping children navigate their emotions, behaviors, feelings, family interactions, and friendships through this challenging time.
Updated 5/29/20

Parent TIP Sheet

Supporting Your Gifted Child During COVID-19. This brand new TIP Sheet gives parents, caregivers, and educators strategies for helping gifted children manage their feelings, sadness, and anxiety during the COVID-19 pandemic. Special 4-page version includes strategies for children at each developmental age.

NEW! Supporting Your Gifted Child During COVID-19 (Español). El COVID-19 nos obliga a adaptarnos a nuevas normas como el distanciamiento social, la educación a distancia y el encierro. Ante esto, los/as niños/as y adolescentes superdotados pueden experimentar un aumento de ansiedad, tristeza, emociones intensas y comportamientos fuera de lo común.

Articles & Blogs
COVID-19 and Anxiety in Gifted Children. While gifted individuals are no more anxious than the general population, these uncertain times can cause anxiety and worry, especially when there are fewer intellectual pursuits in a day. With school closures and social distancing, it is important to help children develop a sense of purpose that can guide them as they deal with the unknown. (Kate Boonstra, March 23, 2020)

Cultivating Calm Amidst a Storm. How to calm our mind, body, and nervous system in the presence of a global health crisis. (Nicole A. Tetreault, Ph.D., March 18, 2020)

Helping Your Child Manage Stress Through Mindfulness.This article, written directly to teens and tweens, helps gifted adolescents understand mindfulness and the formal/informal pathways to mindfulness. Includes apps, books, and online resources for kids. (Michele Kane, Ed.D., *Parenting for High Potential,* Dec 2017)
Management of Anxiety Begins at Home. General article that focuses on the sources of anxiety in gifted children and what parents can do to help reduce anxiety at home. (Sal Mendaglio, Ph.D., *Parenting for High Potential,* Summer 2016)
Videos & Podcasts
Top 3 Strategies for Helping Your Child to Cope With Anxiety During Challenging Times. This interview with Michele Kane, Ed. D., and Patricia Steinmeyer, IAGC Executive Director, packs in many more than three strategies in under 20 minutes.
Video: Coping with the Stress of COVID-19: Tips for Families with Gifted Children. Edward R. Amend, Psy.D., of The Amend Group in Lexington, KY, shares thoughts and tips for parents and children as they navigate a new world with the coronavirus pandemic.
Special Solocast: Thought on Parenting Differently Wired Kids Through a Pandemic. Special short episode in which Tilt Parenting host Debbie Reber shares thoughts and ideas for contemplation surrounding parenting differently wired children through the coronavirus pandemic.
Resources & Evidence-Based Practices
Parenting in Time of COVID-19: From World Health Organization, CDC, UNICEF & Others. To help parents interact constructively with their children during this time of confinement, these six 1-page tips for parents focus on planning one-on-one time, staying positive, creating a daily routine, avoiding bad behavior, managing stress, and talking about COVID-19.
Coronavirus Disease 2019 (COVID-19) Resources. Collection of resources curated by the National Association of School Nurses, including *Teaching Students and Families During COVID-19, Guidance for School Principals & Superintendents,* and *Talking to Children About COVID-19: A Parent Resource* in English, Spanish, Chinese, Korean, and Amharic.
Health Crisis Resources from the National Association of School Psychologists (NASP). This microsite contains numerous resources for various audiences navigating the COVID-19 virus—including special guides for school administrators, crisis response teams, mental health professionals, and parents.
Parenting with Resilience in Unsettling Times. Advice for how parents can manage their own worries and fears, assess what we can and cannot control, and how to talk with our children during the COVID-19 pandemic. (Dr. Dan Peters, *Psychology Today*, March 16, 2020)
Resources for Supporting Children's Emotional Well-being During the COVID-19 Pandemic. Guidance, recommendations, and resources provided by child trauma experts at *Child Trends* and the Child Trauma Training Center at the University of Massachusetts.
Talking to Children About COVID-19 (Coronavirus): A Parent Resource. Also from NASP, this provides guidance to parents in teaching children positive preventive measures, talking with them about their fears, and giving them a sense of some control over their risk of infection to help reduce anxiety.
Teacher, Interrupted: Leaning into Social-Emotional Learning Amid the COVID-19 Crisis Psychologists from the Yale Center for Emotional Intelligence offer social and emotional learning (SEL) evidence-based practices to help educators, parents, and students get through these difficult times. (Christina Cipriano and Marc Brackett, *Ed Surge.* March 18, 2020)

The first journal dealing solely with digital literacy was already founded in 2010 (International Journal of Digital Literacy and Digital competence (IJDLDC), the PISA 2015 and PISA 2018 were still examining the "traditional" reading, mathematics and science ability of 15-year old in 72 and 79, respectively, countries and economies, as well as "financial literacy" (OECD, 2016, 2019). Only PISA 2021 examined students for digital literacy (OECD, 2021). Digital literacy, according to it, is:

Literacy in the 21st century is about constructing and validating knowledge. Digital technologies have enabled the spread of all kinds of information, displacing traditional formats of usually more carefully curated information such as encyclopedias and newspapers. The massive information ow of the digital era demands that readers be able to distinguish between fact and opinion. Readers must learn strategies to detect biased information and malicious content like fake news and phishing emails (ibid, p. 2014).

[SAVI 2021 Evolving-networks-of-human-intelligence]
Gallardo-Echenique el al., 2015, p. 171: Bullen and colleagues, who supported the term "digital learner" early on, reviewed the research on "Digital Natives" conducted in six different countries and at a range of different institutions, and concluded that there is no empirical basis for the notion of digital native. They argue that it is a social and not a generational issue and that the implications for education are far from clear (Bullen, Morgan, Belfer, & Qayyum, 2008; Bullen & Gallardo-Echenique el al., 2015). The assumption that students – **born roughly between 1980 and 1994 – have "natural" digital skills, is not commonly-accepted**. Generalizations based on "generational differences" are not useful for discussions concerning teaching and learning. Gallardo-Echenique et al., 2015, p. 156. *We also need to take into account young people with less skills in the use of technologies, the conditions of access and use of information, the neglect of the impact of contextual, economic, political, social, historical and cultural factors that increase the so-called "digital gap" between those who have access to the information and those who do not.* Factors such as gender, education, experience, social inclusion and exclusion, culture, institutional context, subject discipline, learning design, and the socio-economic background of students are far more important and researchers have only recently begun to examine them (Kennedy et al., 2010; Margaryan et al., 2011). Hence, "It is time to put the digital natives discourse to rest and focus on digital learners" (Bullen & Morgan, 2011, p. 66).

Personal note

During the last 20 years, in each presentation, lecture or discussion with parents of gifted children the issue of "too much computer time" has been raised. First it was about "computers games", and was defined as a problem in families with teenagers. Gradually it has been transformed to "too much screen time" problem and children concerned became younger and younger. The last two years, with covid-19 crisis, seemed, among many families, to be a main cause of the "screens addiction", as I have heard time and again, but when looking deeply into the situation the picture might be different: indeed, the lockdowns and the tension have increased the screen-use, indeed, e-learning, especially for gifted children, made access to their home computer, their laptop or their telephone more accessible, but "too much time at home" and "keeping the children busy" cannot be blamed for any addiction but rather – for a solution that "is always there". for able students who have been studying 5 days a week mainly by zoom, had not been effective (e.g. Dattel, 19/9/20) and many had just turned their computers on but did not participate in the classes at all (the Ministry of Education has not approved of opening the camera during zoom meetings, e.g. Pinchas, 14/12/20), so many school students close their cameras and the most frequent reason for doing it, as had been found by Baratz (n.d.), is "doing something else during classes". If this had been found among the general population, prospects are much higher that the gifted would feel bored, as "learning is the opposite of boredom and learning is the antidote of boredom" (Kanevsky & Kanevsky, 2004, p. 20). The gifted child, who is prone to boredom at school at all times (e.g. Assouline, Lupkowski-Shoplik, & Colangelo, 2018; Siegle, & McCoach, 2018) would be much more bored during zoom classes,

Another example is also computer related: many children have too much screen time, but gifted children, who are good at computers, can infect computers with viruses, make connections with non-safe persons, or learn how to spend money gambling, shopping, etc. before they are 10. Parents of the gifted are challenged as they wish, in most cases, not to stop their children's development in computer's science, programming, etc., but they have to supervise them on a regular basis and be very strict as the gap between their children's technical and scientific abilities and their emotional development is much larger than among the non-gifted.

Screen Time and the Covid-19 Pandemic: What Have We Learnt?

Back in 2016 Pangrazio wrote:

> *We also need to take into account young people with less skills in the use of technologies, the conditions of access and use of information, the neglect of the impact of contextual, economic, political, social, historical and cultural factors that increase the so-called "digital gap" between those who have access to the information and those who do not (p. 171)*

Today we can read it as a prophecy, namely, the notion that as much as information technology is important, as much as having more knowledge about new media, being able to quickly adjust to the latest data, as long as there are inter- and intra- digital gaps, the only certainty existing is that these gaps will widen whenever the system was to be tossed from side to side. We have all just observed it during the covid-19 pandemic, when many populations did not have access to computers, or to online learning, or to more elementary needs – such as medications, equipment and vaccines.

Two Israeli studies examined in the last two years the influence of massive use of digital media on various life aspects. The first (Goldshmidt, 2019) was published before the covid-19 pandemic had burst into our lives; the second (Gershy, 2021) was both conducted and published during the pandemic. However, they both have come to quite similar conclusions: there is no basis for blaming digital media as the main cause of educational, social, emotional problems, neither can these instruments take full responsibility for health- or home- and school discipline issues.

The Goldshmidt (2019) study points at many advantages that digital media have in general; almost all these advantages can be extensively used for gifted children. According to him (ibid), The internet allows remote access to information and services. Online and remote learning, maintaining connections with family members, friends, and colleagues or people who share the same interests, and taking part in social and political discourse. *All these advantages, a*s well as others, such as saving time and money, physical safety, especially for children, ability of parents to supervise, even control the child's connection, *are much more intensified for gifted children and youths*. Gifted children, are, as a rule, less satisfied with school work than non-gifted, and need more cognitive challenges which are hard to satisfy. Online learning, finding others who share the same interests, and exchanging ideas, thoughts, even feelings with others, outside from the immediate familial and social circle, is easily acquired thought screens than in the school, neighborhood and family everyday circles. As for potential negative effects on wellbeing, cognition and learning, interpersonal interactions, depression and anxiety, attention deterioration, screen-addiction and negative physiological influences: in spite of the ongoing debate on these subjects, and in contrast to the prejudice against screens heard

from educators, parents and medical professionals – there is neither transparency regarding the studies published nor consensus as to their results.

The Gershy (2021) study, about the emotional, social and academic influences of extensive screen-time during the covid-19 pandemic was done on 369 parent-child dyads in March 2021, during the third lockdown in Israel. Both parents and children showed substantial increase in screen-time of children in comparison to the pre-covid-19 pandemic. The increase was significant even after the calculation was adjusted, when taking into consideration the online learning time. To the surprise of the researcher, computer-time was not the best predictor of functioning and learning difficulties, but rather the addiction-to-screens level of the child. Functional difficulties were observed only among children whose screen use was not regulated, namely, if they had difficulties to concentrate in other activities, withdrew from important tasks and were highly emotional when not having access to screens. Thus, many children whose screen-time was substantially were, by no definition, screen-addicts. For them, additional screen time was a well-adjusted **response** to a new reality, where all learning and social spaces became unavailable. Thus, extensive screen-use was not a pathology but rather a reasonable option both for socializing and learning.

Regulation of screen-time should be connected to many other issues. For example: what is the child doing during their screen-time? are these uses varied enough according to some criterion? Is screen-time used for nurturing social connections and friendships? Is the child able to regulate their computer-time namely, be in charge of their daily regular activities, such as eating, sleeping, taking care of their hygiene? Is the child able to keep on doing home responsibilities, such as shopping, food preparing – either for themselves or even for younger siblings when necessary? All these questions, and many more, are common to all children. When the child is gifted they should be taught as early as possible to help in everyday house tasks, to become more independent when younger, and to grow up emotionally as soon as possible. Being in charge both on one's own schedule and on one's wellbeing is going to help the gifted child both in their academic path and in their familial and social connections and relationships. Being in charge of one's computer time is a good way to exercise responsibility.

Similar findings have been found in other studies. For example: Paulich et al., (2021) have found, in a nationwide sample of 11,875 participants in the United States, aged 9 to 10 years, from the Adolescent Brain Cognitive Development Study (ABCD Study®), more screen time was only moderately associated with worse mental health, increased behavioral problems, decreased academic performance, and poorer sleep, but it was also positively correlated with heightened quality of peer relationships. Nevertheless, However, effect sizes associated with screen time and the various outcomes were modest; the socio-Economics status of the children was a better predictor of each measure. Thus, the results do not necessarily establish causality, but rather that it unlikely that increased screen time is directly harmful to 9-and-10-year-old children.

Summary and Conclusions

Thus, as much as it is the role of the parents to do anything within their power to help all children to suffer as little as possible from any problem, political or health catastrophes – such as political, health-related of climate-related, it should have been a mutual effort of the whole village – which is the whole world – to do their best for ALL children. But until this happens my advice to the parent of the gifted child is to help them achieve mental balance. This is hard, especially in the time of war, or pandemic, but necessary. The digital world develops quickly whether we like it more or less, and we, as parents, have to accept the fact that our children might be more proficient using whatever it has to offer than we, even when doing our best. But a gifted child, who is – in most cases – more sensitive that other children, needs stability, to be sure they are loved, accepted, and well-nurtured whatever happens. Only by providing home conditions assuring the child that the outer world cannot be as bad as it might be assumed when reading the news, listening to negative forecast or being influenced by internet trolls.

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Research Article

3D printers as an educational tool in gifted education: effective use, problems and suggestions

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Abstract

Nowadays, when the production of knowledge is increasing rapidly, new production technologies have become extremely important to create useful products. The changing human needs and desires to produce many products in a short time enable countries to produce different technologies and integrate them into daily life. The aim of this research is to investigate teachers' and students' views on the educational contributions of using 3D design programs and 3D printers A mixed research method was used within a convergent parallel design. For the quantitative part of the study, a survey was conducted with 108 students. Then, 10 gifted students were randomly selected among the students participating in the survey and interviews were conducted. Interviews were also conducted with 3 teachers worked in Science and Art Centers (SACs) where educated gifted students in Turkey. The data were collected and analyzed through questionnaires and semi-structured interviews. According to the results of the research, it appears that 3D design technologies play an important role in the development of students' knowledge and skills, students use these technologies quite a lot when producing projects or designing the products of their projects, and this situation motivates them in the project production process. In addition, appears that students can print their own course materials to learn.

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Introduction

Technological developments facilitate designing useful products and ensure the realization phases of these products by reducing the duration of access to knowledge and determining new production techniques. Developed countries are societies that produce knowledge and transform this knowledge into new technologies. One thing is true that technology develops rapidly and makes life easier by discovering creative solutions to human needs. Considering the working logic of 3D printers and the change over time, it seems inevitable to benefit from this new technology in many areas (Yıldırım et al., 2018).

Human needs are also changing with the changing world. Therefore, creating new designs in products has become mandatory to satisfy the changing needs of people. The visuality, functionality, and practicality of products come into prominence in preferring products. From this perspective, the design of existing products has gained significance. To add new functional features in products, it is aimed to visualize and transfer products into drawings and transform these drawings into tangible, sensible, and marketable products. However, the use of mental processes stands out in designing products. Designing involves higher-order mental processes such as discovering differences, imagining, inquiring, creative thinking, critical thinking, and reasoning Ministry of National Education of Turkey (MNET) (2006).

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Why Used 3D Printers at Talent Development?

Transformation of the created designs increases both the cost and storage costs. At this stage, 3D printers, which transform 3D designs developed in computer environments into products, provide considerable facilitation to those who design innovative products. The costs of 3D printers have decreased in recent years and will start being used in homes in the near future. Seen as the technology of the future, 3D printers can print out a component you imagine by modeling in computer environments in a matter of hours and eliminate the storage costs. The US president, Barack Obama, noted that 3D printing technology "will create the next industrial revolution" (http://www.hurriyet.com.tr/sanayide-3-boxedyut-devrimi-yasanacak-22592939). The preparation time of designs and their molds, which required several months of work in the past, has been reduced to a few days. When we examine the utilization areas of 3D printers in the world and their examples, they are utilized in many areas, such as:

- Artificial organ production in medical field.
- In the production of artificial tissues using the method of 3D bio-printing with living cells.
- The use of 3D printed components in warplanes in defense industry.
- In the production of products capable of combining vanilla, mint, apple, cherry, and melon flavors with sugar and chocolates in food production.

NASA also sent 3D printers to the international space station to assist astronauts and increase their capabilities.

Utilization Areas of 3D Printers

The current understanding of the workforce requires individuals to have knowledge in many fields. The emergence of a new field of engineering through a combination of several fields of engineering stem from the requirements of this new era. For instance, it may have emerged to educate competent individuals in mechatronics, mechanics, and electronics areas. This workforce often requires more engineering skills. STEM Education, especially in the fields of technology and engineering, has aimed for children to study interdisciplinary from a younger age and the concept of "MAKER" has been put forward at many points where it has deficiencies. In Turkish, however, the word maker is described as "yapan". Characteristics such as inquisitive, creative, solution-oriented, patient, explorer, enthusiastic, skillful, global, and designer are sought in an individual called maker (http://www.makerhareketi.com/). All STEM-related disciplines are considered together as a whole.

3D printers, whose name has been frequently heard in recent years, are used in many sectors. Yıldırım and Çelik's (2018) study also showed that 3D printers have a very wide range of uses and have the potential to be used in almost all areas of science. Productions take place in many areas such as space technologies, manufacturing technologies, health technologies, food production, construction industry, and so forth. Extremely rapid developments are taking place in the aerospace and aviation industry with the utilization of 3D printers. With 3D printers, the prototypes of products in the aerospace and aviation sector can be printed and the one-to-one working principles of the parts can be easily examined, and training on maintenance and repair processes can be carried out practically. In this context, students have examined the technical structure of the differential in details and learned about its tasks and structure. Therefore, graduate students will be able to easily perform maintenance and repair operations on shafts, differentials, and axles in vehicles (Özsoy, 2019). As in all spheres of life, 3D printers are being used in medicine evermore. 3D printers can be used for preoperative examinations in fracture treatments. "The utilization of 3D models offers surgeons advantages by increasing their abilities to perform preoperative simulations. The three-dimensional modeling technique reduces the screw malposition during surgery and increases intraoperative safety by reducing the surgery duration" (Kızmazoğlu et al., 2019).

3D Printers and Education

It also seems that 3D printers are widely used in the field of education. 3D printers are not new technologies. However, their prevalence in daily utilization took some time until the 2000s (Yıldırım, Yıldırım, & Çelik, 2018). Many science and art center students became acquainted with 3D printer technologies, especially in 3D printer ateliers established in science and art centers since 2016. In these ateliers, students learn various design programs in practical ways, and make the products they design tangible by printing them on 3D printers. Further, 3D printers seem to have just started being frequently utilized in activities in The Scientific and Technological Research Council of Turkey Science (STRCTS) and Society Projects. For instance, in a project called the Nature's STEM with Art, carried out in 2016 and 2018 to enable students discover science, technology, mathematics, and engineering applications with artistic elements in the nature, students were offered an opportunity to design available elements in nature, using the 3D design programs and getting their printouts (https://doganinsanatlastemi.weebly.com/).

There are various 3D Design programs. The TinkerCad and AutoCAD programs, commonly used in science and art centers, are used widely. Buhler et al. (2015) classified the 3D design programs from simple to complex as in the following.

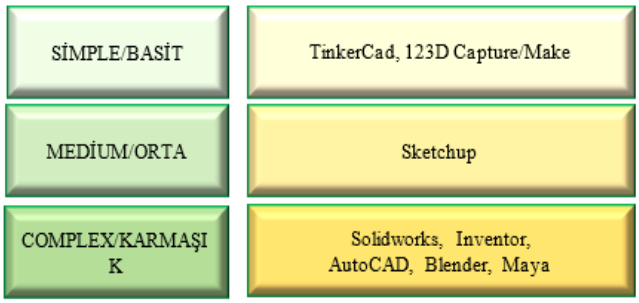


Figure 1

Classified the 3D Design Programs from Simple to Complex (is adopted from Buhler et al. (2015)

Çetin, Berikan, and Yüksel (2019) carried out a formative assessment of students' experiences in the 3D design process and found that students made progress in terms of establishing a part-whole relationship and design skills after the 3D design education.

In their content analysis study on the instructional use of 3D printers, Yıldırım et al. (2018) reported that 3D printers were mostly used in the fields of health and technology, whereas insufficient research was conducted in education. Many studies conducted in education in different countries reported that material design and development stood out more, but few reported that laboratory development stood out more.

Doğan and Uluay (2020) studied the preservice teachers' experiences of using the TinkerCad program. They found that preservice teachers had no difficulty in using this program and that it could be used in science courses.

The 3D design programs and printers are considered as new technologies. As its mechanical structure consists of moving parts, various malfunctions occur and continuous adjustments must be made. In their study with middle school students and their mathematics teacher in a small class with no prior experience with printers, Dickson et al., (2020) noted that the efforts of the students and the teacher to solve the unstructured faults provided them with preliminary evidence for the problems that would occur in the future, and this affected their course achievement.

Given the working principles of 3D printers and the introduction of their varieties in the market in recent years, the number of studies conducted in this area will increase and this technology will be used in many different fields (Yıldırım et al., 2018).

3D design programs mostly operate online and facilitate creating virtual classrooms, allowing students to work collaboratively. Studies concerning the experiences of preservice teachers and students (Doğan & Uluay, 2020; Çetin, Berikan, & Yüksel, 2019) show that the 3D design programs increase students' collaboration, curiosity, and creativity, and that preservice teachers generally hold a positive attitude towards them. Given the models printed by 3D printers appeal to many sense organs, they ensure that learning is permanent (Güleryüz, Dilber, & Erdoğan, 2019).

In the coming years, 3D printers will be used in many courses, especially in technology design, science, and mathematics courses. Today, 3D printers, which are used in many fields, are expected to be used in a wide range of areas, from producing course materials in lessons to printing products specially designed for students' projects. As seen in the studies given above, the purpose of the technology brought by 3D printers is to improve the quality of human life. In this respect, it is very important for a country to produce technology. Finding buyers for the produced technology is directly related to the design. Hence, the vision of the technology and design course curriculum is stated as follows:

"Educate individuals who are aware of problems, generate solutions, have a developed sense of creativity and imagination, construct and express their thoughts, learn to learn, question, are entrepreneurial, open to change and development, and have a developed sense of responsibility to build make their future and that of the society more livable" (MNET, 2006, p.5).

While introducing the concept of Society 5.0, Japan advocates the necessity of Society 5.0 to seek for solutions to its social problems and combat global challenges such as depletion of natural resources, global warming, growing economic disparity, and terrorism. Despite being within the scope of Japan's growth strategy, Society 5.0 corresponds with the 2030 Sustainable Development Goals, jointly approved by 193 member states at the UN Sustainable Development Summit, considering the goals Japan set out (TEDMEM, 2020, p.5). The following figure shows that

3D printer technology is among the main targets of the Japanese government in line with society 5.0 and sustainable development goals.

Figure 2

Sustainable Development Goals and Society 5.0 for SDGs (Fukuyama, 2018)

In addition to STRCTS survey studies, a research study was conducted by the Ministry of Science, Industry, and Technology within the scope of the Turkey Productivity Development Map Project in 2016 with approximately 10,000 enterprises to determine the awareness levels of enterprises regarding industry 4.0 (TEDMEM, 2020). The figure below shows the state of awareness of enterprises about technologies related to the fourth industrial revolution. Research findings show that 3D printing technologies are the area in which enterprises with 20 or more employees have the most intensive knowledge by 49%. In contrast, 51% of enterprises were unaware of these technologies.

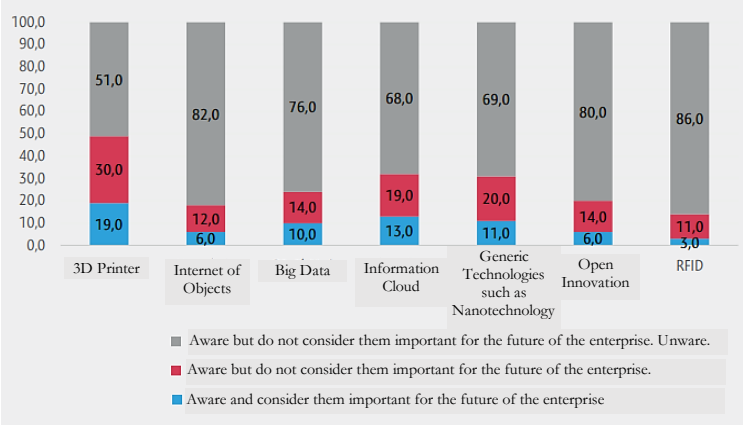


Figure 3

The State of Awareness of Enterprises About Technologies Related to the Fourth Industrial Revolution

Considering the usage of 3D printers in educational environments, they are not among the prioritized technology preferences. The fact that 3D printers appeared a short while ago for the end-user market is one of the primary factors behind why they are not often preferred in the field of education today (Demir et al., 2016). In recent years, they have been in frequent use in science and art centers. The biggest reason for this is the increase in the number of 3D printer ateliers in proportion to the number of science and art centers opened in recent years. There is a limited number of studies in our country on the utilization of 3D printers or the evaluation of products produced with these printers. It seems that studies in Turkey are mostly conducted with university students (Yavuz et al., 2020; Karaduman, 2018; Özsoy, 2019). There are also studies on the educational use of 3D printers in the literature (Choi & Kim, 2018; Chien, 2017; Yamamoto, Hosoda, Satou, Ishiko, & Sawadaishi, 2018; Yıldırım, Yıldırım & Çelik, 2018; Yavuz, Büyükekşi, & Çolakoğlu, 2020).

As the utilization of the technology is new in education and the number of 3D printers is gradually increasing in ateliers opened in science and art centers, conducting this research is very significant. Besides, no study has been conducted to determine the views of students about the 3D design process. Only one study explored the views of students regarding the use of 3D printers. This research is the first study to determine the views of students and teachers doing activities in science and art centers. Therefore, this study is expected to contribute to the literature in terms of obtaining student and teacher views and determining their perspectives on this technology. The purpose of the research is to explore and examine the views of teachers and students on the educational contributions of 3D design programs and 3D printer utilization in a Science and Art Center in Central Anatolia. In respect to this general purpose, the problem statement and sub-problems were formed as in the following.

Problem Statement

What are the views of gifted students and their teachers about using 3D printers as an educational tool?
Teachers and students usage of 3D printers as an educational tools?

Sub-problems

- What are the views of gifted students and their teachers about **effective usage** of 3D printers as an educational tools?
- What are the views of gifted students and their teachers about **encountered problems** at using 3D printers at educational/teaching process?
- What are the **suggestions** of gifted students and their teachers about usage of 3D printers as an educational tools?

Methodology

Research Model

In this research, a mixed-methods research design, described as the combination of quantitative and qualitative methods, approaches, and concepts, was employed (Creswell, 2009). In mixed-methods studies, the aim is to complement the weaknesses of one method by the strengths of the other by using quantitative and qualitative methods together. This way, the validity and reliability of the data collected through both methods will increase (Creswell & Plano Clark, 2011, p.9). As 3D printers are a newly developing technology and have just started to be used in schools, a mixed-method research where quantitative and qualitative data were collected and the findings were synthesized together, was employed in this study to carry out an in-depth and multifaceted examination of students and teachers' views. In this study, which is mostly quantitative-based, a convergent parallel design of mixed-methods research was used. The reason for using this design in the study was to qualitatively evaluate the data obtained quantitatively and to synthesize both data. The research stages were carried out as in the following.

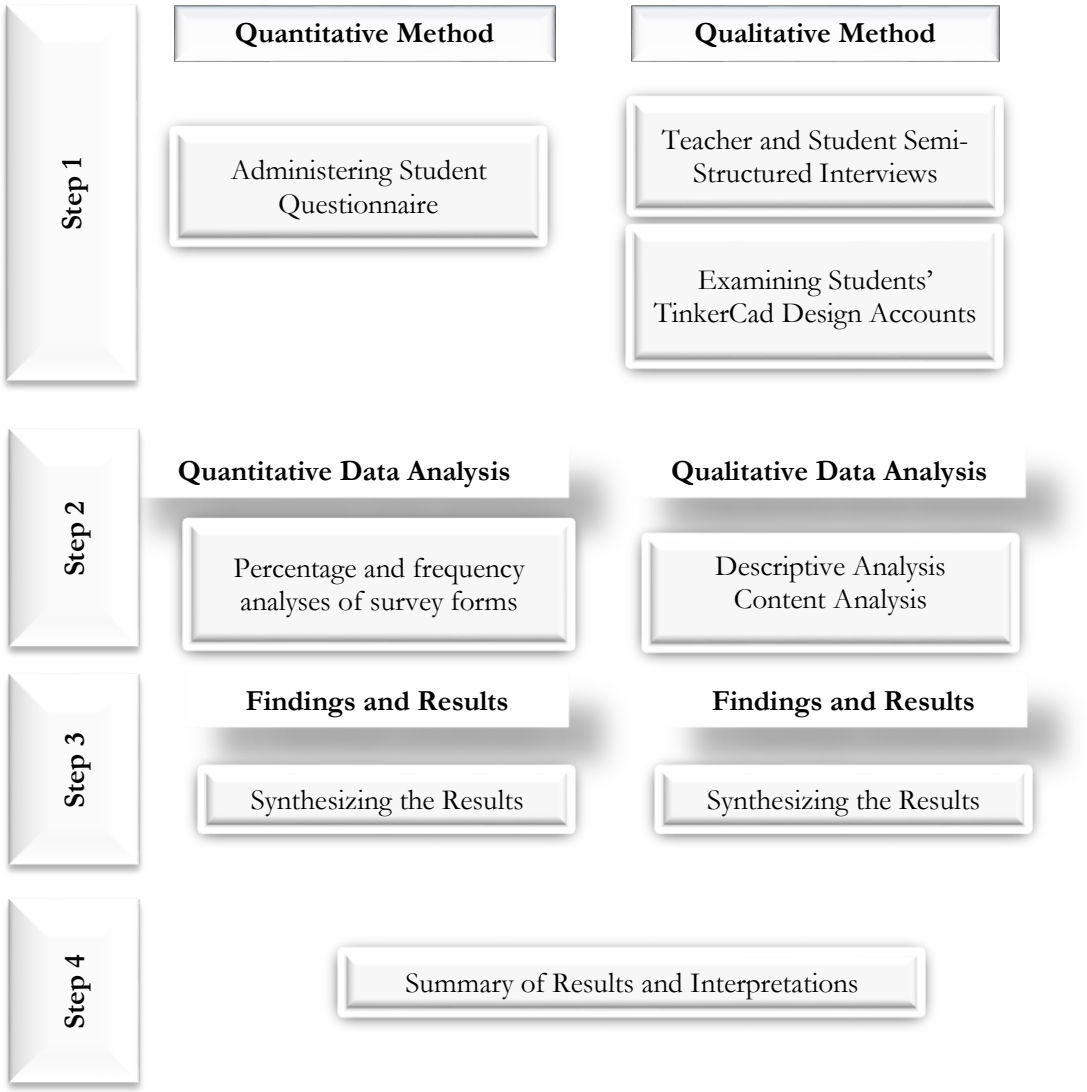


Figure 4

Quantitative + Qualitative Application Process

Validity and Reliability

The validity and reliability for this study were addressed under four headings.

A long-term interaction with participants was established in the research process. In addition, the participants' confirmation and verification of their views were obtained. And, three types of data collection tools were utilized in the study, semi-structured interview, questionnaire, and document analysis. This way, the internal validity of the study was ensured. In addition, expert opinions were obtained and data collection, analysis, and findings plus conclusion and discussion were examined by two experts, and a consensus was reached. Direct quotations were provided in the findings section and the participants' views were directly quoted. In order to make the study transferable, a purposeful sampling method was selected. The reason for the sample selection was that students and teachers had carried out activities using 3D programs and 3D printers for at least half a semester. The target universe of the study comprised 275 students studying at a science and art center in Anatolia, whereas the accessible universe comprised 120 students and three teachers who had experience in 3D programs and printers.

Findings related to the interview and questionnaire forms were presented directly and two researchers' opinions were obtained for the coding consistency. Two researchers separately analyzed the codes, categories, and themes and reached a consensus. In cases where no consensus was made, the coding consistency was examined by computing Miles and Huberman's compliance percentage (Huberman, 2002). Two experts examined the consistency between the study data and results by comparing the results of the study with the data. The steps of validity and reliability studies are given below.

Table 1

The Steps of Validity and Reliability Studies

Validity	**Internal validity Plausibility**	**Obtaining the views of experts**
		Participant confirmation
		Long-term interaction
		Direct quotation
	External validity Transferability	Describing the data collection tools and processes
		Describing the data analysis process
		Describing the characteristics of the study group
		Describing the selection procedure of the study group
		Describing the implementation process of the study
		Describing the researcher's role
		Describing the rationale for selecting the method used
		Describing the validity and reliability measures
		Purposive sampling
Reliability	Internal reliability Consistency	Using a recording device and preventing data loss
		Presenting the findings without interpreting
		Two researchers controlled for the inter-coder consistency
	External reliability Confirmability	Discussing the data in the result section in an appropriate manner
		Checking the consistency between the data
		Checking the data by a third expert

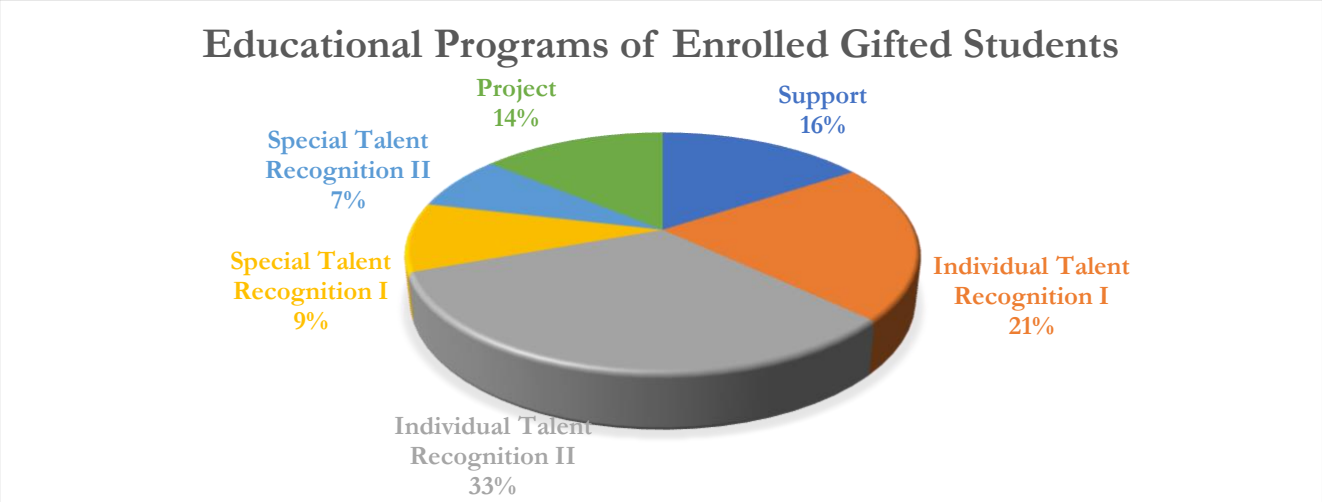
Study Group

A criterion sampling type from purposive sampling techniques was used in this research to determine the study group. Purposive sampling helps discover and describe phenomena and events in many cases (Yıldırım & Şimşek, 2011; 107). Purposive sampling enables conducting an in-depth investigation by selecting information-rich cases depending on the purpose of a study (Büyüköztürk et al., 2016:90). In criterion sampling, the criteria are determined and all likelihoods are plied per these criteria. The criteria could be pre-prepared or determined by the researcher (Yıldırım & Şimşek, 2013). The reason behind choosing the criterion sampling of purposive sampling in this study is the criteria that students and teachers have at least half a semester of experience in 3D design programs and printers. The study group of this research comprised teachers and students receiving education at a science and art center in the Central Anatolia Region in the 2020-2021 school year. Likewise, in the qualitative part of the study, teachers and students included in the interview were determined according to the same criteria and the semi-structured interviews were conducted while collecting the data using questionnaires. Four interviews were conducted in-person and six through online platforms. This is because the science and art centers switched to face-to-face education for a short time and then suspended education due to the pandemic. When selecting the students interviewed, students continuing with their courses and having experience in 3D printing and design were determined on voluntary basis. Ten students and three teachers, who were interviewed, were coded using pseudonyms and complying with ethical rules. Students were coded as IY^{D} in the Support Education Program, MA^{B}, LA^{B}, YU^{B}, RL^{B}, and AO^{B} in the Individual Talent Recognition Program (ITR), $ÜO^{Ö}$ and $UY^{Ö}$ in the Special Talent Development Program (STD), FA^{P} and $UÜ^{P}$ in the Project period, and teachers were coded as RZ^{T}, EA^{F}, and ZZ^{T}. Questions were asked during the interviews to determine the participants' demographic characteristics and their characteristics were determined. The demographic characteristics of the participants are shown in Table 2.

Table 2

The Demographic Characteristics of the Participants

Participant Student	Attending Period	Gender	Participant Teacher	Branch	Gender
IY^{D}	Support	Male	**EA^{F}**	Science	Male
MA^{B}	ITR	Female	**RZ^{T}**	Technology Design	Male
LA^{B}	ITR	Female	**ZZ^{T}**	Technology Design	Male
YU^{B}	ITR	Female			
RL^{B}	ITR	Female			
AO^{B}	ITR	Male			
ÜO^{Ö}	STD	Female			
UY^{Ö}	STD	Female			
FA^{P}	Project	Male			
UÜ^{P}	Project	Male			



ITR: Individual Talent Recognition Program **STD**: Special Talent Development Program

One hundred and eight students, who participated in the survey, 13.9% were in the Support Education Program, 53.7% in the ITR, 9.3% in the STD, and 15.7% in the Project period.

Data Collection Tools

Please create a title for your Questionary for example: Views about Using 3D Printers as an Educational Tools Questionnaire

Views about Using 3D Printers as an Educational Tools Questionnaire

The questionnaire and semi-structured interview forms developed by the researchers were used in the research. Steps relating to the questionnaire study are given in the following figure.

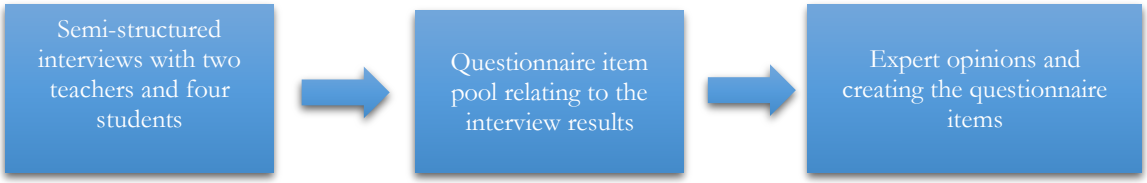


Figure 5

Steps Relating to the Questionnaire Study

The questionnaire prepared for students consisted of 36 items. In the questionnaire development process, the preliminary data were collected with open-ended questions from four students. Eight open-ended questions were emailed to the students in writing due to the pandemic period. Students were determined as ITR, STD, Support, and Project period students, and this way, the questionnaire items were developed with the views of students pursuing their education in different periods at science and art center. The sample open-ended questionnaire questions are "For

what purpose do you use 3D printers and programs?" and "How does using 3D printers make you feel?" As such, a 42-item questionnaire was devised based on student responses, researchers' experiences, and literature review, and then five experts were consulted. The number of items was reduced to 36 after making necessary revisions based on expert feedback. The last version of the questionnaire was examined by three experts and it was ready to use after final refinements. Two of the consulted experts were Professors in educational sciences, one was Associate Professor, one was Assistant Professor, and the other expert was a technology design teacher with around six years of experience at a science and art center who conducted studies with 3D design and programs. Further, the semi-structured interview forms used for teachers in the research consisted of seven questions. When preparing the interview questions, data were collected from two technology design teachers through an open-ended survey method, and the collected data were evaluated by three researchers and the questions were prepared by reviewing the literature. These questions were evaluated by five experts and finalized by making revisions per their feedback. Moreover, the semi-structured interview form prepared for students consisted of six questions. The questions prepared for students underwent the same processes. The following figure shows the preparation process of the semi-structured interview forms prepared for students and teachers. Two open-ended questions were added to the questionnaire form and students' views and suggestions were also obtained in the questionnaire. This way, the data triangulation was ensured.

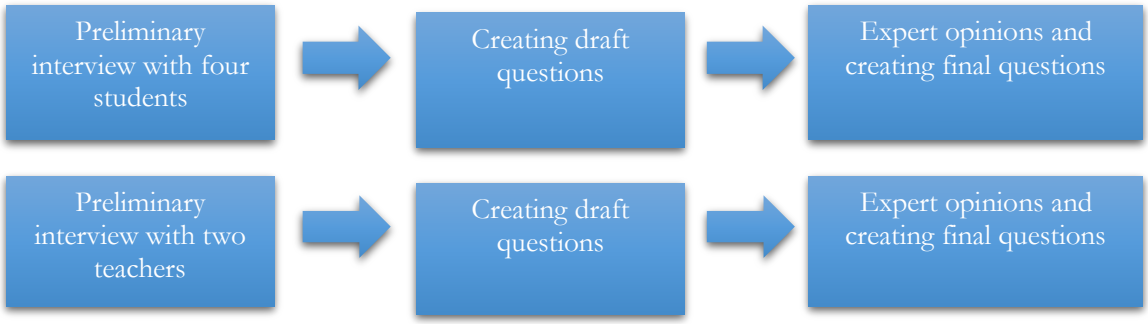


Figure 6

Steps Followed While Preparing Teacher and Student Interview Questions.

Teachers were asked the following open-ended questions: For what purposes do you use 3D design programs and 3D printers in the science and art center (SAC)? What do think about the effect of 3D design programs and 3D printers on SAC support, IRT, STD, and Project students' achievement and motivation? Likewise, students were asked open-ended questions such as what do you think about the effect of 3D design programs and 3D printers used in the SAC on your course achievement? How does using 3D printers make you feel?

Data Collection Process

Some interviews were conducted in-person with students and teachers, whereas some were conducted online. This was because SACs had decided to carry out in-person education at the beginning of the data collection process and then they switched back to distance education due to the pandemic conditions. In this process, five students and one teacher were interviewed in person, but five students and two teachers were interviewed in online environment. In-person interviews were conducted in a quiet environment by talking face-to-face. Student interviews lasted 10-15 minutes. The data collection processes with the questionnaire and interview forms were carried out collaterally. While the questionnaires sent to students through Google form were being completed, the interviews were continued with students. Starting by getting necessary permissions, the process lasted six weeks. Likewise, teacher interviews were also conducted within this period. Teacher interviews lasted 20 minutes on average. Face-to-face interviews were conducted in a quiet environment in a conversational atmosphere and permissions were obtained for the voice recorder. Online interviews were conducted on the date and time specified by the participants through a program frequently used in distance education.

Data Analysis

The study has both quantitative and qualitative dimensions. Percentage and frequency analyses of the data obtained from the questionnaire in the quantitative dimension of the research were conducted. In this respect, the resulting findings were given in the form of frequencies and percentages. Further, the data collected in the qualitative dimension were analyzed through a content analysis method. Conducting content analysis is appropriate when there is no sufficient prior information regarding the research topic (Lauri & Kyngas, 2005). Elo and Kyngas (2007) suggest organizing the data through open-coding, creating categories, and summarizing processes. The reason behind using a content analysis in this study was to uncover the cause and effect relationships and to carry out an in-depth analysis.

In the qualitative dimension of the study, responses given to each question were transcribed. After transcribing the data, the contexts of questions asked in questionnaires and interviews were used when analyzing the data. Responses given to the questions were presented directly, without making any changes. Considering the responses, the codes of questions related to or similar to each other were created and categories were derived. For example, responses such as *the printing is slow* and *the print button is small* that teachers provided to a question regarding the use of printers were considered as codes and evaluated under the "limitations of printers" and this category was included in the theme of *disadvantages of printers*. The data were analyzed by creating themes out of categories. Two randomly selected experts separately carried out the coding process to ensure the internal reliability of the research. This way, Miles and Huberman's (1994) consistency reliability of each item in the open-ended questions form were examined in the content analysis. The reliability values of over 70% indicate that the research is reliable (Miles & Huberman, 1994). The reliability values of students and teachers' views relating to each theme are given in the following table.

Table 3

The Reliability Values of Students and Teachers' Views Relating to Each Theme

	Qualitative Data Content of the Views Form	Miles & Huberman Reliability Value	Miles & Huberman Reliability Percent (%)
1	Views on courses where 3D design programs and printers are used	.100	100
2	Views on the utilization purposes of 3D design programs and printers	.96,42	96
3	Views on programs used in SAC	.100	100
4	Views on the effect of 3D design programs and 3D printers on students	.94,73	95
5	Views on how 3D design programs and 3D printers make students feel	.97,22	97
6	Views on disadvantages of 3D design programs and 3D printers	.92,85	93
7	Views on advantages of 3D design programs and 3D printers	.100	100
8	Views on student opinions and thoughts concerning 3D design programs and 3D printers	.100	100
9	Views on teachers' purposes of using 3D design programs and 3D printers	.87,5	88
10	Views of teachers on advantages of 3D design programs and 3D printers	.90	90
11	Views of teachers on disadvantages of 3D design programs and 3D printers	.93,3	93
12	Views of teachers on 3D design programs and 3D printers taught in SAC	.100	100
13	Views on the effect of 3D design programs and 3D printers taught in SAC	.93,75	94
14	Views on how 3D design programs and 3D printers taught in SAC make teachers feel	.100	100
Average		**96.12**	**96**

Ethic

In the research, the data were collected on a voluntary basis. Individuals unwilling to participate in qualitative and quantitative data collection processes were not included in the research. Personal information collected in the research was only used by the researchers and not shared with anyone else or institutions. No personal identification information was requested from the participants. Necessary permissions were obtained beforehand from the National Education Department to administer the questionnaire to students in the SAC and to conduct the semi-structured interviews. In addition, parent permissions for students participating in the interviews were obtained through official ways by the researchers. Abiding by ethical rules, the names of the participants owning the data were not given and three-letter codenames were given instead. As interviews were conducted with students under 18, verbal permissions were obtained from the parents. Student interviews were conducted after their parents were informed and they were contacted once again for confirmation.

Findings

Quantitative Findings

Table 4

Demographic Information of the Participants

Participant Characteristics	*f*	%
Gender		
Girl	50	46.3
Boy	58	53.7
Age		
8-10 ages	23	21.2
11-13 ages	60	55.6
14-16 ages	17	15.8
17-18 ages	8	7.4
Attending Programs at SAC (Supportive Education for Gifted)		
Support Stage of Education Program	17	15.7
ITR Stage of Education Program	58	53.7
STD Stage of Education Program	10	9.3
Project Stage of Education Program	15	13.9
Attending School Type at Formal Education		
Primary School	17	15.7
Secondary School	76	70.4
High School	15	13.9
Attending Duration to SAC		
1-2 years	21	19.4
3-4 years	52	48.2
5-6 years	35	32.4
Total	108	100

ITR: Individual Talent Recognition Program **STD**: Special Talent Development Program

Per participant characteristics given in the table, f = 50 (46.3%) of SAC students were girls and f = 58 (53.7%) boys. Moreover, 23 students were 8-18, 60 were 11-13, 17 were 14-16, and 8 were 17-18 years old. And f = 17 (15.7) students were in Support, f = 58 (53.7) in ITR, F = 10 (9.3) in STD, and 15 (13.9) in project period. When we looked at school types attended, f = 17 (15.7) students attended to primary school, f = 76 (70.4) to secondary school, and f = 15 (13.9) to high school or schools of similar level. Of these students, f = 21 (19.4) attended SAC for 1-2 years, f = 32 (48.2) for 3-4 years, and f = 35 (32.4) for 5-6 years.

Table 5

Views About the Aims of the Usage of 3D Printers

Items: Aim of Usage	SD		D		U		A		SA	
	f	%	f	%	f	%	f	%	f	%
The 3D design programs and printers we use in SAC help me generate different solutions to the problems I face in daily life.	1	0.9	1	0.9	16	14.8	46	42.6	44	40.7
Activities conducted with 3D design programs and printers we use in SAC increase a sense of curiosity.	2	1.9	0	0	4	3.7	30	27.8	72	66.7
I think the 3D printers are used per their intended purpose.	3	2.8	1	0.9	7	6.5	30	27.8	67	62
I have the opportunity to examine and investigate the outputs I have obtained using 3D programs and printers as tangible and 3D objects.	1	0.9	2	1.9	13	12	38	35.2	54	50

SD: Strongly Disagree, **D**: Disagree, **U**: Undecided, **A**: Agree, **SA**: Strongly Agree

The percentage and frequency table related to the questionnaire items on understanding the purposes of using 3D design programs and 3D printers in SAC directed to students is presented above. According to the table, f = 44 (40.7%) of students strongly agreed with the statement that 3D design programs and printers in SAC help generate

different solutions to daily life problems, f = 46 (42.6%) agreed, f = 2 (1.8) disagreed, and f = 16 (14.8%) were undecided. Further, f = 72 (66.7%) of students strongly agreed with the statement that the 3D design programs and printers used increases my sense of curiosity, f = 30 (27.8%) agreed, f = 4 (3.7%) were undecided, and f = 2 (1.9%) strongly disagreed. However, f = 67 (62%) of students strongly agreed with the statement on whether the 3D printers are used for intended purposes, f = 30 (27.8%) agreed, f = 7 (6.5%) were undecided, f = 1 (0.9%) disagreed, and f = 3 (2.8%) strongly disagreed. Moreover, f = 54 (50%) of students strongly agreed with the statement "I have the opportunity to examine and investigate the outputs I have obtained using 3D programs and printers as tangible and 3D objects.", f = 38 (35.2%) agreed, f = 13 (12%) were undecided, f = 2 (1.9%) disagreed, and f = 1 (0.5%) strongly disagreed.

Table 6

Views About the Preparations for the Usage of 3D Printers

Items: Preparations for Usage	SD		D		U		A		SA	
	f	%	f	%	f	%	f	%	f	%
I would like to take additional courses to feel more prepared for the 3D design programs and printers we use in SAC.	4	3.7	15	13.9	35	32.4	28	25.9	26	24.1
I come to the course by getting preparation before working with 3D design programs and printers.	2	1.9	12	11.1	28	25.9	45	41.7	21	19.4
Preparations made before using 3D printers in SAC take most of my time.	24	22.2	54	50	25	23.1	3	2.8	2	1.9
When I have free time, I watch videos about the utilization of 3D design programs and 3D printers.	17	15.7	32	29.6	26	24.1	29	26.9	4	3.7

SD: Strongly Disagree, **D**: Disagree, **U**: Undecided, **A**: Agree, **SA**: Strongly Agree

According to the percentage and frequency table related to the questionnaire items directed to students to understand whether the utilization of 3D design programs and 3D printers required preparation, f = 26 (24.1%) of students strongly agreed with the statement *I would like to take additional courses to feel more prepared* and f = 28 (25.9%) agreed. However, f = 35 (32.4%) of students were undecided, f = 15 (13.9%) disagreed, and f = 4 (3.7%) strongly disagreed. And, f = 21 (19.4%) of students strongly agreed with the statement *I come to the course by getting preparation before working with 3D design programs and printers*, f = 45 (41.7%) agreed, f = 28 (25.9%) were undecided, f = 12 (11.1%), and f = 2 (1.9%) strongly disagree. Further, f = 24 (22.2%) of students strongly disagreed with the statement *Preparations done before using 3D printers in SAC take most of my time*, f = 54 (50%) disagreed, f = 25 (23.1%) were undecided, f = 3 (2.8%) agreed, and f = 2 (1.9%) strongly agreed. Of these students, f = 17 (15.7%) strongly disagreed with the statement *When I have free time, I watch videos about the utilization of 3D design programs and 3D printers*, f = 32 (29.6%) disagreed, f = 26 (24.1%) were undecided, f = 29 (26.9%) agreed, and f = 4 (3.7%) strongly agreed.

Table 7

Views About the Contribution of 3D Design Programs and 3D Printers to Students

Items: Contributions of the Outcomes	SD		D		U		A		SA	
	f	%	f	%	f	%	f	%	f	%
The 3D design programs' working online helps me to work in collaboration with my friends.	2	1.9	10	9.3	17	15.7	32	29.6	47	43.5
I take on more active roles in lessons by using 3D design programs and 3D printers in SAC.	2	1.9	4	3.7	11	10.2	45	41.7	46	42.6
The 3D design programs and 3D printers in SAC develop my creativity.	1	0.9	1	0.9	4	3.7	21	19.4	81	75
I think the 3D design programs and 3D printers in SAC make abstract subjects or content concrete.	1	0.9	3	2.8	15	13.9	53	41.9	36	33.3
Most 3D design programs' working online (internet connection) provide me facilitations in many issues.	4	3.7	8	7.4	19	17.6	41	38	36	33.3
Using 3D design programs and 3D printers in SAC helps me enter into the production process.	2	1.9	1	0.9	15	13.9	44	40.7	46	42.6
Using 3D design programs and 3D printers in SAC helps gain different perspectives.	2	1.9	2	1.9	7	6.5	41	38	56	51.9
3D design programs and 3D printers in SAC motivate me more in the lesson.	1	0.9	4	3.7	21	19.4	36	33.3	46	42.6
The products produced using 3D printers motivate me towards creating projects.	1	0.9	1	0.9	9	8.3	51	47.2	46	42.6

SD: Strongly Disagree, **D**: Disagree, **U**: Undecided, **A**: Agree, **SA**: Strongly Agree

To understand the contribution of 3D design programs and 3D printers to students, f = 2 (1.9%) strongly disagreed with the statement, *the 3D design programs' working online help me work in collaboration with my friends*, f = 10 (9.3%) disagreed, f = 17 (32%) were undecided, f = 32 (29.6%) agreed, f = 47 (43.5%) strongly agreed. Moreover, f = 2 (1.9%) of students strongly disagreed with the statement, *I take on more active roles in lessons by using 3D design programs and 3D printers in SAC,* f = 4 (3.7%) disagreed, f = 11 (10.2%) were undecided, f = 45 (41.7%) agreed, and f = 46 (42.6%) strongly agreed. Of these students, f = 1 (0.9%) strongly disagreed with statement, *the 3D design programs and 3D printers in SAC develop my creativity*, f = 1 (0.9%) disagreed, f = 4 (3.7%) were undecided, f = 21 (19.4%) agreed, and f = 81 (75%) strongly agreed. Likewise, f = 1 (0.9%) of students strongly disagreed with the statement, *I think the 3D design programs and 3D printers in SAC make abstract subjects or content concreate*, f = 3 (2.8%) disagreed, f = 15 (13.9%) were undecided, f = 53 (41.9%) agreed, and f = 36 (33.3%) strongly agreed. Also, f = 4 (3.7%) of students strongly disagreed with the statement, *most 3D design programs' working online (internet connection) provides me facilitations in many issues*, f = 8 (7.4%) disagreed, f = 19 (17.6) were undecided, f = 41 (38%) agreed, and f = 36 (33.3%) strongly agreed. Moreover, f = 2 (1.9%) of students strongly disagreed with the statement, *using 3D design programs and 3D printers in SAC helps me enter into the production process*, f = 1 (0.9%) disagreed, f = 15 (13.9%) were undecided, f = 44 (40.7%) agreed, and f = 46 (42.6%) strongly agreed. Also, f = 2 (1.9%) of students strongly disagreed with the item *Using 3D design programs and 3D printers in SAC helps gain different perspectives*, f = 2 (1.9%) disagreed, f = 7 (6.5%) were undecided, f = 41 (38%) agreed, and f = 56 (51.9%) strongly agreed. Similarly, f = 1 (0.9%) of students strongly disagreed with the statement, *3D design programs and 3D printers in SAC motivate me more in the lesson*, f = 4 (3.7%) disagreed, f = 21 (19.4%) were undecided, f = 36 (33.3%) agreed, and f = 46 (42.6%) strongly agreed. In addition, f = 1 (0.9%) of students strongly disagreed with the item, *the products produced using 3D printers motivate me towards creating projects*, f = 1 (0.9%) disagreed, f = 9 (8.3%) were undecided, f = 51 (47.2%) agreed, and f = 46 (42.6%) strongly agreed.

Table 8

Problems Encountered in Using 3D Design Programs and 3D Printers

Items: Problems Encountered in Using	SD		D		U		A		SA	
	f	%	f	%	f	%	f	%	f	%
I cannot sufficiently use the 3D printers in SAC, as getting printouts from them takes a long time.	13	12	25	23.1	37	34.3	21	19.4	12	11.1
I experience problems in finding filament in my desired colors and properties for the 3D printers in SAC.	6	5.6	22	20.4	33	30.6	28	25.9	19	17.6
I experience problems while printing out products developed in 3D design programs.	23	21.3	37	34.3	28	25.9	18	16.7	2	1.9
Carrying 3D printers is difficult for me.	11	10.2	31	28.7	34	31.5	23	21.3	9	8.3
I experience difficulty when adjusting the print settings in slicing programs before getting printouts from the 3D printers.	20	15.5	35	32.4	30	27.8	20	15.5	3	2.8
I experience problems in getting printouts because of the small number of 3D printers in SAC.	16	14.8	32	29.6	28	25.9	16	14.8	16	14.8

SD: Strongly Disagree, **D**: Disagree, **U**: Undecided, **A**: Agree, **SA**: Strongly Agree

Table 8 presents the frequencies and percentages of student responses to the questionnaire questions in regard to understanding the disadvantages/problems in using 3D design programs and 3D printers. As per results, f = 13 (12%) of students strongly disagreed with the item on long printing time, f = 25 (23.1%) disagreed, f = 37 (34.3%) were undecided, f = 21 (19.4%) agreed, and f = 12 (11.1%) strongly agreed. To the item on whether students could find filament in desired colors and properties, f = 6 (5.6%) of students stated that they strongly disagreed, f = 22 (20.4%) disagreed, f = 33 (30.6%) were undecided, f = 28 (25.9%) agreed, and f = 19 (17.6%) strongly agreed. Further, to the item on whether students experienced problems when getting printouts from the printer, f = 23 (21.3%) of students stated they strongly disagreed, f = 37 (34.3%) disagreed, f = 28 (25.9%) were undecided, f = 18 (16.7%) agreed, and f = 2 (1.9%) strongly disagreed. Moreover, f = 11 (10.2%) of students strongly disagreed with the item, *carrying 3D printers is difficult for me*, f = 31 (28.7) disagreed, and f = 34 (31.5%) were undecided, whereas f = 23 (21.3%) agreed and f = 9 (8.3%) strongly agreed. To the item directed to students to understand whether they face difficulties when adjusting the print settings in the slicing programs before printing, f = 20 (15.5%) of students mentioned they strongly disagreed, f = 35 (32.4%) disagree, and f = 30 (27.8%) were undecided, but f = 20 (15.5%) agreed and f = 3 (2.8%) strongly agreed. Besides, f = 16 (14.8%) of students strongly disagreed with the on whether the number of 3D printers used in the institution is adequate, f = 32 (29.6%) disagreed, and f = 28 (25.9%) were undecided, whereas f = 16 (14.8%) agreed and f = 16 (14.8%) strongly agreed.

Tablo 9

Emotions Students Feel When Using 3D Design Programs and 3D Printers.

Items: Emotional Status at Using of 3D Printers	SD		D		U		A		SA	
	f	%	f	%	f	%	f	%	f	%
I refrain from using printers in lessons because of the expensiveness of 3D printers.	42	38.9	37	34.3	19	17.6	6	5.6	4	3.7
I enjoy printing out the products I design in 3D design programs from the 3D printers.	1	0.9	1	0.9	4	3.7	24	22.2	78	72.2
Printing out the unique products I design using 3D design programs from printers excites me.	0	0	2	1.9	5	4.6	26	24.1	75	69.4
I prefer using 3D printers in the courses in SAC.	0	0	3	2.8	21	19.4	27	25	57	52.8
I feel comfortable when using 3D design programs and 3D printers in SAC.	1	0.9	8	7.4	16	14.8	43	39.8	40	37
I consider myself competent in using 3D design programs and 3D printers in SAC.	3	2.8	12	11.1	38	35.2	34	31.5	21	19.4
Materials printed using 3D printers increase my interest in the subject.	0	0	3	2.8	4	3.7	38	35.2	63	58.3

SD: Strongly Disagree, **D**: Disagree, **U**: Undecided, **A**: Agree, **SA**: Strongly Agree

Responses regarding the items created to understand students' feelings when using the 3D design programs and 3D printers are given in the table above. Of these students, f = 42 (38.9%) strongly disagreed with the item, *I refrain from using printers in lessons because of the expensiveness of 3D printers*, f = 37 (34.3%) disagreed, f = 19 (17.6%) were undecided, while f = 6 (5.6%) agreed and f = 4 (3.7%) strongly agreed. Also, f =1 (0.9%) of students strongly disagreed with statement, *I enjoy printing out the products I design in 3D design programs from the 3D printers*, f = 1 0.9%) disagreed, and f = 4 (3.7%) were undecided, whereas f = 24 (22.2%) agreed and f = 78 (72.2%) strongly agreed. While f = 2 (1.9%) students disagreed with the statement, *printing out the unique products I design using 3D design programs from printers excites me*, and f = 5 (4.6%) were undecided, f = 26 (24.1%) agreed and f = 75 (69.4%) strongly agreed. And, f =3 (2.7%) of students disagreed with the item, *I prefer using 3D printers in the courses in SAC*, f = 21 (19.4%) were undecided, f = 27 (25%) agreed, and f = 57 (52.8%) strongly agreed. Of these students, f = 1 (0.9%) strongly disagreed with the item, *I feel comfortable when using 3D design programs and 3D printers in SAC*, f = 8 (7.4%) disagreed, f = 16 (14.8%) were undecided, f = 43 (39.8%) agreed, and f = 40 (37%) strongly agreed. Further, f = 3 (2.8%) strongly disagreed with the item, *I consider myself competent in using 3D design programs and 3D printers in SAC*, f = 12 (11.1%) disagreed, and f = 38 (35.2%) were undecided, but f = 34 (31.5%) agreed and f = 21 (19.4%) strongly agreed. In addition, f = 3 (2.8%) of students disagreed with the item, *materials printed using 3D printers increase my interest in the subject*, f = 4 (3.7%) were undecided, f = 38 (35.2%) agreed, and f = 63 (58.3%) strongly agreed.

Table 10

Situations Where Students Get Support While Using 3D Design Programs and 3D Printers.

Items: Need for Support at Using of 3D Printers	SD		D		U		A		SA	
	f	%	f	%	f	%	f	%	f	%
The SAC Administration supports us to use 3D printers.	2	1.9	2	1.9	10	9.3	32	29.6	62	57.4
Our teachers support us to use 3D printers.	1	0.9	0	0	3	2.8	27	25	77	71.3
My family supports me to use 3D printers.	3	2.8	5	4.6	15	13.9	32	29.6	53	49.1
Working with 3D design programs and 3D printers in SAC makes me willing to produce projects.	2	1.9	5	4.6	4	3.7	40	37	57	52.8
Working with 3D design programs and printers may help me select professions like printing technologies/engineering.	5	4.6	10	9.3	24	22.2	39	36.1	30	27.8
When I experience problems regarding the 3D printers in SAC, I get support from my other friends.	3	2.8	9	8.3	26	24.1	45	41.7	25	23.1

SD: Strongly Disagree, **D**: Disagree, **U**: Undecided, **A**: Agree, **SA**: Strongly Agree

Responses that students provided to the items created to understand their states of getting support when using the 3D design programs and 3D printers are given in the table above. Of these students, f = 2 (1.9%) of students strongly disagreed with the item, *the SAC Administration supports us to use 3D printers*, f = 2 (1.9%) disagreed, f = 10 (9.3%) were undecided, f = 32 (29.6%) agreed, f = 62 (57.4%) strongly agreed. Likewise, f =1 (0.9%) of students strongly disagreed

with the item, *our teachers support us to use 3D printers*, and f = 3 (2.8%) were undecided, whereas f = 27 (25%) agreed and f = 77 (71.3%) strongly agreed. With respect to the item, *my family supports me to use 3D printers,* f = 3 stated that they strongly disagreed, f = 5 (4.6%) disagreed, and f = 15 (13.9%) were undecided, whereas f = 32 (29.6%) agreed and f = 53 (49.1%) strongly agreed. Concerning the item, *working with 3D design programs and 3D printers in SAC makes me willing to produce projects*, f = 2 (1.9%) of students stated that they strongly disagreed, f = 5 (4.6%) disagreed, and f = 4 (3.7%) were undecided, while f = 40 (37%) agreed and f = 57 (52.8%) strongly agreed. Further, regarding the item, *working with 3D design programs and printers may help me select professions like printing technologies/engineering*, f = 5 (4.6%) mentioned that they strongly disagreed, f = 10 (9.3%) disagreed, and f = 24 (22.2%) were undecided; however, f = 39 (36.1%) agreed and f = 30 (27.8%) strongly agreed. Lastly, regarding the item, *when I experience problems regarding the 3D printers in SAC, I get support from my other friends*, f = 3 (2.8%) stated that they strongly disagreed, f = 9 (8.3%) disagreed, and f = 36 (24.1%) were undecided, whereas f = 45 (41.2%) agreed and f = 25 (23.1%) strongly agreed.

Two open-ended questions were added to the questionnaire devised to collect the quantitative data from the students and in this section, they responded to the open-ended questions like "If you want to add more, please write." When the responses were examined, 65% of students suggested increasing the number of printers, 45% suggested renewing the computers, 70% suggested spending more time with the printers and getting more printouts, and so forth.

Qualitative Findings

The qualitative were collected both from students and teachers. The data were analyzed under six themes, namely courses in which 3D Design programs and printers are used, their utilization purposes, their benefits to students, problems experienced in the process, emotions felt when using 3D design programs and printers, and suggestions regarding the design programs and printers. However, the qualitative findings relating to teachers were analyzed under six themes, namely utilization purposes, advantages and disadvantages, problems experienced in the process, the effects of the 3D design programs and printers on students, feelings of teachers, plus views and suggestions.

Findings Relating to the Research Question: What Are the Views of Students Studying at the Science and Art Center on Using 3D Design Programs and 3D Printers?

The following table is presented in the light of the qualitative research findings.

Table 11

Codes, Categories, and Views Relating to the Theme of the Courses in Which 3D Design Programs and Printers are Used

Code	Category	f	Views
Technology design	**Disciplines**	**10**	*"As we have to produce a prototype like technology design that we usually do in our projects, we mostly utilize printers in this area."*
Computer		**2**	**FA[P]:** *"We mostly use them in the technology design course, but we also use them in computer and science courses."*
Science		**3**	**AO[B]:** *"I think it is mostly used in technology design and science courses."*

Concerning this theme, during the interviews students were asked "In which courses are 3D design programs and 3D printers mostly used in SAC?" Considering the views of students regarding this question, all students stated that the 3D design programs and printers were mostly used in technology design courses. As seen in the table, they have stated that 3D printers and design programs were also used in science and information technology courses.

Table 12

Codes, Categories, and Views Relating to the Theme of Utilization Purposes of 3D Design Programs and Printers

Code	Category	f	Views
Getting printouts in projects	For Utilization in Projects	**7**	**ÜO[Ö]:** *"I think they are mostly used in design-oriented areas in projects. We had used them to place the sensors under the ground in our project."* *(Questionnaire – Anonymous) "I use the 3D design programs, especially the TinkerCad, in my projects and this helped me win places in STRCTS competitions in Turkey. I won fourth place in the STRCTS Research Project competitions in Turkey by integrating the 3D design into Turkish."*

Hobby	For Personal Purposes	**3**	**FA^{P}:** *"Generally, I make things like home or hobby products that I should obtain quickly without getting out of home or ordering something and waiting until it arrives and similar things using my home printer."*
Relaxation		**1**	
Individual Needs – Things		**4**	
Getting Private Design Printout		**2**	
Study Material	For Learning Purposes	**1**	**AO^{B}:** *"For example, they say let's create a 3D ecosystem, something tangible, but I can design the thing I want to build first in a 3D environment. Therefore, this will be an advantage for me but we have to put it on paper later but I can do this homework first in the 3D program."*
Education		**4**	
Concretizing the Abstract		**5**	**ÜO^{Ö}:** *"Finally, they can touch and feel the design they have made."*

According to the table regarding the utilization purposes of 3D design programs and printers, the ITR and STD period students stated that they mostly obtain the printouts of apparatuses, products, or designs they are going to use in their projects in their science and information technologies courses. Considering the theme of utilization purposes, half of the students stated that they utilized the 3D printers and design programs for the projects. As regards this theme, codes such as Hobby, Individual Needs – Things, Design Printout, Study Material, Education, Relaxation, and Concretizing the Abstract were extracted and these codes were analyzed under the categories of project purposes, personal purposes, and learning purposes.

Findings Regarding the Theme of Programs Used in Science and Art Center

Table 13

Findings Regarding the Theme of Programs Used in 3D Design Programs and Printers

Code	Category	f	Views
TinkerCad	Design Programs	**10**	**AO^{B}:** *"I saw the TinkerCad. I mean we only saw TinkerCad as 3D design but I also tried the Fusion 360 by myself but I put it away for being a bit difficult.*
Fusion 360		**2**	**UÜ^{P}:** *"For a start, we used the TinkerCad and then we used the Fusion 360."*
Cura		**3**	**UÜ^{P}:** *"There are programs like Cura that we use to adjust the designs to the printer to slice."*

The table related to the question "Which programs do you use for 3D design programs and printers in the Science and Art Center?" is given above. In relation to the theme of programs used in SAC, codes such as TinkerCad, Fusion 360, and Cura were created. The codes were placed under the design programs and slicing program category. All students mentioned that they used the TinkerCad program as a design program. Some students also had seen a higher-level program called Fusion 360. Of project and ITR students, **FA^{P}**, **AO^{B}**, and **ÜO^{Ö}** stated that they also had seen a program called Cura, which allows doing several adjustments to print their 3D design products in the printer. Student remarks regarding the theme are given as examples in the table.

Findings Regarding the Theme of the Effect of 3D Design Programs and 3D Printers on Students

Table 14

Code, Categories, and Views Regarding the Effect of 3D Design Programs and Printers on Students

Code	Category	f	Views
Increase in Course Achievement		**6**	**MA^{B}** *"As I create designs, my desire for achievement also heightens and my achievement increases. I can use some of the designs. For example, it increases my achievement in the technology design course."* **FA^{P}** *"I had helped my classmates understand better by printing it in a 3D form from a 3D printer and showing it to them in the class as if it were an experimental and practical lesson."*
Increase in Project Achievement		**3**	**FA^{P}** *"If there is an advantage of having a 3D printer during the prototype making process, the project will work steadily and look more appealing and visually more glamorous compared to other projects from an external perspective, and this is one of the factors that fetches our project and prototype to the fore."*
	Cognitive		
Enable Remembering		**2**	**UY^{B}** *"Yes, because for example when our part is missing, our success is low but when we have more part, our success is higher."* **FA^{P}** *"Having an advantage of owing something like a 3D printer that can turn what you find challenging to learn like issues we can understand abstractly but cannot fully understand into visible and tangible 3D forms helps you understand your lesson even better and help you understand in an even more memorable way."*
Provide Motivation		**3**	**FA^{P}** *"It pushes me towards a feeling as if I have produced a product and succeeded. This makes me more successful in my subsequent works by motivating me evermore and perhaps helps me achieve what I desire by working more determinedly."*
	Affective		
Increase in Interest towards the course		**3**	**UÜ^{P}** *"But when I was getting its printout, I became more interested."*
Provide on Self-Confidence		**1**	**RL^{B}** *"When I create a design, my self-confidence increases and feel stronger."*
Have Fun – Have a Good Time		**1**	

Considering their views relating to the theme of course achievement under the cognitive and affective categories, students used statements like "my achievement increases", "enables remembering", "my motivation increases", "my interest increases towards the course", and "my self-confidence increases." Students expressed that 3D design programs and printers particularly increase their technology design course achievements. Samples relating to students' views are given in the table.

Findings Regarding How Using 3D Design Programs and 3D Printers Make Students Feel

Table 15

Codes, Categories, and Views Regarding the Theme of How Using 3D Design Programs and 3D Printers Make Students Feel.

Code	Category	f	Views
Enjoyable	**Positive Emotions**	**1**	**UÜP** *"I like doing such things. They are fun and enjoyable."*
Fun		**5**	
Give Happiness		**5**	**MAB** *"It makes me happy and I enjoy and I actually like it very much and I closely watch when one of my friends is getting a printout."*
Pleasant- nice		**4**	
Exciting		**4**	
Arouse Curious		**4**	**RLB** *"I am glad. Also, I think it will influence my career choice in the future."*
Satisfactory		**2**	
Appealing		**1**	
Positive Feelings		**3**	**YUB** *"What is good about it is that it is fun. Opposite to all bad things, I become happy. I mean, I feel positive things."*
Feeling Concerned	**Negative Emotions**	**4**	**UYB** *"We apply glue on it to sit on the floor. If it does not sit on the floor, the design may collapse. There is a concern of whether it will collapse or not."*
Impatience		**1**	

The following code emerged per students' views concerning the theme of how using 3D design programs and 3D printers made students feel under cognitive and affective categories: enjoyable, fun, give happiness, nice, pleasant, exciting, arouse curiosity, satisfactory, appealing, and positive feelings, feeling concerned, and impatience.

Findings Regarding the Advantages and Disadvantages of 3D Design Programs and 3D Printers

Table 16

Codes, Categories, and Views Regarding the Advantages and Disadvantages of 3D Design Programs and 3D Printers

Code	Category	f	Views
Nozzle Clogging	**Mechanical Problems**	**1**	**UÜP** *"Problems occur in mechanical terms. Software problems do not often occur. What I just said are generally problems such as the slipping of the belts, throwing gear or the filament's not melting completely, nozzle clogging, I mean the clogging of the part which melts the filament and ensures that it sticks on the tray."* **UÜP** *"It requires knowledge. I mean it requires technical knowledge."* **FAP** *"There is a material process. Bringing or using its materials is probably the biggest problems I have ever faced because of the development of the sector.* **UÜP** *"There is no design fee. The production cost of the printer is the only fee at start, which is a bit pricy and has no any other big issue."*
Slipping of the Belt		**1**	
Throwing Gear		**1**	
Filament Not Melting		**1**	
Long Printing Time		**3**	
Requiring Technical Knowledge		**1**	
Printer Prices		**1**	
Difficulty of Find Extra Parts		**1**	
Disallowing Detailed Drawing	**Program Deficiencies**	**2**	
Program Learning Duration		**1**	

Two categories of mechanical programs and program deficiencies emerged under the theme of disadvantageous circumstances experienced by students concerning the 3D printers and 3D design programs. Codes relating to these

categories were Nozzle Clogging, Slipping of the Belt, Throwing Gear, Filament Not Melting, Long Printing Time, Requiring Technical Knowledge, Printer Prices, Difficulty of Finding Parts, and Disallowing Detailed Drawing.

Table 17

Codes, Categories, and Views Regarding the Advantages of 3D Design Programs and 3D Printers

Code	Category	f	Views
The Programs Are Free	**Positive Views**	**1**	**UÜP** *"I mean, first and foremost, the 3D design programs enable our solution-oriented thinking. There is a problem before us and how can I apply a solution, and this is what they help us do first."*
Easy to Use Programs		**2**	
Solution-Oriented Thinking		**1**	
Functionality		**4**	

As seen in the table, codes such as "programs are free", "easy to use programs", "solution-oriented thinking", and "functionality" emerged from student statements in the "positive views" category relating to the theme of the advantages of 3D design programs and 3D printers.

Findings Regarding Views and Thoughts of Students on 3D Design Programs and 3D Printers

Table 18

Codes, Categories, and Views Regarding the Theme of Students' Views and Thoughts on 3D Design Programs and 3D Printers

Code	Category	f	Views
Training should be provided in every school	**Suggestions**	**1**	**RLB** *"I mean we are the selected students in our regular schools, but I want the unselected students to see it as well because it is a good application."*
Internet should speed up		**2**	
Every student should receive training		**1**	**AOB** *"It would be better if making animation in TinkerCad is easy because making animation is difficult."*
Animations should be added to the programs		**1**	

Codes like "training should be provided in every school", "internet should speed up", "every student should receive training", and "animations should be added to the programs" were obtained from student statements under the "suggestions" category relating to the theme of students' views and thoughts on 3D design programs and 3D printers.

Findings Regarding the Theme of the Utilization Purposes of 3D Design Programs and 3D Printers

Table 19

Codes, Categories, and Views Regarding the Theme of Teachers' Purposes of Utilizing 3D Design Programs and 3D Printers

Code	Category	f	Views
Getting printouts in projects	**Project**	**3**	**ZZT** *"We use them for drawing in 3D design programs and getting their printouts. I mean, in short, we use them after designing parts that kids will use in their projects to turn them into products."* **RZT** *"They develop solutions for the project problems. When developing these suggestive solutions, we need special products and the kids can design these special products in three-dimensional programs, get the printouts of their designed products from the printer, and use them in their projects."*
Producing hard to-reach material		**1**	**EA[F]** *"The last thing we did was a spectroscopy experiment and there was a material that we were couldn't find. We made it using 3D, without which we would not have been able to make it or we had to tackle with carpenters."*
Preparing for the future	**Personal Development**	**1**	**RZ[T]** *"Fields of occupations relating to industry 4.0 and 3D printing engineering will take shape. I think preparing our children to the future will make a contribution."* **ZZ[T]** *"We support them by explaining the 3D design programs and they make their designs using their imagination and get their printouts from the 3D printer."*
Designing one's own products		**2**	

Per students' views relating to the theme of utilization purposes of 3D design programs and 3D printers shown in the table, codes such as "getting printouts in projects", "printing hard-to-reach materials", "preparing for the future", and "designing one's own products" emerged in the "project" and "personal development" categories.

Findings Regarding Teacher Views on Advantages and Disadvantages of 3D Design Programs and 3D Printers

Table 20

Codes, Categories, and Views Relating to Advantages and Disadvantages of 3D Design Programs and 3D Printers

Code	Category	f	Views
Concretizing the abstract	**Benefits**	**2**	**RZ[T]** *"The TinkerCad program has such an advantage where you can create virtual classrooms. As a teacher, I see the children's designs, and we can also work jointly on that design together with children."* **EA[F]** *"I mean when necessary, we go together with them to their technology design teachers. There are things that we may not know, which we consult with them and I have to say that we do interdisciplinary work together."*
Raising production awareness		**1**	
Saving time		**1**	
Producing hard-to-reach materials		**1**	
Cloud-based working		**1**	
Virtual classroom opportunities		**1**	
Interdisciplinary work		**2**	

As a result of the interviews conducted with teachers, codes such as "concretizing the abstract", "raising the production awareness", "saving time", "producing hard-to-reach materials", "cloud-based working", "virtual classroom opportunities", and "interdisciplinary work" were extracted in the category of "benefit" relating to the theme of advantages of 3D design programs and 3D printers.

Table 21

Codes, Categories, and Views Relating to The Disadvantages of 3D Design Programs and 3D Printers

Code	Category	f	Views
Slow printing	**Limitations**	**2**	**RZ^{T}** *"Sometimes we experience problems of adhesion on the tray or we can experience problems like filament breakage that occurs when fixing the filaments from the back. We can say that these are disadvantages we experience when using the 3D printer."*
Limited printing dimension		**1**	
Single color printing		**1**	
Tray adjustment		**2**	**ZZ^{T}** *"Changing the filament requires specific technical knowledge and preparation. Therefore, we cannot leave students, especially the support group, on their own. When the filament needs to be changed, we help them by providing guidance."*
Slicing issues		**1**	
Time-consuming learning		**1**	
Printer price (expensive)		**1**	**EA^{F}** *"As I said at first, from to time, we may experience problems with respect to the slicing programs in student dimension.*
Few printers		**2**	
Filament clogging		**1**	**RZ^{T}** *"The SAC groups are not very crowded. We can provide more opportunities for printer utilization if printers are procured for every single student."*
Mechanical issues		**1**	**EA^{F}** *"There are problems with what we have at hand like removing it, changing its part, and greasing that part, but if you ask the pros or cons, the pros of course."*
			ZZ^{T} *"Technical adjustments such as fixing the printing floor glitches and the printing tray of 3D printers are important. When these adjustments are not done properly, the printing does not provide good results."*
Internet infrastructure		**1**	**EA^{F}** *"The problem we experience is the low internet speed. A solution should be found as soon as possible."*

As a result of the interviews conducted with teachers, the codes "slow printing", "limited printing dimension", "single color printing", "inability to remove from the tray", slicing issues", "time-consuming learning", "expensive printer prices", "filament clogging", "mechanical issues" and "internet infrastructure" were extracted in the category of "limitations" relating to the theme, disadvantages of 3D design programs and 3D printers.

Findings Regarding Teacher Views on 3D Design and 3D Printing Programs Taught in SAC

Table 22

Codes, Categories, and Views Related to the Theme of 3D Design and 3D Printing Programs Taught in SAC.

Code	Category	f	Views
TinkerCad	**Design**	**3**	**ZZ^{T}** *"We use TinkerCad because it is the easiest, fastest to learn, and the most easily accessible program."*
Fusion 360		**3**	
Cura	**Slicing**	**2**	**RZ^{T}** *"We use the TinkerCad for designing and after TinkerCad we use the Fusion 360."*

Under the theme of 3D design and 3D printing programs taught in SAC and the categories of "design" and "slicing", the programs called "TinkerCad", "Fusion 360", and "Cura" were reportedly used.

Teacher Views on the Effects of 3D Design and 3D Printing Programs Taught in SAC on Students

Table 23

Codes, Categories, and Views Related to the Effects of 3D Design and 3D Printing Programs Taught in SAC on Students

Code	Category	f	Views
Increases achievement	**Instructional**	**2**	**RZ[T]** *"I definitely think that they increase their achievement. When they were doing projects in other branches, for example, when they were working on a theme in the Turkish course, they started using 3D printers. I mean the 3D design and printer entailed such an awareness that after learning this system, the kids actually can integrate what they have learned to other courses as well."*
Facilitates project production		**2**	
Excites		**3**	
Increases their self-efficacy		**2**	
Increases self-confident		**2**	**ZZ[T]** *"They gain a sense of self-efficacy by saying that I can think of a given problem, solve it, design it, and print its product. This of course makes us delighted."*
Increases motivations		**3**	
Thinks differently		**1**	**RZ[T]** *"Students can experience feelings like now I can design and produce this product on my own and handle the software part by myself; they are not difficult as shown on TVs and social media, and I can do it."*

In the "instructional" category of the theme relating to the effects of 3D design and 3D printing programs taught in SAC on students, the codes "increases achievement", "facilitates project production", "excites", "increases their self-efficacy", "increases their self-confidence", "increases motivation", and "thinks differently" were obtained.

Findings Regarding Teacher Views on How 3D Design and 3D Printing Programs Taught in SAC Make Teachers Feel

Table 24

Codes, Categories, and Views Relating to the Theme on How 3D Design and 3D Printing Programs Taught in SAC Make Teachers Feel

Code	Category	f	Views
Satisfaction	**Positive Feelings**	**3**	**EA[F]** *"When things are going well, I would say so glad I have you."*
Motivation		**2**	
Happiness		**3**	**RZ[T]** *"They give a feeling of excitement and together with this excitement a sense of learning increasingly continues in me because it makes you happy when you see kids learn and can do something on their own. At the same time, it motivates me; I mean are we are in mutual communication with students. As they learn something from me, they get more motivated and want to work more and as I see the excitement in them, I want to learn more and more. Therefore, it encourages me to research new technologies."*
Excitement		**3**	
Increased desire for learning		**1**	**ZZ[T]** *"Of course, it makes us delighted when they experience the production chain and show this motivation. After getting a 3D printout, they express and share with us and their friends feel like I can do it, I can design it, and I can succeed. As such, this is a state which increases our motivation as well."*

Codes such as "motivation", "happiness", "excitement", and "increased desire for learning" were obtained in the category of "positive feelings" of the theme related to what 3D design and 3D printing programs taught in SAC make teachers feel.

Discussion and Conclusion

This study was conducted to explore teacher and student views on using 3D design programs and 3D printers. In general, students and teachers stated that 3D design programs and printers are used per their intended purposes, the design programs and printers are highly functional in solving daily life problems, they facilitate many tasks in daily life, and despite having some disadvantages, students and teachers were satisfied with using the printers and learning design programs, as reflected in both the qualitative and quantitative data.

Primarily, students' views on 3D design programs and printers used in SAC were addressed in the study. In the questionnaire administered to the students, attempts were made to understand in which course or courses they mostly used the 3D printers and design programs and for what types of purposes. As per the resultant quantitative finding, students mostly used the design programs and printers in the technology design course and the reason behind it was that they received the 3D design and printer education in this course. In addition, they stated that they also used the printers in information technologies and science courses. The fact that students utilized the printers to print the parts or prototypes of projects they fulfilled in these courses was qualitatively supported by interviews conducted with them. In a study conducted on the effect of designs created by children using the TinkerCad 3D design program on their development process, students stated that they applied their acquired skills in mathematics, geometry, visual arts, and basic science courses (Yüksel, Çetin, & Berikan, 2019). The resultant qualitative and quantitative findings were similar to those in this research. Students utilize the theoretical and practical education they receive in technology and design courses in fulfilling their project ideas in different courses. They expressed that they utilize the design programs and printers, as they provide an opportunity to create prototypes and produce their missing parts in projects like STRCTS and Technofest (https://www.tubitak.gov.tr/en, https://www.teknofest.org/en/). For instance, two students stated that they obtained 3D printouts for a project idea they had developed for the Turkish course and their project became more comprehensible, whereby they won the national award. In a study titled "Preservice Teachers' Views on Using 3D Printers in STEM Applications" by Güleryüz et al. (2019), the preservice teachers defined the 3D printers as a technology of the 21st century skills, which facilitates learning, concretize knowledge, and provides material support in the learning process. Students noted that they used the design programs and printers to print products and print their private designs for hobby purposes and they also used them for instructional purposes to produce learning materials in courses. As students' current semester level in the SAC increases, their utilization purposes also differ. Students who have produced their own printers can design and print a product that they need at home. This result shows that printers are very important tools in terms of raising students' production awareness. The design process could be a significant factor career choices of students, who design products they need both in project development and their daily life, in coming years. In this context, one teacher stated that they also teach printers for future careers and try to raise students' awareness in this regard. The results obtained in the light of the qualitative and quantitative data also support teacher opinions. An interviewed teacher described that printers have become "our saviors" in courses and projects. Likewise, the technology design teachers stated that students often use printers in projects both in their courses as well as in other courses. Particularly, the ITR, STD, and Project students used the design programs and printers for project purposes. From the qualitative data collected one can understand that printers are generally used for their intended purposes, they concretize the abstract and that holding what they have in mind on their hands excites them as well as increases their interest and motivation towards courses and projects. Nemorin and Selwn (2017) also expressed that design processes sometimes can turn into interesting activities for students who are unmotivated and uninterested at the beginning.

In interviews conducted with students and teachers, the contributions of 3D design programs and printers to students were also explored. Per quantitative data collected from students, one could argue that students see the design programs and printers as sources of their motivation. A vast majority of students stated that they improved their creativity, found an opportunity to do joint activities with their friends, entered into the production process with their designs, found an opportunity to work online, gained different perspectives, and became more active in courses in which they used printers. In addition, the products students produce using design programs and printers motivate them towards project production. As a result, the findings suggest that they may contribute to students' development both cognitively and affectively. The results from interviews conducted with students and teachers also support these results. Some students built their own 3D printers and used these printers in schools where they studied and produced

concrete instructional materials related to some subjects they mentioned. For example, one student stated that they encountered challenges when learning the structures of molecules and compounds in the chemistry course but handled these challenges through printers. Supporting this remark of students, Scalfani and Vaid (2014) concluded that 3D printing is a perfect method to manufacture the 3D models of molecules and extended solids. In the interviews conducted, teachers maintained that students' achievements increase, they take on more active roles in project production processes, approach events and facts from different angles, meanwhile, students taking the design course have a higher motivation towards the course, and that their self-confidence and sense of self-efficacy also increase. As appears from all these results, when students use 3D printers and design programs, they contribute to students both cognitively and affectively. Students' integrating what they learn into other courses, their desires to learn new and higher-level design programs according to circumstances could be the indicators of students' self-efficacy and self-confidence development. Students' utilization of design programs in their assignments or projects increases their sense of achievement. The reason for this is that students' designing and printing out concretely their imaginative thoughts and that each of these concrete printouts are materials which could be used in solving many problems may increase both their achievements and their senses of self-confidence. In addition, this could be considered a factor that increases students' self-efficacy levels and motivations. In this regard, Verner and Merksamer (2015) stated that assignments that enable building concrete models and using them in real teaching practices motivate students and improve their information about digital technologies.

The study also included findings regarding the views of students and teachers on the advantages and disadvantages of 3D design programs and 3D printers. Per quantitative data collected from students, 31% of students stated that they were unable to use the printers a lot due to long printing time, whereas 37% were undecided in this regard. Considering the responses, 35% of students did not experience such challenges. The study showed that students experienced problems in finding filament, a material used for 3D printers, and some experienced problems while getting printouts and experienced challenges in the slicing process, which is the last stage of preparation for printing. In addition, one of the issues that students found most problematic was waiting for their turns to print for a long time because of the insufficient number of printers according to the quantitative data. Similar remarks emerged in interviews conducted with students and teachers in this regard. The qualitative findings showed that the problems students experienced were mechanical issues and program deficiencies. Students experienced many problems with the mechanical part of the printers and received support both from their teachers and peers in order to solve them. Nozzle clogging, slipping of the belt, throwing gear, filament-related issues, expensiveness of printers, long printing time, and so forth were among the issues that students mentioned. Teachers also referred to similar issues under the limitations category regarding the disadvantages of printers mentioned by students. In addition to slow printing, tray adjustment, and the insufficient number of printers, teachers reported problems such as limited printing dimension, single-color printing, expensiveness of printers, internet infrastructure issues, mechanical issues, and learning takes time. Per these remarks, the qualitative data support the quantitative data. To conclude, students and teachers experienced problems in using printers and these circumstances had some disadvantages in using printers in education and project processes. However, because of being a technology and having moving parts, the emergence of such problems in printers may sound normal. In order to solve the problems they experience when working with design programs, students in support and ITR period get support from their teachers. Some students did not receive such support during distance education. One could argue that the utilization of printers requires technical knowledge, acquired over time by practice. As such, Nermorin and Selwn (2017) stated that even making a design printable with a basic 3D printer requires significant technical efforts and skills. Demir et al. (2016) noted that individuals expected to have the necessary skills to utilize 3D printer technologies effectively do not yet have the required qualifications to use the software and equipment that comprise the components of 3D printing technologies and that costs are also high. SAC students receive practical education regarding 3D design programs and printers for more than two years, develop projects, and produce the necessary parts in most projects they develop, whereby they attain qualifications related to printing technologies. In this regard, Leinoen et al. (2020) stated that the technical skills of students related to 3D design processes can be developed through assignments and in-depth studies given by their teachers and ensure that students learn about these skills. Students given an opportunity to use technology may be able to develop their technical skills about modeling by using the design programs. Şen et al. (2020) stated that students who use the TinkerCad program and printers gain experience in technology utilization and that students' utilization of information and communication technologies through 3D STEM activities improves their technical skills and engineering design processes.

Students' and teachers' views about the advantages of 3D design programs and printers were amassed under the positive views and benefit categories. The students stated that the design programs are free of charge and that the

TinkerCad program has advantages such as being easy to learn, functionality, and developing different perspectives. Teachers talked about advantages such as facilitating interdisciplinary work, concretizing the abstract circumstances, raising production awareness, producing difficult materials, offering cloud-based working, working in virtual classrooms, and saving time. Considering the quantitative data, a vast majority of students reported that printers and design programs had them acquire different perspectives, they experienced a sense of involvement in the production process, they could concretize abstract issues and contents, online programs provided facilitation, they were motivated, and their creativity developed. All these results show that the quantitative data are supported by the views obtained qualitatively. In a study conducted to unravel the contributive effects of 3D-CAD applications on the creative design of students and examine the differences in 3D-CAD effects on students, Chang et al. (2016) reported that activities conducted with 3D-CAD programs improved students' creative performance. There are also studies in the literature where students have not been able to be deeply involved in the process (Leinonen et al., 2020). As appears from the findings and the literature, 3D technologies have various advantages besides having benefits in students' development.

This research also sought to determine students' and teachers' affective feelings when working with 3D design technologies. What students and teachers felt in this regard was congruent. According to the questionnaire data collected from students, a vast majority of them stated that they were happy, excited, and felt comfortable when working with 3D printers and design programs and did not hesitate to use them, wanted to use them in other courses, and their interest increased and felt themselves adequate. Students stated in the interviews that they were fun, satisfactory, pleasant and nice, exciting, intriguing, delightful, interesting, and gave positive feelings, but some students also mentioned that sometimes they felt concerned and got impatient. It is observed that students experience very different emotions when working with 3D technologies. It appears that most of these emotions are positive, but from time to time they also go through negative emotions such as feeling anxious, worrying, and losing patience. As such, students experience more negative emotions in the printing phase of their designs. Reasons such as the long printing phase and the design not sticking to the printer's tray in the first stage, possible mechanical failure in later stages, and loss of electricity may be factors causing anxiety and impatience in students. Teachers also expressed similar feelings in the interviews. Moreover, teachers noted that positive emotions such as happiness, excitement, motivation, and increased interest in learning developed. Leinonen et al. (2020) stated that students get involved in project processes related to 3D design with the designs they create in digital production activities and practical art lessons using 3D modeling and printing technologies and meanwhile, they feel joyful, happy, and strong. The results obtained in this study are similar to the results of the study by Leinonen et al.

Considering the findings related to the views of teachers and students on the utilization of 3D design programs and printers, in the category of suggestions, students offered opinions and suggestions that the internet speed should increase, 3D technology training should be given in every school, every student should receive training, and animation feature should be added to the programs. In addition, in the opinions and suggestions section inquired at the end of the questionnaire, students had opinions and demands like there should be more printers and computers in more institutions, and there should be printers that print faster. In addition, in the questionnaire, students running projects mentioned about the conveniences they experienced when using printers and design programs in the project processes. According to the results obtained from the resultant findings, 3D technologies play a significant role in developing students' knowledge and skills. It is also understood that students use these technologies quite a lot when creating projects or designing the products of their projects, and this motivates them in the project production process. It also appears that students can print their own course materials to learn abstract subjects if they are given sufficient education and offered an opportunity to practice with these technologies.

Recommendations

In this study, which examined the views of students and teachers about 3D design programs and the use of printers, the following suggestions were presented based on their results.

Recommendations for Applicants

Schools like science and art centers or other schools with learning environments such as application ateliers and design skills ateliers that provide training and teach these technologies to students in cooperation with qualified instructors can be a significant factor in involving students in the production process. 3D technologies facilitate the implementation of the project ideas put forth by students. Therefore, this situation encourages students to present ideas and generate solutions to problems and involves them in the production process. It appears that students

produce products for hobby purposes, produce some parts or models they need in daily life and produce concrete materials in abstract lessons using the experiences they have gained.

In the light of all these results, considering that 3D technologies positively affect students' course achievement, planning lessons with an interdisciplinary focus and using 3D technologies effectively will benefit students.

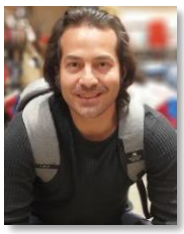
The educators wanting to utilize the 3D printer technologies in their institutions could first determine the purposes upon which they are going to use the printers. These technologies could be included in ateliers and classrooms considering the price and performance balance. They could prepare basic educational programs for their students on issues such as design principles, solid modeling, and 3D drawing by selecting 3D design programs according to students' levels. They could guide students to fulfill their own learning by having them practice printer technologies over time.

Recommendations for the Further Research

In the light of the results obtained from the research, the following suggestions are presented.

The views of students and teachers in this study could be examined in a qualitative study. Likewise, a quantitative study could be conducted on the effect of 3D design programs and printers on course achievement. This study, conducted on gifted students and SAC, could be conducted in other formal educational institutions.

Biodata of the Authors



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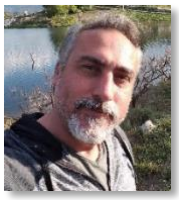

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Appendix 1

Views about Using 3D Printers as an Educational Tools Questionnaire (English)

Strongly Disagree 1, Disagree 2, Undecided 3, Agree 4, Strongly Agree 5

Views about Using 3D Printers as an Educational Tools Questionnaire					
Items	1	2	3	4	5
Dimension 1. Aim of Usage					
The 3D design programs and printers we use in SAC help me generate different solutions to the problems I face in daily life.					
Activities conducted with 3D design programs and printers we use in SAC increase a sense of curiosity.					
I think the 3D printers are used per their intended purpose.					
I have the opportunity to examine and investigate the outputs I have obtained using 3D programs and printers as tangible and 3D objects.					
Dimension 2. Preparations for Usage					
I would like to take additional courses to feel more prepared for the 3D design programs and printers we use in SAC.					
I come to the course by getting preparation before working with 3D design programs and printers.					
Preparations made before using 3D printers in SAC take most of my time.					
When I have free time, I watch videos about the utilization of 3D design programs and 3D printers.					
Dimension 3. Contributions of the Outcomes					
The 3D design programs' working online helps me to work in collaboration with my friends.					
I take on more active roles in lessons by using 3D design programs and 3D printers in SAC.					
The 3D design programs and 3D printers in SAC develop my creativity.					
I think the 3D design programs and 3D printers in SAC make abstract subjects or content concrete.					
Most 3D design programs' working online (internet connection) provide me facilitations in many issues.					
Using 3D design programs and 3D printers in SAC helps me enter into the production process.					
Using 3D design programs and 3D printers in SAC helps gain different perspectives.					
3D design programs and 3D printers in SAC motivate me more in the lesson.					
The products produced using 3D printers motivate me towards creating projects.					
Dimension 4. Problems Encountered at Using					
I cannot sufficiently use the 3D printers in SAC, as getting printouts from them takes a long time.					
I experience problems in finding filament in my desired colors and properties for the 3D printers in SAC.					
I experience problems while printing out products developed in 3D design programs.					
Carrying 3D printers is difficult for me.					
I experience difficulty when adjusting the print settings in slicing programs before getting printouts from the 3D printers.					
I experience problems in getting printouts because of the small number of 3D printers in SAC.					
Dimension 5 . Emotional Status at Using of 3D Printers					
I refrain from using printers in lessons because of the expensiveness of 3D printers.					
I enjoy printing out the products I design in 3D design programs from the 3D printers.					
Printing out the unique products I design using 3D design programs from printers excites me.					
I prefer using 3D printers in the courses in SAC.					
I feel comfortable when using 3D design programs and 3D printers in SAC.					
I consider myself competent in using 3D design programs and 3D printers in SAC.					
Materials printed using 3D printers increase my interest in the subject.					
Dimension 6. Need for Support at Using of 3D Printers					
The SAC Administration supports us to use 3D printers.					
Our teachers support us to use 3D printers.					
My family supports me to use 3D printers.					
Working with 3D design programs and 3D printers in SAC makes me willing to produce projects.					
Working with 3D design programs and printers may help me select professions like printing technologies/engineering.					
When I experience problems regarding the 3D printers in SAC, I get support from my other friends.					

Thanks

Appendix 2

Views about Using 3D Printers as an Educational Tools Questionnaire (Turkish version)

Hiç Katılmıyorum 1, Katılmıyorum 2, Kararsızım 3, Katılıyorum 4, Kesinlikle Katılıyorum 5

3D Yazıcıların Eğitimsel Bir Araç Olark Kullanımına Yönelik Görüşler Anketi					
Maddeler	1	2	3	4	5
Bölüm 1. Kullanim Amacı					
BİLSEM' de kullandığımız 3D tasarım programları ve yazıcılar, karşılaştığım günlük yaşam problemlerine karşı farklı çözümler üretmemde yardımcıdır.					
BİLSEM' de kullandığımız 3D tasarım programları ve yazıcılar ile yapılan etkinlikler merak duygumu artırır.					
BİLSEM' de 3D yazıcıların amacına göre kullanıldığını düşünüyorum					
3D tasarım programları ve yazıcılar kullanarak elde ettiğim çıktıları somut ve 3 boyutlu nesneler olarak inceleme ve araştırma imkânı bulurum					
Bölüm 2. Kullanım Hazırlıkları					
BİLSEM' de kullandığımız 3D tasarım programları ve yazıcılar konusunda kendimi daha hazır hissetmek için ek dersler almak isterim.					
3D tasarım programları ve yazıcılar ile çalışmadan önce derse hazırlanarak geliyorum.					
BİLSEM' de 3D yazıcı kullanımı öncesi yapılan hazırlıklar çok vaktimi almaktadır.					
Boş zamanlarımda vakit buldukça 3D tasarım programları ve 3D yazıcı kullanımı hakkında videolar izlerim.					
Bölüm 3. Sonuçların Katkısı					
3D tasarım programlarının çevrim içi olarak çalışıyor olması arkadaşlarım ile ortak çalışma yapma imkânı sağlar.					
BİLSEM' de 3D tasarım programları ve 3D yazıcı kullanarak derslerde daha aktif rol alırım.					
BİLSEM' de 3D tasarım programları ve 3D yazıcılar yaratıcılığımı geliştirir.					
BİLSEM' de 3D tasarım programları ve 3D yazıcıların soyut olan konu veya içerikleri somut hale getirdiğini düşünüyorum.					
3D tasarım programlarının çoğunun online (internet bağlantısı) çalışıyor olması bana birçok konuda kolaylık sağlar.					
BİLSEM' de 3D tasarım programları ve 3D yazıcı kullanımı benim üretim sürecine dahil olmamı sağlar.					
BİLSEM' de 3D tasarım programları ve 3D yazıcı kullanımı bana farklı bakış açıları kazandırır.					
BİLSEM' de 3D Tasarım programları ve 3D yazıcılar derse daha çok motive olmamı sağlar.					
3D yazıcılar kullanılarak üretilen ürünler beni proje üretme konusunda motive eder.					
Bölüm 4. Kullanımda Karşılaşılan Sorunlar					
BİLSEM' de 3D yazıcılardan baskı almak uzun sürdüğü için 3D yazıcıları yeteri kadar kullanamıyorum.					
BİLSEM' de 3D yazıcılar için istediğim renkte ve özellikte flament bulmakta sorunlar yaşıyorum.					
3D tasarım programlarında ortaya çıkan ürünleri yazıcıdan baskı alırken sorunlar yaşıyorum.					
3D yazıcıları taşımanın zor olması beni zorlayan durumlardandır.					
3D yazıcıdan baskı almadan önce dilimleme programlarında baskı ayarı yaparken zorluk yaşıyorum.					
BİLSEM' de 3D yazıcı sayısının az olması nedeni ile baskı almada sorunlar yaşıyorum.					
Bölüm 5. 3D Yazıcı Kullanımında Duygusal Durum					
3D Yazıcılar pahalı olduğu için derslerde yazıcıyı kullanmaktan Çekiniyorum.					
3D tasarım programlarında tasarladığım ürünleri 3D yazıcılardan baskı alırken eğleniyorum					
3D tasarım programları ile özgün ürünler tasarladığımda yazıcıdan baskı almak beni heyecanlandırır.					
BİLSEM' de derslerimde 3D yazıcı kullanmayı tercih ederim					
BİLSEM' de 3D tasarım programları ve 3D yazıcı kullanırken kendimi rahat hissederim.					
BİLSEM' de 3D tasarım programları ve 3D yazıcılar konusunda kendimi yeterli görüyorum.					
3D yazıcı ile basılmış materyaller benim konuya olan ilgimi artırır.					
Bölüm 6. 3D Yazıcı Kullanımında Destek İhtiyacı					
31. BİLSEM Yönetimi bizi 3D yazıcı kullanmamız konusunda destekler.					
32. Öğretmenlerimiz 3D yazıcı kullanmak konusunda bizlere destek veriyor.					
33. Ailem 3D yazıcı kullanmam konusunda beni destekler.					
34. BİLSEM' de 3D tasarım programları ve 3D yazıcılar ile çalışmalar yapmak beni proje üretme konusunda istekli hale getiriyor					
35. 3D tasarım programları ve yazıcılar ile çalışmam baskı teknolojileri/mühendislik gibi meslekleri seçmem için destek olabilir.					
36. BİLSEM' de 3D yazıcılar ile ilgili sorunlar yaşadığımda diğer arkadaşlarımdan destek alıyorum.					

Teşekkürler

Appendix 3

Interview Form for Teachers (Turkish Version)

Görüşme Formu-Öğretmen
Demografik Sorular
Lisans derecesi ile mezun olduğunuz bölüm nedir? Ya da branşınız nedir?
Mesleğinizde kaçıncı yılı çalışıyorsunuz?
BİLSEM' de kaç yıldır görev yapıyorsunuz?
3D tasarım ve 3D yazıcılar ile ilgili katıldığınız hizmet içi eğitim kurslar nelerdir?
Görüşme Soruları
1- Bilim ve sanat merkezlerinde (BİLSEM) 3D tasarım programlarını ve 3D yazıcıları hangi amaçla kullanmaktasınız?
2- BİLSEM 'de verilen derslerde 3D tasarım programlarını ve 3D yazıcıları kullanmak ne gibi avantajlar ve sınırlıklara neden olmaktadır
3- BİLSEM 'de 3D tasarım programlarını ve 3D yazıcıları 3D Tasarım programlarını kullanma konusunda öğrenciler ile veya teknik konularda sorunlar yaşıyor musunuz? bu sorunları çözmek için neler yapıyorsunuz?
4- 3D tasarım programları ve 3D Yazıcıların bilsem destek, BYF, ÖYG ve Proje öğrencilerinin başarı ve motivasyonlarına etkisi hakkında neler düşünüyorsunuz?
5- 3D tasarım programları ve 3D yazıcıları kullanılarak işlenen bir dersin, BİLSEM destek, BYF, ÖYG ve Proje öğrencileri üzerinde ne gibi etkileri bulunmaktadır? (başarı, öz-yeterlik, motivasyon vb.)
6- Derslerde 3D tasarım programları 3D yazıcı kullanmak size neler hissettiriyor?
7- 3D tasarım programları ve 3D yazıcıların BİLSEM Derslerinde kullanımına ilişkin eklemek istediğiniz görüş ve düşünceleriniz varsa açıklayabilir misiniz?

Appendix 4

Questions Asked in Interviews with Teachers (English)

Interview Form- Teacher
Demographic Questions
What department did you graduate from?
What year are you working in your profession?
How many years have you been working at SAC?
What are the in-service training courses you attend about 3D design and 3D printers?
Interview Questions
1- For what purpose do you use 3D design programs and 3D printers in science and art centers (SAC)?
2-What are the advantages and limitations of using 3D design programs and 3D printers in the courses given at SAC?
3- Do you have problems with students or technical issues in using 3D design programs and 3D printers at SAC? What are you doing to solve these problems?
4- What do you think about the effects of 3D design programs and 3D Printers on the success and motivation of support, ITR, STD and Project students?
5- What kind of effects does a course taught using 3D design programs and 3D printers have on BİLSEM support, ITR, STD and Proje students? (Achievement, self-efficacy, motivation, etc.)
6- How does it make you feel to use 3D design programs and 3D printers in lessons?
7- If you have any opinions and thoughts about the use of 3D design programs and 3D printers in SAC Courses, could you explain them?

Thanks

Appendix 5

Questions Asked in Interviews with Students (Turkish Version)

Görüşme Formu-Öğrenci
Demografik Sorular
En son devam ettiğin program nedir?
Devam ettiğin okul türü nedir?
BİLSEM' de kaç yıldır öğrenim görüyorsun?
Görüşme Soruları
1- Bilim ve Sanat Merkezlerinde (BİLSEM) 3D tasarım programları ve 3D yazıcılar daha çok hangi derslerde kullanılıyor?
2- BİLSEM' de 3D tasarım programlarını ve 3D yazıcıları hangi amaçla kullanmaktasınız?
3- BİLSEM 'de derslerde 3D tasarım programları ve 3D yazıcılar kullanılması ile ilgili neler düşünüyorsunuz? Neden bu şekilde düşünüyorsunuz?
4- BİLSEM' de kullanılan 3D tasarım programları ve 3D yazıcıların ders başarınıza etkisi konusunda neler düşünüyorsunuz?
5- BİLSEM' de derslerde 3D tasarım programları ve 3D yazıcı kullanmak size neler hissettiriyor?
6- 3D tasarım programları ve 3D yazıcıların kullanımına ilişkin eklemek istediğiniz görüş ve düşünceleriniz varsa açıklayabilir misiniz?

Teşekkürler

Appendix 6

Questions Asked in Interviews with Students (English)

Interview Form-Student
Demographic Questions
What is the last program you attended?
What type of school do you attend?
How many years have you been studying at SAC?
Interview Questions
1- In which courses are 3D design programs and 3D printers mostly used in Science and Art Centers (SAC)?
2- For what purpose do you use 3D design programs and 3D printers at SAC?
3- What do you think about the use of 3D design programs and 3D printers in the lessons at SAC? Why do you think this way?
4- What do you think about the effect of 3D design programs and 3D printers used in SAC on your course success?
5- How does it make you feel to use 3D design programs and 3D printers in lessons at SAC?
6- If you have any comments or thoughts about the use of 3D design programs and 3D printers, can you explain them?

Thanks

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Research Article

Scaffolding through cognitive mapping based on diagnosing students difficulties in solving problem

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Abstract

This study shows the diagnosis of difficulties faced by students when solving problems with a system of linear equations with three variables and efforts to overcome them by providing scaffolding interventions. The approach used in this study is qualitative. The sample selection using a purposive sampling technique was made by giving three math problems, the topic of a system of linear equations with two variables, then three students were selected to be the research subjects. The selection of students is determined based on the category of communication skills and low, medium, or high mathematical abilities. The research data were obtained from 3 sources: test sheets, semi-structured interviews, and the results of student work after scaffolding was given. Several research results show students' difficulties in solving three-variable linear equation systems problems based on Polya-based cognitive mapping: first, the difficulty in understanding the problem. This difficulty arises because of mental holes that students should not have at grade levels, such as knowledge of fractions, algebra, basic concepts of triangles, and others. Second: Difficulty compiling a solution. This can be seen when students cannot correctly model contextual problems into mathematical models. Third, the implementation of the complete plan can be identified through students' mistakes when performing arithmetical algebraic operations and applying appropriate mathematical rules/principles, the leading cause of which can occur due to inaccuracy and misconceptions about mathematical concepts. The researchers tried to overcome these problems by providing Level 2 scaffolding with the techniques proposed by Angirelli, including (explaining, reviewing, and restructuring).

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Introduction

Education is one of the basic foundations in starting and building the civilization of every human being. Through education, every human being is expected to become a superior human resource who has the attitudes, knowledge, and skills to adapt and contribute to their lives (Parno et al. 2020; Widana, 2018). Mathematics is one of the disciplines of knowledge that must exist in curriculum subjects at every level of education in schools (Blinder, 2013). Every student's fundamental basic science in living their daily lives (Prayitno, 2018). The importance of competence in mathematical knowledge makes it often dubbed the "Queen of Science," which means how significant the role of mathematics is as the root of knowledge from various scientific disciplines. The essential part of mathematics learning in schools is the learning process itself. The method of learning mathematics can train one's thinking logically, critically, and creatively to become the basis for someone to face the challenges of the times (Surya & Syahputra, 2017; Thinking, 2015).

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However, learning mathematics is a common scourge that scares most students; students sometimes think mathematics is a boring subject and complicated, even scary (Boote & Boote, 2018; Parno et al. 2021). The leading cause can occur because of students' difficulty digesting or understanding the subject matter. The problems experienced by students in understanding the lesson can be seen when students are asked to solve related math problems. Related math problems are similar, usually presented in various forms such as puzzles, story problems, or specific event phenomena (Blinder, 2013; Lutfianto et al. 2013). It can describe students' cognitive knowledge in solving mathematical problems in questions.

Based on an interview with Mrs. T as a mathematics teacher in one of the high schools in Parepare, South Sulawesi, Indonesia, stated that the daily exam on the material of a three-variable linear equation system showed low results, where only <50% of students managed to meet the minimum passing criteria with a score of >70, according to him most students fail to solve problems because they are not able to develop good problem-solving strategies even though most of the students are judged to have technically understood mathematically solving systems of linear equations of three variables. This shows that there are still students' difficulties in solving the problems of a three-variable system of linear equations. Therefore, it is necessary to search for / diagnose students' issues and overcome these difficulties.

In carrying out the diagnosis of difficulty, cognitive mapping is used. Explains that cognitive mapping can be used in various ways, including solving problems individually and in groups (Ramirez et al. 2016; Zahara et al. 2020). This technique makes it easy to identify the issues and creates a problem structure. In addition, the most important thing is that cognitive mapping will help formulate the difficulties experienced by students and determine the appropriate assistance intervention procedures (Gordon & Ramani, 2021; Martins et al. 2019).

Cognitive mapping in problem-solving requires a design that describes the flow of thinking or steps for solving coherent and clear problems. A description of the flow of thought or steps for solving readable and clear difficulties can be viewed from the strategy used because it is an essential part of solving problems (Buchori & Cintang, 2018; Cho & Kim, 2020). In her book entitled How to Solve, Polya states that the crucial thing in solving issues lies in strategy. The strategy in question is a heuristic strategy (Prayitno, 2018). Heuristic strategies are general steps to guide problem-solving in finding solutions to problems. According there are four general steps, namely, understanding the trouble (understanding the problem), planning a settlement (devising a plan), implementing the payment (carrying out the program), and examining back (looking back) (Rosydiana, 2017; Yuwono et al. 2018). Therefore, through Polya-based cognitive mapping, it will be more helpful for researchers to formulate the difficulties experienced by students coherently and transparently.

Suggested that one of the solutions that can be applied to overcome student difficulties is to build scaffolding. Scaffolding is an assistance intervention effort that can be in the form of questions, instructions, reminders, directions, or encouragement to students when these students experience errors or difficulties in solving problems. According to Slavin, Learning support is for someone in the early stages of learning (Awadelkarim, 2021; Thomas et al. 2021). The support is slowly removed, leading to more independent learning (Błazik-Borowa et al. 2020; Milara et al. 2020).

Based on the description above, this article describes the results of a study entitled Diagnosing Students' Difficulties in Solving the linear equation system of three variables (LESTV) problem through Polya-Based Cognitive Mapping and Efforts to Overcome with Scaffolding. This study aimed to describe the diagnosis of students' difficulties in solving LESTV problems revealed through Polya-based cognitive mapping and efforts to overcome them with scaffolding actions.

Problem of Study

Based on the background and research objectives above, the essential issues to be uncovered through this research are: What types of difficulties do students experience when solving problems on a two-variable system of linear equations? What are the causes of the problems encountered by students when solving problems, and how are the efforts to overcome students' difficulties in solving the problem of a two-variable wild equation system through Polya-based cognitive mapping with scaffolding?.

Method

Research Model

The approach in this research is a qualitative approach with a descriptive type of research. The subjects in this study were students in one of the high schools. The issues in this study were students who had studied the material for solving a system of three-variable linear equations. Researchers took three samples as research subjects based on the level of students' abilities (good, moderate, and less than one person each) and students' communication skills so that the disclosure of the completion process can be carried out correctly. Determination of a subject like this is expected

to represent the actual conditions in the field. Students who were selected as research subjects were then interviewed. Clarify, explore, or clarify the subject's work results when Solving LESTV problems. Therefore, the interviews conducted were semi-structured.

This research approach is a qualitative approach with a descriptive type of research. The subjects of this study were students of one of the high schools. The issues of this research are students who study the material for solving a system of linear equations with three variables. To ensure proper disclosure of the settlement process.

Participant

The researcher studied three subjects selected through the purposive sampling technique, taking into account the students' mathematical skills (one each for the good, medium, and bad categories) based on the students' completion results and good communication skills. Thus, it is hoped to reflect the actual situation on the ground.

Data Collection Tools

Furthermore, disclosure is made through interviews with the three selected subjects. Interviews were conducted to clarify, investigate, or clarify the results of the subject's work in solving LESTV problems. Therefore, the interviews conducted were semi-structured.

Table 1

Instruments of Questions LESTV

No	Questions
1	The perimeter of ABC is 70 cm. The length of AC is 2 cm longer than the length of AB, and the size of BC is 6 cm shorter than the length of AC. Find the side lengths of triangle ABC.
2	Triangle ABC's minimum angle is 1/3 of the middle grade, and the maximum angle is twice the sum of the other two angles. What is the measure of each angle of triangle ABC?
3	The cuboid's length, width, and height are A cm, B cm, and C cm, respectively. The perimeter of the base of the block is 76 cm, the circumference of the front pillar is 80 cm, and the rim of the right side is 68 cm. What is the volume of the block!

During the interview process, the subject was asked to verbally display the steps for solving the written questions revealed based on the Polya completion steps. The data obtained are coded and used as the basis for mapping with coherent and clear cognitive information. After knowing the location of the student's difficulties, the researcher carried out scaffolding so that the subject was expected to overcome the challenges and solve problems appropriately. The structure is in direct interaction between the teacher and the students involved. The form of interaction in question is scaffolding level 2, including explaining (explaining), namely conveying the concepts learned, reviewing (reviewing), which is refocusing students' attention, and restructuring (rebuilding understanding), which is simplifying something abstract so that it can be understood. Students (Fatahillah et al. 2017). Table 1 contains 3 LESTV questions. While Figure 1 is a Polya-based cognitive mapping design that is expected to solve the problems of a three-variable system of linear equations given to students.

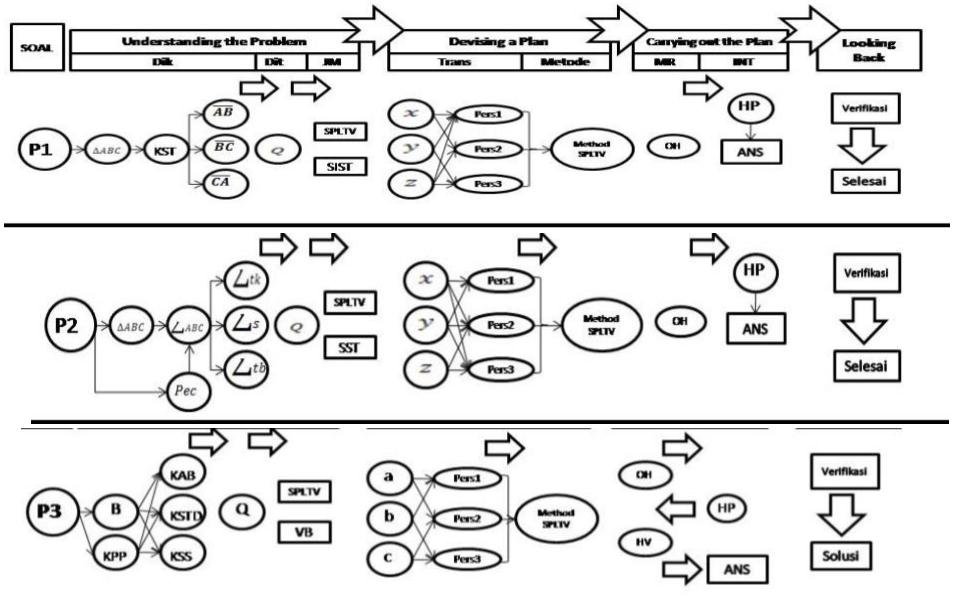
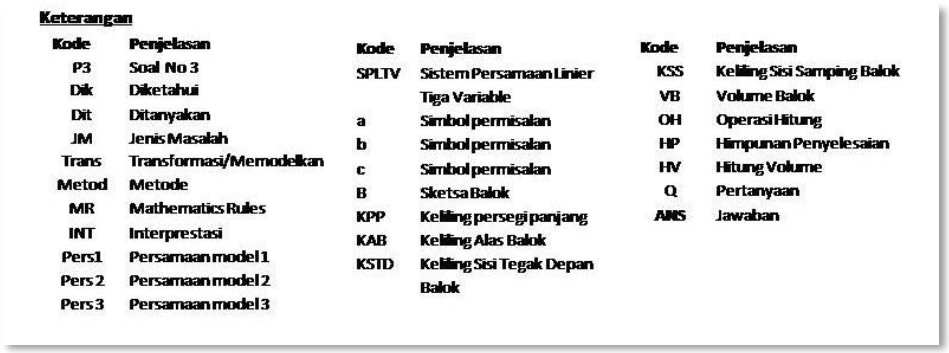


Figure 1

Polya-based Cognitive Mapping on Questions



Keterangan

Kode	Penjelasan
P3	Soal No 3
Dik	Diketahui
Dit	Ditanyakan
JM	Jenis Masalah
Trans	Transformasi/Memodelkan
Metod	Metode
MR	Mathematics Rules
INT	Interprestasi
Pers1	Persamaan model 1
Pers 2	Persamaan model 2
Pers 3	Persamaan model 3

Kode	Penjelasan
SPLTV	Sistem Persamaan Linier Tiga Variable
a	Simbol permisalan
b	Simbol permisalan
c	Simbol permisalan
B	Sketsa Balok
KPP	Keliling persegi panjang
KAB	Keliling Alas Balok
KSTD	Keliling Sisi Tegak Depan Balok

Kode	Penjelasan
KSS	Keliling Sisi Samping Balok
VB	Volume Balok
OH	Operasi Hitung
HP	Himpunan Penyelesaian
HV	Hitung Volume
Q	Pertanyaan
ANS	Jawaban

Results

The results and discussion can be separated into different sub or combined into one hero. The summary of the results can be presented in graphs and figures. The results and discussion sections must be free from multiple interpretations. The discussion must answer research problems, support and defend answers with results, compare relevant research results, state the study's limitations, and find novelty.

This study describes the types of difficulties faced by students when completing LESTV with Polya-based cognitive mapping and efforts to overcome them with scaffolding. For this reason, three different groups of research subjects are described: a group of students with high math abilities in subjects 1(S1), a group of students with moderate math abilities in subject 2 (S2), and a group of students with low math abilities subject 3 (S3). Presented the results of each sample based on the student's character:

Table 2

The results of Examining Student Answers

Subject	Questions LESTV		
	Number One	Number Two	Number three
S1	√	-	√
S2	√	-	-
S3	-	-	-

Based on the examination results of students' written answers conducted by the researcher, as shown in Table 1, none of the three samples could solve the three questions correctly. This means that the three samples each have difficulties in solving problems. Diagnosis of S1 difficulty in question no two and efforts to overcome it with scaffolding.

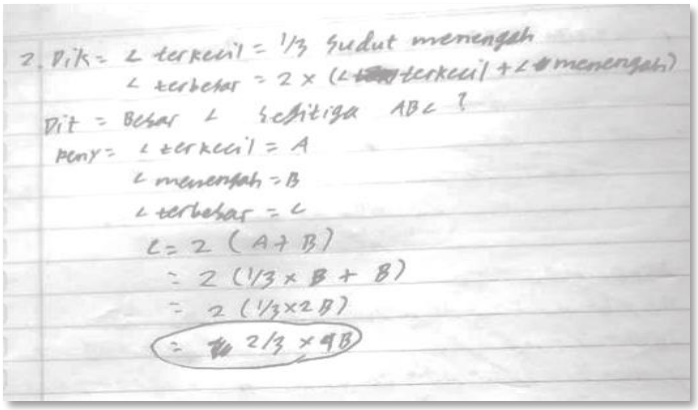


Figure 2

Completion of S1 for Question No. 2

Based on the results of S1 work and interviews, the researcher concluded that the difficulty experienced by S1 was the difficulty in understanding the problem completely (Understanding the problem). The following scaffolding interactions are given:

P: Try to read the question and explain what you understand! (Review)

S1: (reading the test questions and then the completion tests that have been made while explaining the purpose of the writing, when reading the completion section of S1, I realized that I had written equation two after being substituted with equation 1), gosh, I'm sorry, I misunderstood the equation.

P: Try to justify the deck! (Review)
S1: (Writes the equation, then looks confused and silent) I don't know how to continue the equation.

From the quote above, it can be seen that S1 can describe the information from the test statement but cannot reveal further information that the question wants. The following scaffolding is provided:

P: OK, deck, first I want to ask, will two linear equations with three variables be enough to find the solution for each equation? (Restructuring)
S1: Eee. I can't seem to do it, sis (looks doubtful)
P: Try the deck; use another solving method you have learned! (Restructuring)
S1: (trying to solve using the elimination method) Still can't, Sis. I need one more equation; the equation is constantly repeated.
P: yes, the solution will not be found because the resulting equation is constantly repeated/same. Now you can not find one more equation of the triangle? (Restructuring)
S1: Hm.., how do you do it? (looks confused as he stares and rereads the test questions)
Q: I want to ask, what do you know about a flat triangle? (Review)
S1: Has three sides, sis
P: Apart from that, try to focus on what is discussed. (Review)
S1: Eee, Has three angles total 180o
P: Well, that's right. Can you make it into a new equation? (Restructuring)
S1: (pause for a moment thinking, then surprised full of happy expression) Aaa, I already know, sis. the most extensive-angle + medium angle + most small angle = 1800. I can finish this bro, wait a minute, sis; I'll try it first.

S1 continues the solution by rewriting the three equations neatly and then looking for the solution set of the three-variable linear equation system using the elimination and substitution (mixed) methods. The solutions found are x, y, z = {15°,45°,120°}, respectively. Then at the end of the solution, S1 verifies the answer by matching the results of the hp substitution to the equation in the problem. The descriptions of cognitive mapping and scaffolding efforts for undergraduates in solving problem 1 are as follows.

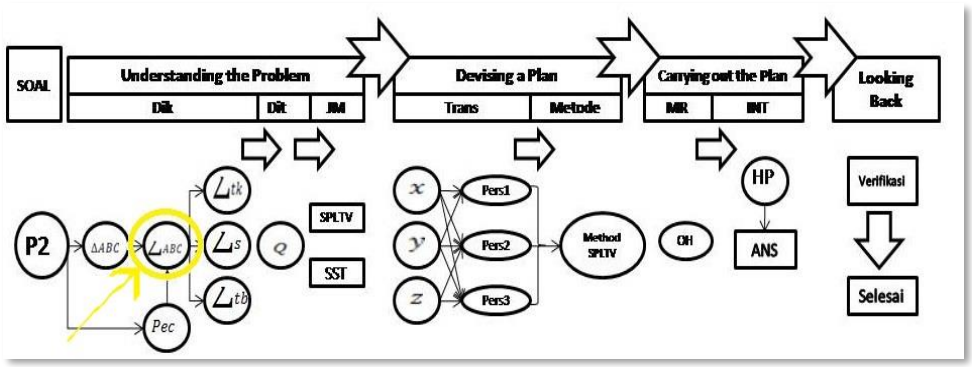


Figure 3
Mapping the Difficulty of S1 Question Number 2

Diagnosis of S2 difficulty in question number two and efforts to overcome it with scaffolding

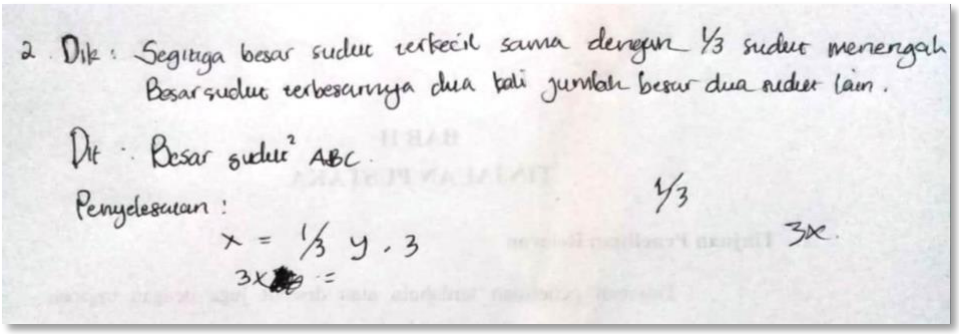


Figure 4
Completion of S2 for Question No. 2

Based on the master's work and interviews, the researcher concludes that understanding the problem (Understanding the problem) is also experienced by masters. The following scaffolding interactions are given:

P: OK, for question Number Two, why don't you proceed to the completion stage? Are you having trouble? (Review)
S1: Yes, Sis, I don't know how to make it into an equation, Sis, hehe…
P: can you tell me what you understand from the question! (Review)
S1: (S1 rereads the question, and it seems that he doesn't understand its meaning).
P: Can you describe roughly what the triangle shape looks like! (Review)
S1: Hm..,(Looks confused)

From the quotation above, it can be seen that S2 has difficulty modeling cases into equations, but S2 also seems to have trouble describing the triangular shape of the problem. Here is the scaffolding provided:

P: Try to draw the triangular shapes that you know. (Restructuring)
S1: Here, Sis, (Draw the shapes of triangles in a row: right triangle, equilateral triangle, isosceles triangle, any triangle).
Q: I want to ask, what is the difference between these triangular shapes. (Restructuring)
S1: The lengths of the sides are different, and the angles are also different.
P: That's right, each has a different side length, angle, and shape from the other. Try to focus on the rise in the problem; describe the shape of the triangle in the issue! (Review)
S1: (Looks back at the question while reading silently) Oh well, an isosceles triangle only has two different large angles. Roughly any triangular shape.
P: Yes, that's right, there are three different large angles in the triangular form (the largest, medium, and most minor tips). Now, you can not write the equations. (Restructuring)
S1: Oh yes, sis, wait a minute, I'll try, sis.

S2 tries to write by assuming x, y, and z as minor, medium, and numerous triangle angles. Equation 1 looks correct by writing $x = 1/3\ y$ or $3x - y = 0$, but when writing the second equation, S2 looks less precise, so it requires parentheses that flank the addition of x and y. As a result, the equation written becomes $z = 2\ x + y$ or $2x + y - z = 0$. When P tries to ask the truth of equation 2, it appears that S2 is silent for a moment thinking and then suddenly realizes that there is a dangerous parenthesis operation. At the completion stage, S2 seemed confused in finding the third equation of the problem, realizing the difficulty, along with the scaffolding provided:

P: OK, in discussing the angle of a triangle, how many triangle angles do you know so far? (Restructuring)
S1:180° no more and no more petite sis (quick answer)
P: OK, can any of you make an equation? (Restructuring)
S2: Ready, I understand, sis, $x + y + z = 180°$ like this, sis?.
P: Yeah, right. please solve it. (Restructuring)

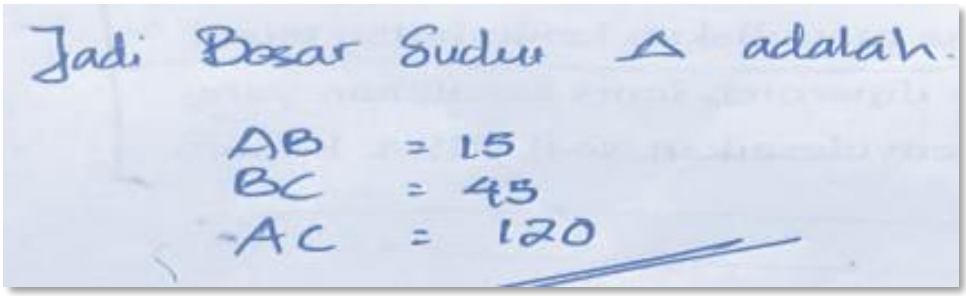


Figure 3
Conclusion of S2 Answers to Question Number Two

From Figure 3, it can be seen that S2 made a mistake when writing triangular angle notation, which resembles side notation. So P asks S2 to correct the error by finding the right note independently, then S2 rewrites the correction. The descriptions of cognitive mapping and scaffolding efforts for Masters in Solving Problem 1 are as follows:

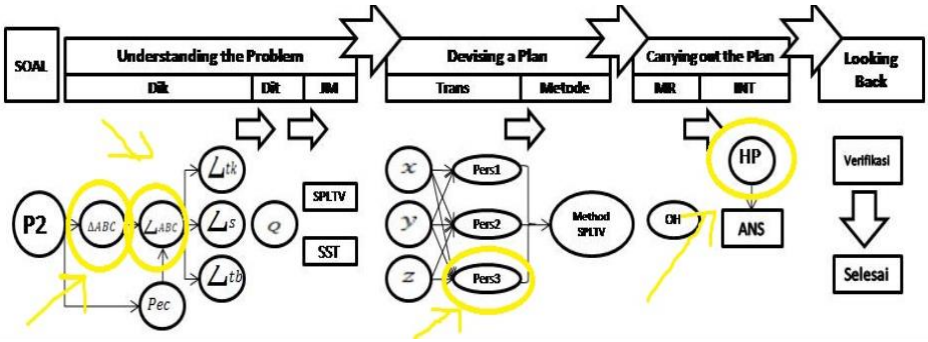


Figure 5

Mapping the Difficulty of S2 Question Number Two

Diagnosis of S1 difficulty in question number three and efforts to overcome it with scaffolding

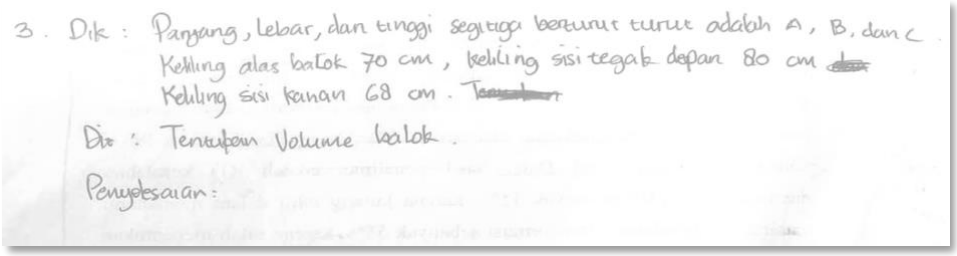


Figure 6.

Completion of S2 for Question Number Three

Based on the results of the master's work and interviews, the researcher concluded that the difficulties experienced by the undergraduate were the difficulty of understanding the problem completely (Understanding the problem) and making plans by modeling it mathematically (Devising a Plan). The following scaffolding interactions are given:

P: Try to read the questions slowly so that they are easy to understand, then convey the meaning or information about the questions one by one! (Review)

S2: (reads the questions slowly and then asks) Yes, bro, but sis, that's part A cm, B cm, and C cm. It's a bit confusing, sis?

From the quote above, it can be seen that S2 has difficulty understanding the sentence 1 question. S2 does not think that A cm, B cm, and C cm are the lengths of the ribs on the beam, which are described in succession with the shaft's length, width, and height.

P: Oh yes, deck, try sketching the shape of the space first! (Restructuring)

S2: This is a block, right, (while sketching the block)

Q: Yes, do you know the beam's length, width, and height? (Review)

S2: this is long, wide, then this is your height (while pointing to the sketch you made)

Q: So what's confusing about A, B, C? (Review)

S2: Ohh, A, B, and C are the same as x, y, z, sis. (It looks like the students have pseudo)

P: Not the same, but that's just an example. What kind of example? (explanation)

S2: A is the length of the block, B is the width of the league, then C cm is the height of the block.

P: Well, that's just an example of the unknown size (Explaining)

S2: yes, sis. How do you make the equation?

From the quote above, S2 has been able to change his mindset toward the LESTV solution. However, the final selection shows that S2 still has difficulty modeling the information into mathematical equations. When asked to show each circumference which was informed about S2, he was able to show it but did not realize the equations that could be formed in it. The following scaffolding is provided:

P: Take a look at the length of the ribs on each circumference that you have shown. In the beginning, you have labeled the size of the ribs with, for example, A cm, B cm, and C cm. Now, can you not make it into an equation? (Restructuring)

S2: What do you mean, brother? (looks confused, understanding PP sentence)

P: Take a look at the circumference of the base of the beam. Can you not make it into an equation with the size given earlier? (Restructuring)
S2: Ooh, understand, the circumference of the base of the block A + B + A + B = 78
Q: Can you not simplify it? (Restructuring)
S2 : So, bro, 2A + 2B = 78
P: Now, you can do the same thing on any circumference! (Restructuring)
S2: Oh yes, you can.

S2's difficulty in solving problem number three can be overcome through the provision of scaffolding above; this can be seen when S2 can write three equations through information about the circumference of the side of the beam. After being compiled into a three-variable linear equation system, S2 seems to solve correctly using the determinant matrix/crammer's rule solving method. And then don't forget to verify the answer by showing the result of substituting the value of the solution set into the existing equation. The descriptions of cognitive mapping and scaffolding efforts for undergraduates in solving problem 1 are as follows:

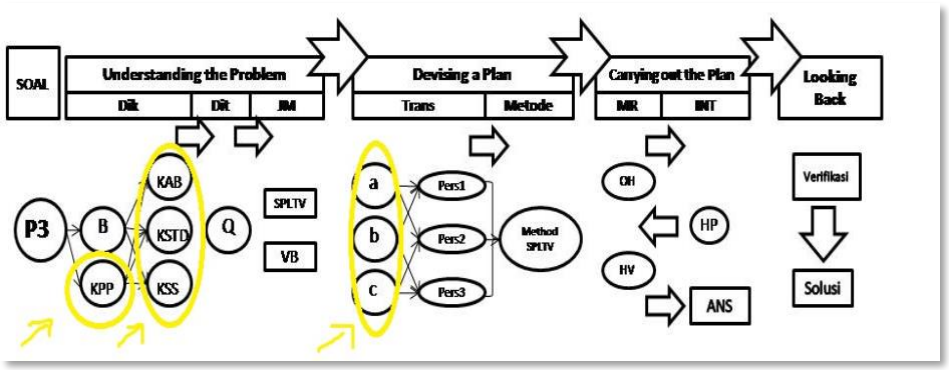


Chart 7
Mapping the Difficulty of S2 for Question Number Three

Diagnosing S3 difficulties on question number one and efforts to overcome it with scaffolding

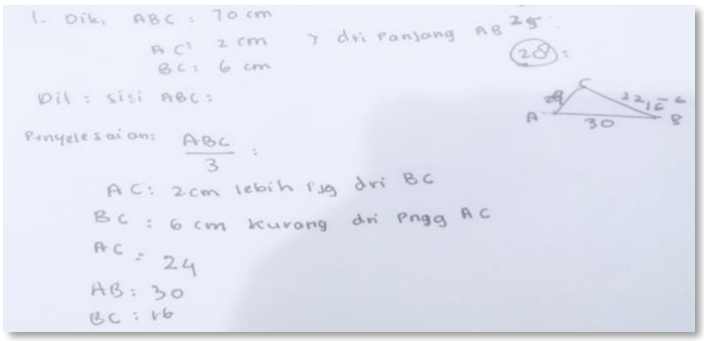


Figure 8
Results of S3 Work for Question Number One

Based on the results of doctoral work and interviews. S3 did not seem to have difficulty understanding the meaning of this question, as seen through the interview results where S2 could explain the importance of the question well. In addition, the solution that S3 tries to make shows an exciting diagnosis where S3 tries to guess the length of each side, which starts by dividing by three the perimeter of the triangle to produce an estimate of the size of the three sides, and tries to guess while matching it with the information known from the problem. However, it can be seen that the final answer given is still wrong because there are still questions that contradict the last response provided. So P concluded that S3 had difficulty developing a settlement plan (Devising a Plan). The following scaffolding interactions are shared:

P: You have understood the meaning of the question; what do you think we can do here to model the statement into a mathematical equation? (Reviewing)
S3: What are you? (still confused by the question P sentence)
P: Usually, we start by making an example first. What can we try to make an equation first? (Restructuring)
S3: the length of the shortest, medium, and longest sides. Can you make x, y, and z, bro?

P: Well, that's right, that's what I mean. The shortest side can be represented by x, the medium side by y, and the longest side by z; now, you can not write down each equation? (Restructuring)

S3: Wait, let me try, sis

S3 writes down the three equations and solves the LESTV using the elimination method.

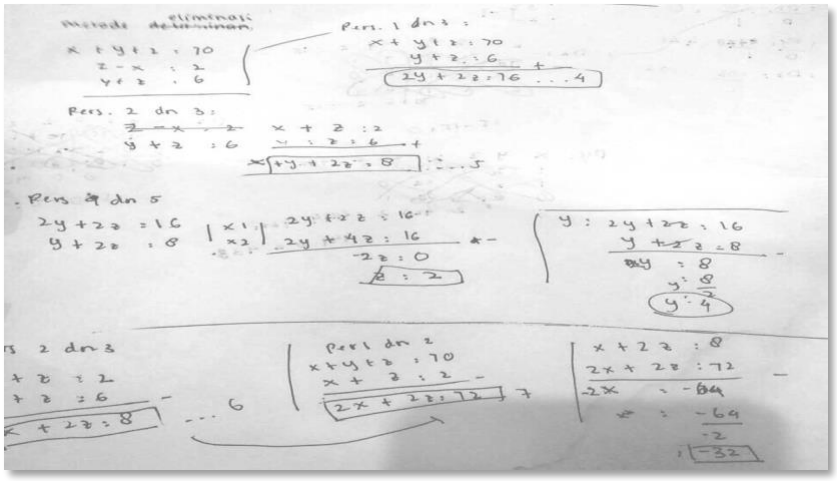


Figure 9

Completion of S3 for Question No One After Scaffolding 1

From Figure 7, S3 made a mistake at the beginning when writing y+z = 6 in the third equation, even though it should have been written y –z = 6, so the solution in the next step should have been written has continued errors. In this condition, P asks S3 to verify the value of hp obtained in the initial equation to make S3 aware of the mistakes in the solution. Realizing that there was an error in the answer, S3 tried to re-examine the solution made but could not learn where the mistake in the solution was made. Finally, P asked S3 to review the written equation three. After re-dissecting the equation simply, S3 was able to see the operating error used in the third equation, as shown in Figure 7. After improving the third equation, S3 solved the problem with the correct answer accompanied by proof of verification of the correctness of the solution set. The descriptions of cognitive mapping and scaffolding efforts for undergraduates in solving problem 1 are as follows:

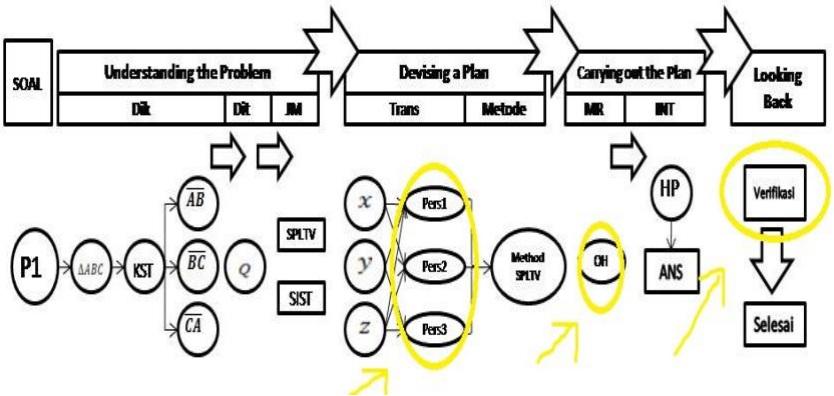


Figure 9

Mapping the Difficulty of S3 Question Number One

Diagnosis of S3 difficulties on question number two and efforts to overcome it with scaffolding

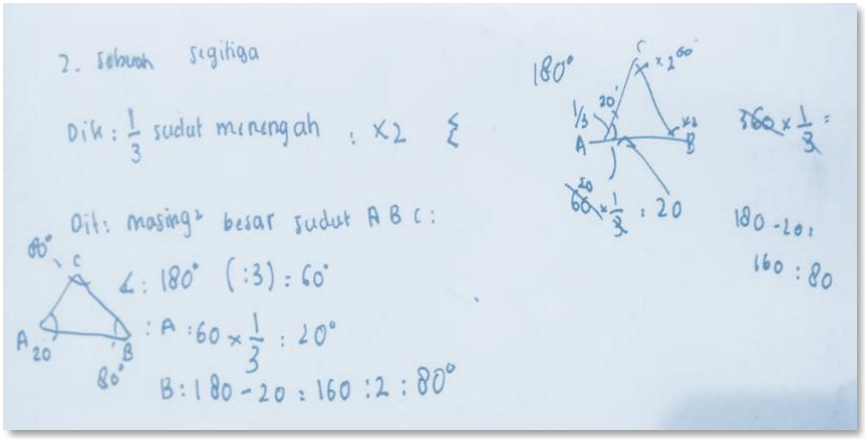


Figure 10
Results of S3 Completion for Question No. 2

Based on the results of the master's work and interviews, the researcher concludes that the difficulties experienced by the doctoral doctor are the difficulty of understanding the problem completely (Understanding the problem) and developing a good settlement plan (Devising a program). The following scaffolding interactions are given.

P: OK, number three, try to explain what is understood from the problem and how to get the solution!? (Review)
S3: OK, sis, here what I understand is a triangle with 1/3 middle angle, then multiply by two the other two angles are more extensive, my solution is bro, right triangle angle is 180° with 3 points, so I divide it by three first, so the result is 60 °, then I divide 60 ° by three so that we know the size of one of the angles of the triangle, which is 20 °, the remaining 160, I divide by 2 = the result is 80 ° sis (Explains in a stammering tone, slightly embarrassed to describe his thoughts which is pessimistic about the answer).

From the quote above, it can be seen that S3 misunderstood the information about the question. S3 tried to estimate by guessing the angle in the narrated question. Still, the data was incomplete, resulting in an incorrect answer because another statement did not adequately verify it. The following scaffolding is provided.

P: Interesting, the explanation seems to be misinformation (laughs jokingly). OK, deck, let's look again at the problem. How many angles are there that you want to look for? try to mention. (Reviewing)
S3: ee.. angle of triangle ABC bro.
P: Yes, please read the question carefully. How many different angles are there from the triangle in question? (Restructuring)
S3: Oh, there are three, sis. The first is the smallest angle, the second is the middle angle, and the third is the most significant, bro.
P: Yes, that's right, each question has a different angle. Look at your answer. Do you meet the criteria for the question? (Review)
S3: Hehe, no, Sis.

After realizing the error in the solution, scaffolding was directed to construct an understanding of S3 to solve the problems independently. The following structure is given:

P: So, can you solve it by using the LESTV solution? (Review)
S3: Huh..?
Q: Do you remember the first step to take in LESTV? (Review)
S3: For example, Sis.
P: OK, what can be, for example, in the problem? (Restructuring)
S3: Hmm..(long time thinking), maybe the smallest angle = x, the middle angle = y, and the most extensive angle = z
P: Well, that's right. Now, can't you slowly arrange the equations with the example you made? (Restructuring)
S3: Hm, I'll try it first, sis

S3 slowly reads carefully and tries to understand the meaning of the problem, and then it is modeled into a three-variable linear equation. At this stage, S3 compiles the equation including the third equation, namely $x + y + z = 180°$.

Still, when writing the first equation, it is x = 1/3 y. S3 must need basic guidance assistance with fraction multiplication operations from P to convert the equation to 3x –y = 0 to make it look identical to the other equations. After all the equations were compiled, S3 tried to solve the LESTV using the elimination method but realized that the resulting solution was still wrong by verifying the substitution of hp into the equation. The interview results concluded that S3 only experienced inaccuracy in seeing the calculation operations in its completion.

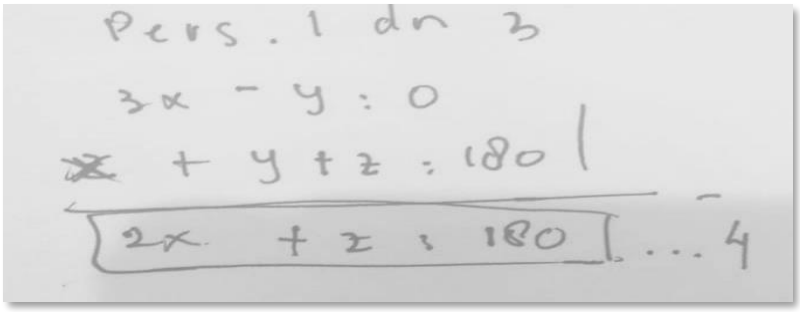


Figure 11.

Errors in the S3 Calculation Operation in Question No. 2

From Figure 9, it can be seen that S3 had a mistake, namely writing –y – y = 0 and 0 -180 = 180. After realizing this error, S3 immediately corrected and found an answer by solving the problem. The descriptions of Polya-based cognitive mapping and scaffolding efforts for Doctoral Degree in Solving Problem 2 are as follows:

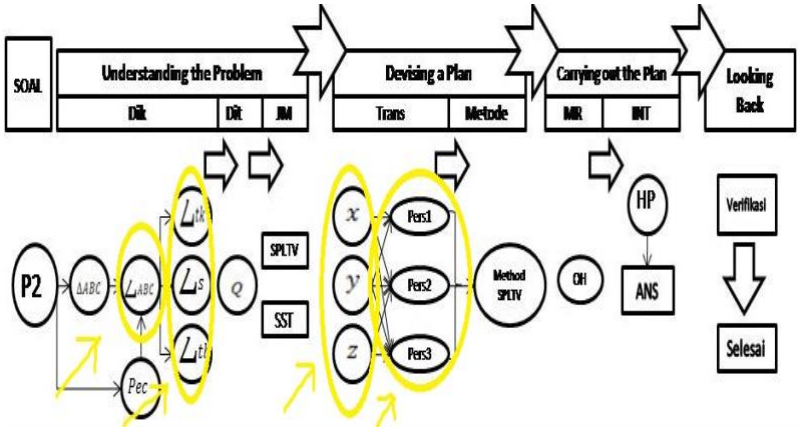


Figure 12

Mapping the Difficulty of S3 Question Number Two

Diagnosis of S3 difficulties in question number three and efforts to overcome it with scaffolding. In collecting the completion answer sheets, it was found that the S3 completion sheets were still empty. Disclosure of difficulties can only be known through interviews. The interview results concluded that S3 really could not understand the meaning of the question statement (Understanding the problem). Besides that, S3 also had difficulty modeling the statement into the form of a mathematical equation. The following scaffolding interactions are given:

Q: How come Number three is empty? (Review)
S3: Hehe, I don't understand what you mean.
P: Same as the previous question, try to read slowly and convey what you understand. (Review)
S3: (reading the question) Eh, here is what I understand, Sis. There is a block with a circumference of 76 cm from the base of the beam, 80 cm to the rim of the front upright, and 68 cm to the right side. Asked to find the volume kak.
P: OK, so what should we do if we want to find the volume of the block?
S3: Using the formula length x width x height bro.
Q: That's right, so we need information about the beam's length, width, and height. Is there any information on the problem? (Review)
S3: Here, you will explain, Sis, the length, width, and height of the blocks, respectively, A cm, B cm, and C cm.
P: Well. Now try to sketch the shape of the beam, then label each side of the shaft with that information. (Restructuring)
S3: What do you mean?

P: Try drawing first what the shape of the block looks like if the length, width, and height are different. (Explaining)
S3 : (Draw the blocks)
Q: Which part of the rib tells the length, width, then height? (Review)
S3: Ee, this is the length, this is the width, then this is the height (while pointing to the picture)
P: OK, try the other ribs also labeled. Those are parallel sides of the same length, right? (Review)
S3: Yes, sis. (write one by one) oh.. this is the equation that will be made later, sis, from the information about the circumference (starting to understand the meaning of constructive scaffolding), the front and right sides, right, sis (pointing one by one to the part of the sketch that is intended.
P: That's right. Try to make your equation for each circumference. (Restructuring)
S3: Oh yes, sis.

From the scaffolding quote above, S3 can understand the purpose of the scaffolding action given, as evidenced by the completion of the S3, which can model the statement in question into a mathematical equation. Followed by solving the three-variable linear equation system using the elimination-substitution method. The following scaffolding is provided:

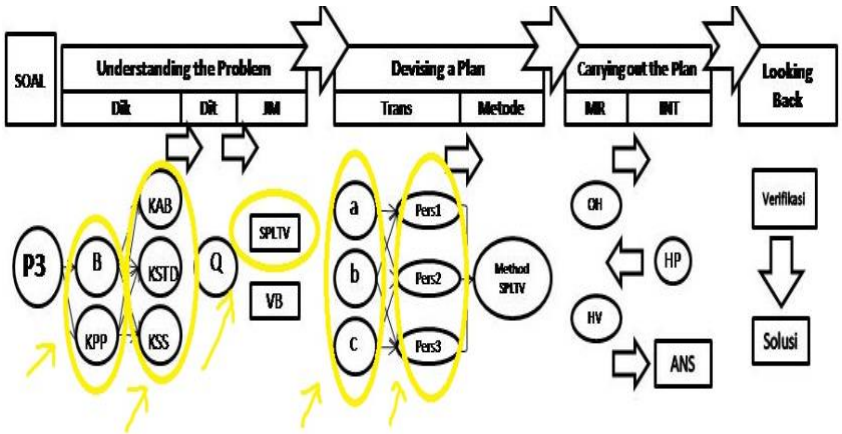


Chart 13
Mapping Errors S3 Question Number Three

Discussion

Based on the results of calculations and data analysis from this quasi-experimental study, it shows that the average effective learning behaviour learning outcomes of the experimental class that uses art-based learning (ABL) are higher than the control class that uses teaching-based practices. Learning in microteaching classes using art-based learning has a real effect on the development of effective teaching behavior of prospective teacher students. Teaching behavior with minimum standards to be based on the impact on student academic involvement (Maulana et al. 2017) initial understanding of how effective teaching can develop learning condition, classroom management, clear instruction, active learning, teaching adaptation, teaching and learning strategies. ABL has proven to be successful in developing learning outcomes in aspects of teaching behaviour.

Through art-based learning students can explore their imagination, creativity, skills and presentation of their masked works. This research supports the statement of Cathy Nutbrown (2013) that humans need art for holistic development; efforts to integrate art with other areas of learning; and stronger and clearer conceptualization of art-based learning is needed. The arts in education make learning experiences meaningful and authentic, this facilitates the development of creative problem solving, critical thinking skills, offers opportunities for students to explore, understand and appreciate themselves, and directly to their communities (Hulsbosch, 2010). ABL functions as an integrative, personal growth and development tool, documentation of experience, and for transfer of learning to work (Deaver, 2012). This research is an attempt to find a comprehensive explanation of the class given art-based learning in the practice of becoming prospective teachers.

Students' talents and interests can be directed by making something great but easy to do, easy to adapt, and using new simulations. The new simulation has been made through the visual form of the mask. Students' great interest in visual form images (Kurniawan et al. 2019) is in line with the dissertation from Brenner (2010) in the implementation of ABL, actually students who have very little artistic skills can also create great art. Student-centered learning makes it easier to adapt and reduce students' burden in understanding and learning the material presented by the teacher (Putranta & Jumadi, 2019). Art creation is a means of each individual to make new simulations (Springborg & Ladkin,

2018). Through ABL, prospective teacher students try to demonstrate creating art by creating masks with themes and stories from the material they want to teach, from preparing, making, presenting and reflecting.

Conclusion

From the results of this study, several conclusions can be drawn as follows: Difficulty in completing questions 1 in S1 and S2 because it cannot reveal complete information about the meaning of the statement of questions, besides that it occurs because the subject cannot relate to the problem given to the mathematical concepts that have been studied/mathematical models to make three linear equations variable from information about the circumference of the triangle and the length relationship between the sides of the triangle (shortest, medium and longest). The form of action given is level 2 scaffolding: explaining, reviewing, and restructuring.

It is challenging to solve question 2 in S1, S2, and S3 because it cannot reveal complete information about the meaning of the question statement sentence. At S2, there is a cognitive hole where S2 cannot simplify equations with fractional operations, so they have difficulty executing the equation using the LESTV solution method. In S2, the test occurs because of misinformation and conceptions about the problem, assuming the given triangle is the same as an equilateral triangle, even though the triangle described by the problem is an arbitrary triangle with three different angle sizes. In addition, S2 and S3 still experience errors in executing the completion plan. This happens because of the difficulty in determining the problem-solving strategy. The form of action given is level 2 scaffolding: explaining, reviewing, and restructuring.

Difficulty in completing question 3 occurred in S2 and S3 because they could not understand the meaning of the question statement sentence. In S2, a problem arose because there was a tendency for S2 to think pseudo, unable to reveal the examples stated in the questions in the form of notation A, B, and C. S2 considers that such an example is not as usual with the usual solutions so that it becomes one of S2's difficulties, besides that S2 also has a little difficulty determining a good solution strategy. In S3, he could not write down any solutions because he could not understand the intent of the questions. From the interview results, the researcher concluded that S3 was difficult to understand the information about the questions. Still, there were also difficulties in S3 when compiling a completion plan and executing the completion and the form of action given. Is scaffolding level 2, namely, explaining, reviewing?

Difficulty understanding the problem is the most common problem in every child. This difficulty occurs because the format of the questions presented is not as usual in class. The design of the questions consists of a story, and the questions are asked at the end of the story. The tendency of students to think pseudo in solving problems is one of the obstacles at this stage where students are no longer faced with similar questions but are modified to make the process of thinking and search visibility.

Some subjects experienced minor errors in solving due to a lack of accuracy in carrying out calculation operations. The answers to questions were not appropriately verified after finding the solutions.

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Research Article

Exploring challenges experienced by foundation phase teachers in using technology for teaching and learning : a South African case study

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Abstract

The Department of Education introduced the policy on e-Education in 2004, encouraging all teachers to implement technology for teaching and learning. Despite this encouragement, most South African teachers are experiencing many challenges to effectively use technology for teaching and learning in the foundation phase. As a result of the COVID-19 pandemic, schools had to adapt to the use of technology for teaching and learning. This placed most teachers in a compromising situation since teachers were now forced to engage and use technology for education. For this reason, this study promoted us to explore the challenges experienced by foundation phase teachers in using technology for teaching and learning in two schools in one district in Gauteng Province: South Africa. The Technological Pedagogical Content Knowledge framework was used as a lens to understand the challenges experienced by foundation phase teachers. The authors applied a qualitative research approach within the interpretivist paradigm to explore and understand participants' lived experiences of their challenges. Purposive sampling was used to select eight foundation phase teachers from two schools in Gauteng Province. The findings revealed that most teachers experienced challenges due to lack of knowledge and understanding of how to use technology effectively for teaching and learning; a lack of support from management to promote the use of technology and inadequate, inappropriate and outdated technological resources and equipment. Teachers also indicated that they did not enjoy the support from their senior managers and education officials. They recommended that all teachers undergo focused training and development on the use of technology for teaching and learning and that the education department should consult teachers and ensure that all systems are in place prior to mandating the implementation of technology in the foundation phase.

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Introduction

The e-Education policy was introduced to all South African public schools to transform education and to prepare learners for the 21st-century demands and needs of using technology (Department of Education [DoE], 2004). One of the primary goals of this policy was the emphasis and obligation placed on education to use technology for the improvement of learning outcomes and skills development. Digital technologies have become an essential part of people's lives and affect all sectors of society, including education. It is for this reason, that the DoE identified the need to introduce the implementation of technology in all phases in the education system (DoE, 2004). Despite the policy mandate, teachers are challenged and reluctant to use technology for teaching and learning (Vandeyar, 2013).

The closure of schools due to the COVID-19 pandemic and the urgency to find alternative ways of supporting learners, prompted many schools to adopt technology for teaching and learning. Most teachers in South Africa and globally held the view that technology will revolutionise the field of education and alter the way they will teach and instruct learners. Despite this knowledge and awareness not all teachers were equally enthusiastic about using technology as part of their instruction. The COVID-19 pandemic placed most teachers in a compromising situation whereby they were forced to use technology for teaching and learning. Teachers were introduced to new technology which they were unfamiliar. They lacked the necessary skills and knowledge on how to use technology for teaching and learning. As a result of this phenomena many teachers in the foundation phase experienced high levels of stress and anxiety.

The DoE (2004) policy was developed and aligned to the Mishra and Koehler's (2006) Technological Pedagogical and Content Knowledge (TPACK) model. This model emphasised the importance of technological content knowledge (TCK) for teaching and learning. Although there is much emphasis on capacity building and relevant and appropriate training for the implementation of technology for teaching and learning, there is a huge gap between teachers abilities, knowledge and understanding to implement technology for teaching and learning (Vandeyar, 2013). The TPACK model clearly articulate the importance of content knowledge (CK), pedagogical content knowledge (PCK) and TCK (Mishra & Koehler, 2006) which is lacking in most South African foundation phase teachers (Ramorola, 2010). According to Powers & Blubaugh (2016), they state that all teachers should have the ability, knowledge, understanding to include basic technology and technological applications in their teaching and learning to develop skills in learners to meet the 21st century needs and demands.

This qualitative case study reported in this article investigated the challenges experienced by teachers using technology in the foundation phase classes (Grades 1-3). The authors formulated the following research questions to guide this study (i) What challenges do early grade teachers experience in implementing technology in their foundation phase classroom? Insight into the different barriers early grade teachers face when using digital technology in their teaching and learning programs could create a better understanding of their challenges. These challenges would assist in developing appropriate recommendations that would motivate and encourage teachers to implement technology in their classrooms. These insights could contribute to what Ayers, Mechling and Sansosti (2013) refer to as launching a process of thinking to enable the development of appropriate learning programs that will accommodate the diverse needs of learners by integrating digital technology more effectively

Powers and Blubaugh (2016) and de Silva, Chigona & Adendorff (2016) agree that the use of digital technology is natural to 'digital native' children (learners); since these children are born into a world where technology has become part of their daily lives. In her study, van Jaarsveld (2017) found that children as young as six months to 8 years interacted with digital technologies with the support of their parents. Digital technology has become the new norm for teaching and learning; therefore, to exclude the use of digital technology in the teaching and learning processes is tantamount to separating their classroom experiences from their daily life experiences. Azarfam and Jabbari (2012) argue that teachers should be mandated to implement technology in their classrooms to accommodate all learners in this digital era. This would require teachers to change their teaching and assessment practices. Teachers continued to provide worksheets and other learning material to learners and expected their parents to support the teaching and learning at home instead of using this opportunity to utilise technology (Jantjie, 2020). The Covid-19 pandemic provided the opportunity for most

educational institutions to embark on an online teaching and learning approach. However, in South Africa, most teachers in the foundation phase seldom use technology for teaching and learning (Hannaway, 2019).

Roualdes (2013) believes that digital technology in the foundation phase classroom remains a powerful means for teachers to enhance their educational programs. Therefore, it is necessary and beneficial for them to become accustomed to and familiarise themselves with the use of digital technology to improve their teaching and learning. According to the National Council of Teachers of Mathematics (2000), teachers need to embrace modern thinking and endeavour to use digital technologies to facilitate learner development. According to the data from the National Education Information Management System (DBE, 2018), the table below presents the information on computer labs in both primary and high schools and those primary and high schools that have internet connectivity.

Table 1

Statistic Data about Technological Facilities of Primary Schools at South Africa

Province	No computers		Internet Connectivity	
	Primary Schools	**High Schools**	**Primary Schools**	**High Schools**
Eastern Cape	4049	685	2456	1322
Free State	388	144	306	171
Gauteng	235	154	280	107
KwaZulu-Natal	2950	935	2342	1964
Limpopo	2138	1119	2546	838
Mpumalanga	735	161	281	275
North West	644	161	281	275
Northern Cape	216	31	0	0
Western Cape	503	70	250	13
Total	11858	3590	9313	5369

Department of Basic Education, 2018. Education Management Information Systems (EMIS)

Gauteng is one of the leading provinces that has been using technology for teaching and learning. According to de Silva, Chigona and Adendorff (2016) there has been an increase in school implementing technologies into their educational programmes. The Department of Education (2004) developed the White Paper on e-Education, highlighting the importance of technology for 21st-century skills. The race to implement technology has come with its benefits and its challenges. Embracing technology at the classroom level is not easy. Cost, access, and time are usually considerable barriers – also referred to by Ertmer (1999) as first-order barriers. Second-order barriers relate to a lack of knowledge regarding how best to integrate technology for the benefit of learners across a diverse range of subject areas (Powers & Bubaugh, 2016). Azarfam and Jabbari (2012) assert that this lack of knowledge leads to fear and anxiety when using and implementing digital technology in educational programs, thus resulting in ineffective implementation.

Project Photos

Computer labs in schools in Gauteng to promote technology use for teaching and learning

This computer lab aims to promote technological enhancement to help learners adapt to the growing digital world of learning.

Learners are using computers games for learning

Figure 1

Project Photos of Schools in Gauteng Province

Looking at ineffective implementation and use of digital technology in teaching and learning programs, this study gives a scopic view on both internal and external factors contributing to this anomaly. Azarfam and Jabbari (2012) stated that the seriousness of anxiety or technophobia among teachers regarding digital technology in classroom practices is often disregarded. Technophobia can typically be defined as a fear of technology, as supported by Brosnan (1998), who describes it as a negative and irrational response or attitude to technology and the use thereof. According to Juutinen, Huovinen and Yalaho (2011), technophobia is essentially causing one of the biggest stumbling blocks for successful digital technology integration into teaching and learning programs. Insight into the challenges foundation phase teachers face when using digital technology in their teaching and learning programs could contribute to creating a better understanding of the fears and anxieties faced by teachers and, in effect, motivate change in teaching practices.

According to Blinnikova (2017), technologies are developing faster that we can grasp and understand it. This lack of understanding causes fear and rejection to implement technologies in teaching and learning. Blinnikova (2017), states that technophobia is an internal resistance that arises when individual begin to think and talk new technology. The COVID-19 pandemic significantly attributed to this phenomena when the Department of Education embarked on online teaching and learning. Since teachers were forced to use technology, there is evidence of high levels of persistent prejudice and negative attitudes towards implementing technology. Research by (Ramorola, 2010) has found that the level of technophobia among individuals can be related to personal traits and person confidence among teachers. Technophobia an also be associated with the fear of losing one's autonomy and control over one's action. Vandeyar (2013) state that teachers are anxious because their learners are more knowledgeable on the use of technology, the different software and programmes. Cascio and Montealegre (2016) argue that the attitude towards any new technology depends on whether it interferes with an individual's self- identity and morality.

Literature Review

Technological Content Knowledge

It is a lack of sufficient technological knowledge that contributes to the challenges to use technology in the foundation phase and the phenomenon of technophobia among teachers. Many foundation phase teachers are under the impression that digital technology and the use thereof cannot meet the learning needs of learners (Azarfam & Jabbari, 2012), thus resulting in a misperception of the effectiveness of the use of digital technology. Teachers need to understand and be aware of the learning needs of all learners in this technologically driven world (Parette et al., 2013), but often this insight is clouded by negative emotions towards the use of digital technology (Juutinen et al., 2011).

Powers & Blubaugh (2016) agree that teachers should have the knowledge, understanding and the ability to include digital technology in their teaching and learning programs. They should also develop educational technology activities appropriate for different learning situations which expect teachers to have sound content and technological knowledge and understanding. Kayalar (2016) further states that although teachers have good content and pedagogical knowledge, they lack technological knowledge. This is confirmed by Hennessey, Habler, and Hofman (2015) who state that teachers often experience difficulty associating theory and practice. The reason could be that, in many third world countries, most teachers are not trained to use technology in their classrooms.

Hennessey et al. (2015) and Davidson, Richardson, & Jones (2014) found that most training programmes concentrate of developing the theoretical (content) knowledge of teachers, and often compromising the practical implementation. Misconceptions thus arise amongst teachers that the use of digital technology is time-consuming and that it distracts from the primary curriculum objective (Hennessey et al., 2015). A finding by Afshari et al., (2009) revealed that teachers have not been trained to implement technologies for teaching and learning. The lack of training has resulted in teachers lacking knowledge and competency to effectively use technology for teaching and learning. Yurdakul et al. (2012), is of the opinion that insufficient technological knowledge is a barrier to assimilating technology integration for teaching and learning, therefore contributing to teachers apathy and reluctance to use technology (Azarfam & Jabbari, 2012).

As learners belong to a technologically driven generation (Huddlestone, 2016), they are interested in technology and focused on its use and development (Gallardo-Echenique et al., 2015). Using technological devices that are of interest to screen-orientated learners, the learners' attitude towards learning changes, opening up a gateway for successful learning (Yurdakul et al., 2012). According to Blair (2012), the role of digital technology in the classroom needs to be seen in a new light. It is crucial for learners to develop specific skills to succeed in a technology-based life. In this regard, critical thinking, creativity, communication, and collaboration must be acquired and developed in a technology-supported classroom and learning environment (Blair, 2012). According to Kayalar (2016), technology offers teachers the opportunity to redesign and modernise teaching resources to suit various learning situations and environments. This provides an opportunity for developing a holistic and interactive learning environment that captures the attention of all learners. This window of opportunity to optimise teaching and learning is lost when digital technology is not effectively used in the foundation phase classroom due to the various challenges experienced by the teacher (Vandeyar, 2013).

Lack of Sufficient Digital Resources and Support

Due to the increasing development and internet connectivity in first-world countries, Terras and Ramsay (2012) state that these developments offer more access to digital technology for teachers. In most developing countries, including South Africa this phenomena is not apparent. This lack of connectivity is one of the reasons why the use of technology is less effective; further, contributing to the challenges and experience of technophobia amongst teachers (Juutinen et al., 2011). It has also been noted by Keengwe, Pearson and Smart (2009) that despite some teachers having access to digital technology devices in their classrooms, they do not receive appropriate assistance and support from school management. Teachers report a lack of support from relevant stakeholders especially when they are faced with technical difficulties and selection of appropriate software content for their learners (Vandeyar, 2013). This lack of support creates anxiety and stress, resulting in an unwillingness to explore and discover the potential the technology can offer. Hennessey et al. (2015) and Ramorola (2010) state that often teachers are not included in the discussion or consultation forums regarding policies and the implementation of technologies for teaching and learning. It has been found that teachers are 'left-out' in the decision making platform or the selection of age-appropriate digital content for their learners. Teachers are the key stakeholders in developing and implementing digital technologies in the foundation phase classroom to develop 21st century skills and therefore they should be consulted in the decision making process (Kayalar 2016; Vandeyar, 2013; Keengwe et al. 2009).

Both Hennessey et al. (2015) and Pelgrum (2001) agree that teacher education, professional development and support have been neglected, especially in African countries in the area of technology and technology upgrade. The implementation of digital technologies in the foundation phase classrooms can effectively create a successful teaching environment which can spark the interest and enthusiasm of young learners towards the use of digital technologies. Unfortunately, implementation is easier said than done (Vandeyar, 2013; Philip & Garcia, 2013).

When looking at the wide range of barriers that prevent the successful implementation of digital technology it is essential to note the impact of teaching culture and the attitude of teachers (George & Ogunniyi, 2016). However, the struggle is not digital technology but rather the implementation thereof in their teaching and learning programs. According to Azarfam and Jabbari (2012), in most cases, teachers revert to using a traditional teaching approach where they are the information holder and the learner must be taught. This teaching method is the least effective way of teaching, but it is the only method of instruction that teachers are most familiar with (George & Ogunniyi, 2016), therefore the revert to the traditional teaching.

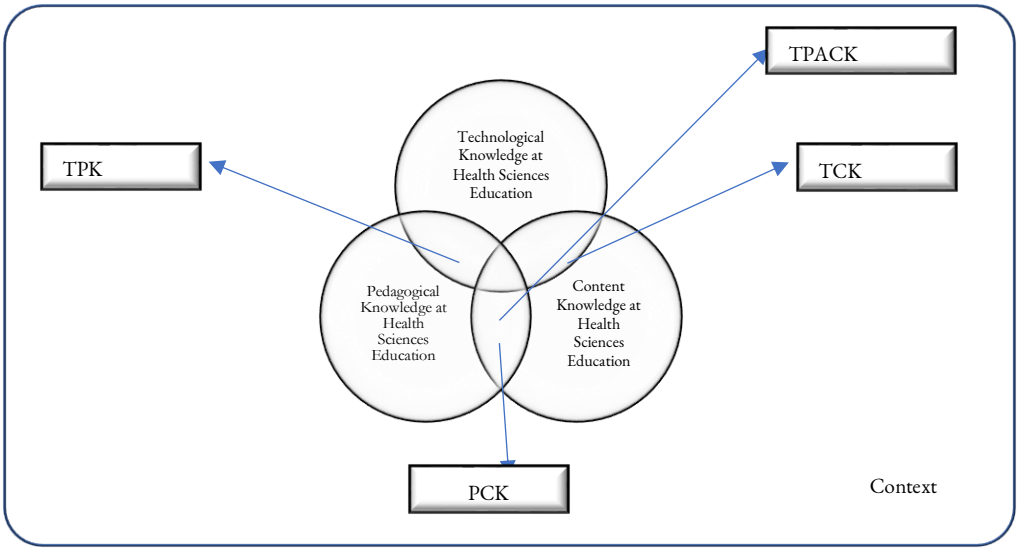
Hennessy et al. (2015) confirm that when the focus is on the learners and creating the most suitable learning opportunities by using digital technology, learners will be encouraged to reach their full potential. Unfortunately, this outcome is not always the case because of the challenges teachers experience and their lack of enthusiasm to implement technology. This culture of teaching does impact the successful implementation of digital technology in teaching and learning programs, therefore it is imperative that teachers are encouraged and supported to embrace technology (Lai, 2011).

Theoretical Framework

In this paper, the Technological Pedagogical and Content Knowledge (TPACK) model, proposed by Mishra and Koehler (2006), was used as a lens to explore the challenges experienced by teachers in implementing technology for teaching and learning in Foundation Phase (See figure 1). This model was developed on the Pedagogical Content Knowledge (PCK) model initially established by Shulman (1986, 1987). In addition to the PCK model, the advancement of technology substantially impacts the way we teach and the way students learn. Consequently, the TPACK model was introduced into education which is currently recognised as the most widely used framework to evaluate different perspectives in education with technology (Goradia, 2018; Sang et al., 2016).

There are three core components to the TPACK model: pedagogical knowledge, content knowledge, and technological knowledge. The basic claim of the model is that the proper combination of these components gives way to four other types of knowledge, namely: content knowledge (what); pedagogical knowledge (how), and technological pedagogical content knowledge (which technology/ies) (Elas, Majid & Narasuman, 2019; Oner, 2020). The model presents technology as the third core domain of teacher-knowledge and content and pedagogy (Oner, 2020). Glowatz and O'Brien (2018) argued that various other blended knowledge domains could be derived from the three domains, such as technological content knowledge (TCK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK) and TPACK.

Many schools have utilised technology for teaching and learning to improve students' engagement and achievement in the educational context (Andyani et al., 2020). The TPACK model is a useful theoretical lens to explore the dynamic elements in education with technology (Glowatz & O'Brien, 2017). This model further assists in defining teachers' efficiency when using digital technologies (Archambault & Barnett, 2010; Chai et al., 2011). The TPACK model is helpful for understanding, developing and improving tools suitable for effective learning and teaching (Archambault & Barnett, 2010). It is useful, especially in determining the experiences and practices of foundation phase teachers when using digital technologies, as well as the challenges they face. Chai et al. (2011) stated that the TPACK model is an effective framework that can cast light on educational problems experienced by teachers in the 21st century. Mishra and Koehler (2006) mentioned that it is crucial that teachers have a firm understanding of how technological knowledge relates to pedagogical and content knowledge to ensure effective teaching and learning.



TPK: Technological Pedagogical Knowledge **PCK**: Pedagogical Content Knowledge **TCK**: Technological Content Knowledge **TPACK** : Technological Pedagogical Content Knowledge

Figure 2

The TPACK Model (Adapted from © 2012 by tpack.org)

Aim and Problem of the Study

This study aimed to explore the challenges experienced by foundation phase teachers in implementing technology for teaching and learning. Technology is rapidly gaining momentum across the globe, and still, South African foundation

phase teachers are reluctant, despite the DoE (2004) encouraging teachers to use technology in their classrooms. This study focused on Foundation Phase teachers in one district in Gauteng Province in South Africa. Using the TPACK model developed by Mishra and Koehler (2006) as a lens to explain the challenges experienced by teachers and their reluctance to implement technology. This model articulates and recommends the importance of sound technological content knowledge (TCK) for implementing various technologies for teaching and learning.

Research Problem

The main problem of the research focused

- What are challenges experienced by foundation phase teachers in implementing technology for teaching and learning in the foundation phase?

Sub-problems

- What strategies can be developed to support teachers to implement technology for teaching and learning.

Methods

Research Model

Qualitative research focuses on the meanings, characteristics, and experiences of phenomena or participants (Lune & Berg, 2017; Yin, 2018). In this study, a qualitative research approach with an interpretivism paradigm was applied to understand the challenges experienced by teachers in implementing digital technology in the foundation phases (Mogashoa, 2014; Yin, 2018). This research approach allows the researchers to investigate the challenges experienced by foundation phase teachers use technology for teaching and learning. The interpretive paradigm is a subjective epistemology that makes sense of data participants' experiences through researchers' interpretation (Kiyunja & Kuyini, 2017); this approach allows the researchers to explore the participants' experiences (Creswell, 2014).

A single case study design was selected in this study, "an intensive study about a person, a group of people or a unit, aimed to generalise over several units", as argued by Gustafsson (2017:2). Two different schools in Gauteng were selected as the case. Both schools were identified as recipients of many digital technology devices to be used as part of an upliftment program. This method provided an opportunity to explore a particular in-depth investigation on significant factors of a phenomenon, which referred to the experiences of technology in this study (Yin, 2018).

Participants

Eight (8) participants were selected in this study from two different schools in Gauteng Province. Only teachers who were teaching in the Foundation Phase were invited to participate in this study. Teachers were informed of the data collection process prior to them consenting to participate. All eight participants agreed and signed the consent forms to participate in a separate focus group interview. Two interviews were held, one in each school with all the participants.

For this study, the codes T1FRA –T8F3B were used. The T refers to teachers; number 1-8 refer to the participant number; F refers to females; R-3 refer to grades R-3 and A and B refer to the two schools. The authors ensured the focus of the study was to delve into the views and perceptions of the identified participants towards the experiences of teachers using technology in the Foundation Phase during the Covid-19 lockdown.

Table 2

Structure of Participants

Participant No	School	Gender	Code
Teacher 1 – Female - Grade R	A	F	T1FRA
Teacher 2 – Female – Grade 1	A	F	T2F1A
Teacher 3 – Female – Grade 2	A	F	T3F2A
Teacher 4 – Female – Grade 3	A	F	T4F3A
Teacher 5 – Female – Grade R	B	F	T5FRB
Teacher 6 – Female – Grade 1	B	F	T6F1B
Teacher 7 – Female – Grade 2	B	F	T7F2B
Teacher 8 – Female – Grade 3	B	F	T8F3B

The two identified schools were recipients of many digital technology devices through the teacher and learner empowerment project as part of an upliftment programme. The researchers used a purposive sampling strategy to identify the research sites. The criteria for selecting both these schools were very specific and purposive: they had to be primary schools in Gauteng province; the school had to use digital technology to support lessons and the participants had to indicate their willingness to voluntarily participate in the research project.

Data Collection Tool

Data collection is a systematic process of gathering information to answer research questions and evaluate outcomes (Kabir, 2016). The researchers used a semi-structured open-ended interview schedule as the data collection instrument. Interviews allow researchers to investigate phenomena with specific purposes and still maintain the flexibility of inquiry, according to Cohen, Manion and Morrison (2018). Consequently, semi-structured open-ended interviews were conducted to elicit information on teachers' experiences of using technology in the Foundation Phase.

Semi-structured Interview Form

The researcher developed the semi-structured interview form. The form was divided into two subsections, A and B. Section A requested biographical data, and section B elicited participants' responses regarding using technology in the Foundation Phase. The researcher followed the guidelines advocated by Maree (2020), that most questions should be open-ended to give participants the opportunity of sharing their personal, lived experiences of the phenomenon under study; that the researchers use language that the participants can understand and respond appropriately; and that questions should not be leading to a particular response. Finally, all questions should be short as possible. To ensure the validity and unbiasedness of the questions, the researcher presented the questionnaire to senior staff members in the Early Childhood Education department at the University of Pretoria to critique and advise whether the questions were clear, concise, appropriate and unambiguous. Since there were no severe modifications, the instrument was valid and suitable for this study (Annexure A).

Data Analysis

The six-step thematic analysis was adopted in this study to identify similar and dissimilar views with qualitative data and make sense of important themes in the research (Creswell, 2014; Maguire & Delahunt, 2017). Post transcription and member checking took place to ensure that the data was correct and without misinterpretation (Maree, 2020).

Ethics

Ethics approval was granted by the ethics committee of the University of Pretoria (EC16/06/01) and the Gauteng Department of Education. All participants were formally invited and signed the consent forms agreeing to participate in the study willingly. They were further informed of voluntary participation and were not obliged to remain throughout the study. All participants consented to participate in the face-to-face interview at their school. They were guaranteed anonymity and confidentiality of their participation. They were also informed that no names would be used during the reporting phase of the study. The table above presented each participant with a code as a pseudonym to uphold this clause.

Results

The participants in this study were a homogenous group of foundation phase teachers. Only females participated in this study since most foundation phase teachers in South Africa are females. All these teachers had more than five years of teaching experience and had some experience in the use of technology for teaching and learning. The objective of this study was to explore the challenges experienced by Foundation Phase teachers when using technology for teaching and learning. Four (4) broad themes emerged from the focus group interviews, which revealed significant challenges:

- Teacher's knowledge and skills and attitudes toward technology
- Lack of resources, maintenance and technical support
- Poor support from school leadership and management
- Teacher development and training.

Theme 1: Knowledge, Skills and Attitudes towards Technology

In preparation for the effective implementation of digital technology in teaching and learning programs, 21st-century teachers need to possess the knowledge, skills, and understanding of digital technology for teaching and learning (Mishra & Koehler, 2006; Powers & Blubaugh, 2016). This view was agreeable to all participants in the study. T3F2A voiced her view by stating, '*we are moving into the 21st century and our young children know how to use computers, laptops and iPad. I will need to learn how to use these if I want to be a teacher in the 21st century.'*

Findings reveal that many teachers lack ICT related knowledge and understanding. Even when the proper resources are available, teachers often struggle as a result of inadequate knowledge and understanding of specific technology, technology-supported pedagogy, and technology-related classroom management. This phenomenon is echoed by T1FRA who stated, '*although I used computers at home for typing, I have no knowledge of how to teach computers to children. My son showed me how to capture marks for my class*.' T3F2A and T4F3A also agreed with T1FRA.

> *They stated that they were in a similar situation. They get support from their partners on using computers and other ICT technology at home. They also indicated their lack of enthusiasm to learn because of fear that they may "break or damage" the equipment. Furthermore, they stated that they were old teachers and ready to retire; therefore, it was futile for them to learn to use computers, iPad and other digital equipment.*

Despite their lack of enthusiasm and other factors to use technology, all the participants agreed that they have the resources at home but lack appropriate knowledge and skills to implement the technology for teaching and learning. They also indicated that if they were given the necessary training on how to use computers and the programs, maybe they will be willing to implement.

The findings suggest that most teachers have some experience using computers, but they may lack the opportunity to use them in the classroom as a learning resource. They may, therefore, struggle to use digital technology to improve their teaching and learning. Ramorola (2010) states that for many teachers who are new to computers or the internet, the use of technology for teaching and learning can be a fearful experience. T5FRB aptly voices this view. T7F2B said, '*our department of education want us to use computers in our classroom and they talk of 21st-century skills, it's easy for them to say that, yet they do not understand or know how scary it is for an over 55-year-old foundation phase teacher to start using a computer for the first time.'* T5FRB agreed with T7F2B when she said, '*I am more embarrassed in class when my learners tell me that I am not doing the right thing. I might as well not use the computer room than go there and struggle. My learners seem to know more about computers than me. It's kind of embarrassing with my grade Rs."* When a teacher finds technology overwhelming or frightening, it is unlikely that they will use technology for teaching and learning. Teachers may be reluctant to incorporate technology in their planning for teaching and learning.

The choice of whether and how to use technology for teaching and learning is dependent on the teachers and the views and perceptions they hold about technology. The participants' attitude towards the use of digital technology in their teaching and learning programmes was ambivalent. Eight respondents indicated:

> *they do not mind using technology for teaching and learning. They believe that they should be capacitated with the appropriate knowledge and skills to use ICT technology in the foundation phase classroom. They also agreed that the technology is becoming popular among children when they see how their children use cell-phone technology and iPads for games.*

T2FRA and T3F2A said, *'technology and computers are everywhere, look at the shops, internet café, cell phones, iPad, these children know them all. Give your foundation phase learners a cell phone and they will change the screen, ringtone and everything – you look like an idiot in front of them.'* T8F3B concluded by saying, '*I would like to use technology...we as teachers don't have the appropriate skills to implement technology correctly, and it can be of help to our learners*.' In contrast, T5FRB indicated that she did not want to use digital technology in their classrooms due to her lack of knowledge and understanding. She indicated, '*there were too many challenges, making it impossible to implement and maintain the use of digital technology on a more frequent basis and in more learning areas*.' For these reasons, T5FRB

indicated that she did not want to use digital technology to support her teaching and learning programmes. Ramorola (2010) agrees that teachers who are not confident to use technology refrain from using it in the classroom. Along the same lines, T6F1B indicated: "*I don't know how to use it (digital technology) as part of my lessons...*" This reveals that a lack of knowledge and skills to use digital technology in learning programmes is one of the main reasons digital technology is not being effectively implemented in classrooms. Once again, T5FRB blatantly stated that '*someone must come and train me very well in computers before I can change my mind to use it in my class. Otherwise, they must give me a teacher-aid who can help me in the computer room.'* This statement by the participant shows how desperately teachers need sufficient training and support.

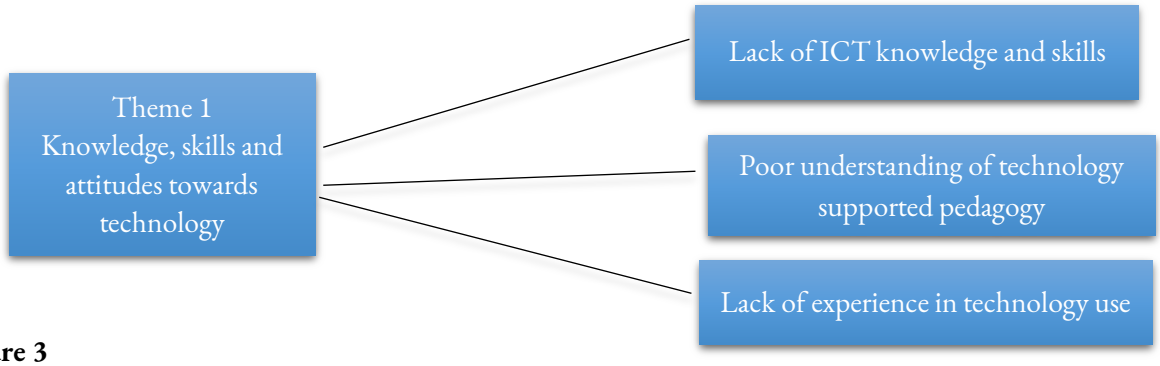


Figure 3

Codes of First Theme

Theme 2: Lack of Resources, Maintenance and Technical Support

Data obtained from the participants revealed that their school did not have sufficient equipment such as computers, printers, scanners, mouse, mouse pad, updated internet connection. They noted that this posed a significant challenge to them in the foundation phase as they had large classes and few computers. Learners were forced to sit in groups of five around one computer. They indicated for example, '*we cannot manage our learners in the computer lab. There are so few computers and children are constantly fighting with each other to use the computers.'* T4F3A said, '*I have to manage discipline in the classroom, instead of showing them how to use the computers*.' T7F2B and T8F3B agreed that 'schools *should provide more computers and larger computer classrooms to accommodate all the learners. These small heated rooms with just a fan to cool the place is not enough for us*.' T2F1A further articulated that '*more often when I go to the computer room there is no internet connection or we have power outages. I just waste my time going to the computer labs. I can spend that time teaching reading in my class*.' T4F3A, T5FRB, T7F2B and T8F3B indicated that the use of digital technology in teaching and learning programmes is made 'very challenging', with limited resources available to them. Seeing that resources are limited, participants seemingly face a hefty challenge in classroom management when implementing digital technology in their classrooms. It is the experience of T1FRA that *'[l]earners also become lazy, it's like they don't want to do regular classwork after working with the computers*.' T5FRB supports this by stating: '*I experience a big problem in class discipline when I try and use technology in a lesson, it is as if the learners become different, they are so unruly'.* The findings highlight discipline is a major challenge for most teachers during and after computer lessons. Participants indicated that learners lacked the enthusiasm to revert to normal teaching. They found their learners became more playful and disobedient.

Another major challenge experienced by teachers is maintenance and technical problems. T2FRA states '*every time I go to the computer lab, I always find computers not working. I must send a message to the secretary in the office. I have to wait and wait, no one comes to help. Then time is up and we have to leave*.' T4F3A also indicated that she has similar problems, for me '*it's just bad luck, whenever it's my turn to use the computer room, there's no power, or the cables are gone missing. It is so frustrating walking my learners to the lab and then finding out that there is no power. My principal tells me to do a theory lesson, what do I know about computer theory. All I can tell them is that this is a mouse, computer screen, keyboard...'* Many teachers are unfamiliar with using technology and technical problems which exacerbate the situation. Teachers are left helpless with a rowdy class of learners. There is no qualified technician in the computer labs to assist teachers timeously. Participants stated that all schools should employ technical support from outside services since the

education department does not provide this service. As a result of maintenance and technical problems, lessons are often disrupted and teachers cannot make use of the technology in the laboratory.

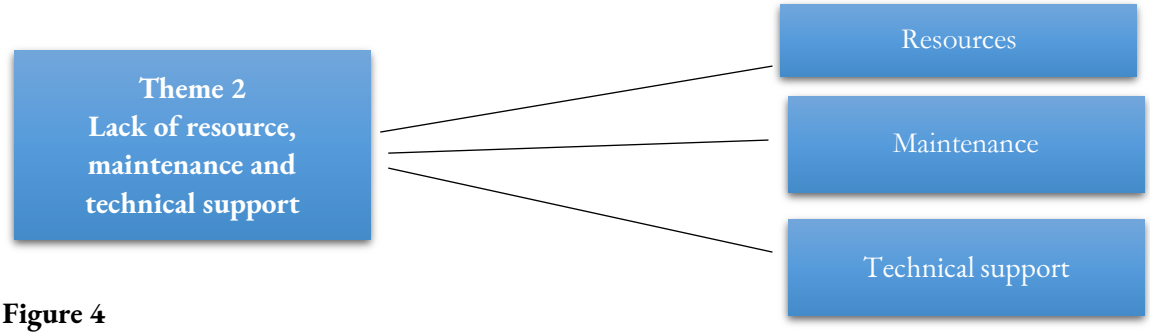


Figure 4

Codes of Second Theme

Theme 3: Poor Support from Principals and School Management Team (SMT)

The school principal and the management team play a crucial role in supporting their teachers to use technology in the foundation phase. The following issues contribute to the effective implementation of technology: leadership, school timetabling structure and school planning. If these issues are not properly managed they can become difficult to overcome since the authority at school lies with the school management. T1FRA and T3F2A indicated that

> *their principal does not believe in using computers for teaching and learning. In no uncertain terms, he has indicated to his teachers that they should concentrate on teaching their learners to read, write and do mathematics. He has indicated that children can learn about computers when they are in the senior phase. Foundation Phase should focus on the 3Rs (Reading, Writing and Arithmetic).*

T4F3A also agreed with her colleagues, T1FRA and T3F2A. She commented that

> *the principal made it very clear that children can learn to use computers, cell phones and iPods at home and not in school. The computer periods should be used to teach reading skills or mathematics.'*

When school principals and the management teams are unsupportive or uninformed about the value of technology for teaching and learning, teachers tend to lose interest in using the available technologies at schools. T7F2B and T8F3B agreed when they said, *'this is one of the biggest reasons teachers don't want to use computers. We have managers who don't support us, why must we break our heads.*' It was found that if school leaders are not interested in technology, they are not willing to utilise funds to improve technology. T6F1B stated '*when things break in the computer lab or get stolen, they are never replaced. The principal and secretary are always telling us that they have no money to repair or connect the internet*.' In the Foundation Phase, heads of department (HoDs) emphasised writing skills, thus preventing teachers from using technology. They do not see the need for technology in the foundation phases. T1FRA said, '*my HoD is the same, she too comes from the old school of thought, just like the principal, reading, maths and writing. That's all she wants every day from us'.*

Another challenge is placing technology (computer) lessons on the school timetable. SMTs usually place technology (computers) just before lunch break. Teachers have just an hour to be in the technology lab, and these labs are situated far away from the foundation phase classes. Learners take a while to walk to the classes, and by the time they settle down, almost 20 minutes of their time is gone. Teachers indicated that the limited time they have to use the computers is then spent on discipline and classroom management, then using technology to enhance learning.

All of the respondents indicated that they did not receive sufficient support. As a result of the lack of support they experienced challenges in implementing technology in their classes. Most of the participants articulated that they require support in the computer laboratory with issues pertaining to computer hardware and software usage. All the participants agreed that they are not sufficiently supported to identify age-appropriate educational programs for their learners. Participants also indicated that the hardware/devices needed to be upgraded, maintained and repaired for effective implementation of technology. It was mentioned that teachers do not have the time, skills or knowledge to ensure that the technological devices are in good working condition. They believed that the school should contract professionals outside support to maintain the computers and other ICT equipment. T5FRB stated:

when a device is damaged or when it needs updates and stuff like that, we don't know how to fix this and we have no one that can help us. It really helps with skill development, but it is not practical to implement it on a permanent basis.

All the participants agreed that insufficient support and poor hardware maintenance in the computer lab cause teachers not to implement technology in their teaching. Seeing that it attributed to anxiety and stress experienced by teachers.

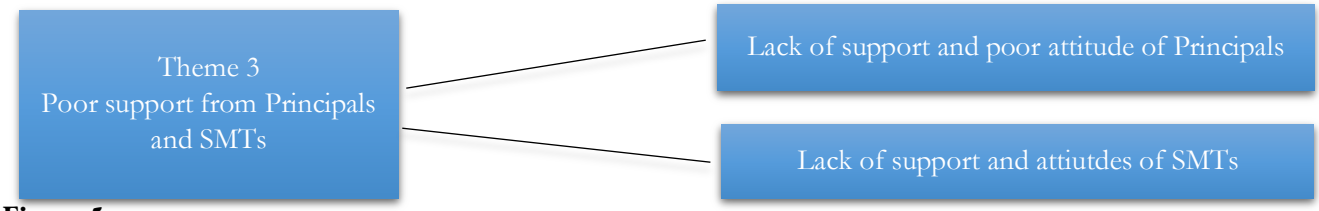


Figure 5

Codes of Third Theme

Theme 4: Teacher Development and Training

Teacher training and development are critical components for the effective implementation of the curriculum and, more especially the use of technology in the classroom. Many schools lack qualified technology teachers, which is evident in the foundation phase. Teachers are called for a one-day workshops and are expected to implement technology in their teaching and learning. When the participating teachers were asked whether they felt that they were sufficiently trained to implement digital technology in their teaching and learning programs, all participants indicated, that they were insufficiently trained to effectively implement digital technology in their classrooms and to incorporate it into the curriculum they teach.

T7F2B stated, *'we don't get trained properly and we don't receive any support to implement technology in our classrooms.'* T5FRB and T6F1B further indicated that '*the training they give us is more a crash course in computers; we come out worse than we went in. Sometimes, I am more confused with all the computer jargon.'* T1FRA *stated that 'if only they make the training more practical, I am certain we will learn more. Too much theory and less practical, yet they still want us to implement in our foundation phase classes.'*

It was observed that teachers were willing to learn and develop new teaching methods through the use of computer technology in the classroom. They all agreed that they should be given intensive continuous training at least once a month. There were enthusiasm among teachers to receive appropriate training, however the few training opportunities they received was not adequate. These trainings and workshops did not provide teachers with the hands-on experience which they required. Thus, these trainings did not meet the needs of teachers to effectively implement technology in their foundation phase classrooms. T2FRA and T8F3B clearly indicated that insufficient training was one of the main reasons teachers did not use digital technology in their classrooms. T6F1B further stated that *'that is the main reason I do not use technology in my classroom. I don't know how to use the devices that were given to us at the school, never mind how to implement it in my teaching*.

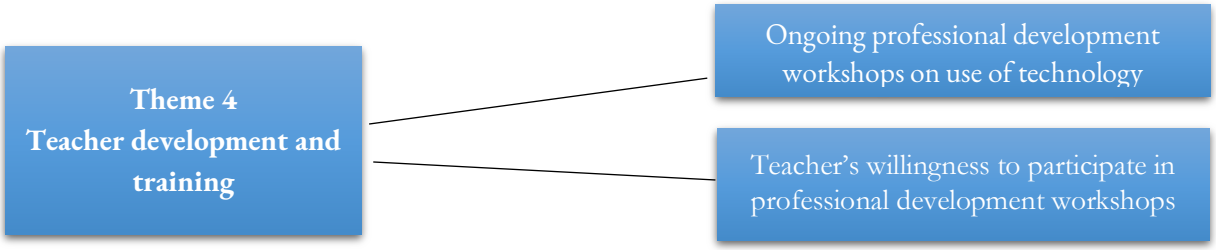


Figure 6

Codes of Fourth Theme

Discussion

The article aimed to understand better the challenges experienced by foundation phase teachers in implementing technology for teaching and learning. The findings of this study are significant as it reveals that foundation phase

teachers experience the following challenges: lack of in-depth understanding of the use of technology, leadership and technological support, insufficient resources and insufficient capacity and training programmes.

In-depth Understanding of the Use of Technology

The data collected from participants revealed that most foundation phase teachers lacked in-depth knowledge and understanding of using technology for teaching and learning. Foundation phase teachers in this study lacked sufficient technological pedagogical knowledge. The findings concur with Vandeyar (2013) who also found that most South African teachers are expected to implement technology into their education programs, but are not appropriately trained in the use of technology. The findings also highlighted that participants were exposed to computers, iPods, cell phone technology, but most had minimal experience in using technology and were supported by a family member. This was revealed by participants T1FRA, T2F1A and T3F2A. Yurdakul et al. (2012) stressed the importance of teachers developing technological pedagogical knowledge to understand better how to use technological tools for teaching and learning. Levy (2009) agrees that foundation phase teachers need proficient pedagogical content knowledge to establish a holistic view of how technology improves and enhances teaching and learning. Foundation Phase teachers need to develop themselves competently on how to implement technology in the foundation phase. According to Azarfam and Jabbari (2012), if teachers do not empower themselves with appropriate knowledge and understanding of technology in the classroom, this may lead to anxiety, fear and a reluctance to use technology for teaching and learning. Vandeyar (2013) also concurs by stating that most South African teachers are not eager to implement technology in their classrooms due to the lack of knowledge, understanding and ability to operate ICT equipment.

School Leaders Role

School leaders play a significant role in leading the use of digital technologies. According to Lindqvist (2019), those school leaders who encouraged the use of digital technologies found favour and enthusiasm among their staff. Their teachers were more eager and willing to use technology for teaching and learning. This study revealed that most teachers did not receive the desired support from their school management teams. The findings highlight that school leaders emphasised the importance of teaching 'Reading, Writing and Numeracy' in the foundation phase. This was revealed by participants T1FRA and T3F2A. Keengwe et al. (2009) agree that teachers do not receive appropriate support and assistance from the school management team. Teachers complained that official from the department also did not support them or guide them on how to use technology to enhance their teaching.

Technological Support and Technical resources

Most participants experienced a lack of support regarding technical resources and technological support. In this study, it was found that participants often had to take their young learners to the computer laboratory which was away from their classes. Participants indicated that they lost quality time and often the resources were not readily available to all learners. Learners had to sit in groups of five around one computer, which disadvantaged learners from getting access to the computers. Furthermore, the time allocated for computer lessons were an hour and this was insufficient for all children to participate in the activities actively. Participants often experienced defective equipment and other resources in the computer laboratory. They complained that computers were not in working order, they could not access software, power-failure, items such as mouse, mouse-pads and cables were often missing. Ramorola (2010) states that for successful use of technology in classes, more computers, printers, scanners, mouse, mouse-pads, interactive smartboards, data projects, and age-appropriate software should be made available to all foundation phase classes. All these resources should be available to all learners.

Training and Development

The DoE (2004), through its e-Education policy, encourages all teachers to implement technology for teaching and learning. The participants in this study indicated that they lacked the appropriate training and development on successfully implementing technology for teaching and learning. According to the TPACK model, teachers need to be capacitated with the appropriate technological pedagogical content knowledge to successfully implement technology for teaching and learning (Koehler & Mishra, 2008). This view is supported by Vandeyar (2013), who states that teachers

need to receive appropriate and relevant training and development to implement technology in their classrooms successfully. Hennessey et al. (2015) and Ramorola (2010) believe that teachers are significant people for the effective implementation of digital technologies for the 21st classroom. It is therefore imperative that they receive ongoing teacher training and development.

Enthusiasm and eagerness to learn and develop new ways of teaching using digital technologies were not lacking amongst most teachers. The authors recommended that the DBE should plan focused training and development workshops to all teachers in the district. The meeting of teachers from different schools would encourage network learning communities to be formed as support groups. The communities of practice will allow foundation phase teachers to identify with teachers who are faced with similar challenges. This support group will motivate and encourage teachers to use technologies in their classrooms. According to the DBE (2011) communities of practice and network learning communities play a significant role in personal professional development of educators.

For the successful implementation of digital technologies for teaching and learning it is pertinent that the education department ensures that the necessary infrastructure, resources, teacher development programmes, and ongoing support are carefully planned, before embarking on a large scale implementation of technology in the foundation phase classes. Teachers will use technology appropriately and effectively if they are conversant and comfortable with it, especially if they have had sufficient experience to technology in an instructional environment.

Conclusion and Recommendations

The planned integration of digital technology into teaching and learning programs in many South African schools are seldom successful. There are many challenges and hurdles to overcome to achieve effective implementation of digital technology in classrooms. According to Yurdakul et al. (2012), a significant barrier to technology integration is teachers' lack of knowledge and competency. Teachers are challenged to implement and manage the use of technology successfully. Roualdes (2013) agrees when he states that many foundation phase teachers admit to being unprepared to face the challenges of diverse learning needs. Therefore, teachers find it extremely difficult to adapt the curriculum and incorporate technology into their daily teaching and learning (Wilson et al., 2011). Several factors collaboratively contribute to the unwillingness of teachers to implement digital technologies for teaching and learning.

Although there is much apathy and lack of enthusiasm to implement technology for teaching and learning, there are some teachers who have shown positive attitude towards using technology for teaching and learning. These teachers have found that their learners benefitted from technology lessons. For this reason and others, teachers are willing to make the sacrifice and attend professional teacher development programmes to capacitate themselves. They see technology playing a significant role in education in the future. The COVID-19 pandemic has hastened the process of implementing technology in the classroom, despite most teachers being unprepared for the suddent sign in teaching and learning. Vandeyar (2013) and Blinnikova (2017), agree that if teachers are given the necessary support from their school leaders and school management teams, they would show positive attitude towards implementing technology in their classrooms. Furthermore, teachers must be given the necessary technical support and resources for effective teaching and learning using technology. It must also be noted that, despite the many challenges, teachers indicated that they enjoyed some positive experiences and learning with their foundation phase learners in the computer laboratories.

It is recommended that teacher education programmes are reviewed and that the content of these training programmes is carefully aligned to the needs of teachers in the foundation phases. Training should consider the pedagogical, technological and content knowledge, focusing on the skills to effectively integrate all knowledge fields that will effectively implement digital technology in foundation phase classrooms. Teachers should be supported continuously to implement technology. This support should include hardware support, where equipment is regularly serviced and in good working conditions. Software support is also essential, where teachers can consult with professionals regarding the most updated technological programmes that will be best suited for specific teaching programmes in the foundation phases. This support will ensure that digital devices are used effectively to promote the optimal development of foundation phase learners.

Enthusiasm and eagerness to learn and develop new ways of teaching using digital technologies were not lacking amongst most teachers. It is, therefore, recommended that professional development programmes for improved capacity building should be planned and well-coordinated. The DBE should encourage network learning communities and communities of practices to be established as envisaged in the Integrated Strategic Planning Framework for Teacher Development in South Africa (DBE, 2011). The communities of practice will allow foundation phase teachers to identify with others in a similar situation. This support group will motivate and encourage teachers to use technologies in their classrooms. There should be focused training on using various updated age-appropriate applications and software.

It is recommended that the education department should ensure that the appropriate infrastructure and other resources are readily available before large scale implementation is carried out. Teachers will use digital technology if they are accustomed and comfortable with the technology. Teachers need to have sufficient experience to technology in an instructional environment with support from the school leaders and management teams, including education officials. According to Mishra and Koehler (2006), the TPACK model emphasises the importance of content knowledge. Since the education department is encouraging teachers to use technology for teaching and learning, it is important that the education department make provision for the necessary and appropriate training and development for all teachers. Through ongoing professional development, teachers would be empowered with knowledge and understanding of implementing technology for teaching and learning.

Recommendations for Further Research

Since this study was limited to two primary schools in a district in Gauteng Province, it is recommended that further studies of a similar nature be conducted in different provinces in the country with a larger sample. The findings may vary significantly since some provinces are the forerunners in using technology in their classrooms.

Limitations of the Study

The research was limited to a small sample of two schools in the Gauteng Province district. The authors believe that the findings may vary in other districts across the province and country. Some schools are engaging successfully with technology due to the Covid-19 pandemic and the call for online teaching and learning.

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Annexure A

Individual Semi-structured Interview Schedule

UNIVERSITEIT VAN PRETORIA UNIVERSITY OF PRETORIA YUNIBESITHI YA PRETORIA Faculty of Education Fakulteit Opvoedkunde Lefapha la Thuto
Individual Semi-structured Interview Schedule
Interview questions/prompts (the questions are only guidelines and the researcher will further be guided by the data gathered from the focus group interview and the completed semi-structured questionnaire).
Please specify your age
Q1. How long has your school been using digital technologies
Q2. How often do you use digital technologies in your classroom?
Q3. Share your experience on the use of digital technologies in your classroom.
Q4. What are the challenges you face when implementing digital technologies as a support tool?
Q5. How are you supported at your school to implement digital technologies?
Q6. What training and capacity building programmes have you attended on use of technology in the classroom?
Q7. How often were these training/workshops/capacity building programmes done?
Q8. How do your learners experience the use of technology for teaching and learning?
Q9. What kind of support do you require to enhance your skills in the use of technology?

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Research Article

Educator professional development towards management of curriculum implementation: A case study in Correctional Centres of Gauteng Region, South Africa

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Abstract

This experience which is under constant 'surveillance' within the correctional facilities is not often discussed by researchers. Basic literacy and numeracy skills are offered to adults who were socially marginalized and economically disadvantaged prior to their imprisonment. Educator professional development (EPD) is a key mechanism for improving classroom instruction and student achievement hence curriculum management is imperative for educators through their possession of motivational and inspirational skills. inadequate educator orientation, training and development as one of the leading impediments to effective curriculum implementation in schools. This study is qualitative in nature and is located in the interpretive paradigm. Therefore, a case study design was employed to explore and provide a detailed description of educators' understanding, experiences, practices and the challenges they encounter in a correctional service setting. This goal is in planning and developing an effective in-service development programme as it is important to note that recent reviews of continuous and consistent EPD indicates that DCS in Gauteng is ineffective in bringing about the required change in the teaching practices of educators. It is therefore imperative for educators in correctional centres to manage curriculum effectively and efficiently.

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Introduction

This article is based on the experiences and perceptions of educators in Correctional Centres in Gauteng Region: South Africa who chose to educate offenders. Offenders have a need for educational programmes that are in line with the education system of the country thus qualified academic or technical educators are employed in terms of Correctional Services Act 111 of 1998 to render that service. There is substantial evidence that educator professional development (EPD) aimed towards management of curriculum implementation forms an integral part of teaching and learning and of education as a whole. Hence Section 5(ii) (bb) of the SACE Act emphasises the standards of programmes of pre-service and in-service educator education.

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One would imagine how successful management of curriculum implementation of National Curriculum Statement (NCS) to Curriculum and Assessment Policy Statement (CAPS) change must be accompanied by proportionately high-quality EPD towards successful and improved learner achievement. CAPS was introduced in Grade R-12 not as a new curriculum but as the curriculum that can be accessible to educators. It is widely recognised that EPD is a key mechanism for improving classroom instruction and student achievement as curriculum management is imperative for school principals through their possession of motivational and inspirational skills. EPD for educators is aimed at adequately undertaking their essential and demanding tasks and assist to enhance their professional competence and performance continually (Department of Education, 2006:4).

The study seeks to outline the challenges faced by research participants towards management of curriculum implementation and to identify possible solutions through a professional development. The anticipated possible outcome would be a development of a model towards the proper management of curriculum policy implementation strategy in correctional centres through EPD.

Background

Regulation 10 (2) (a)-(b) of the Correctional Services Act 111 of 1998, states that offenders have a need for educational services that are in line with the education system of the country thus rehabilitation can be achieved through combating illiteracy in Correctional Centres by providing educational programmes to offenders and increase training facilities for developmental activities. Therefore, according to National Education Policy Act no 27 of 1996 (NEPA) Section 4(c) – (d) stipulates the right to equitable education opportunities, redress of past inequality and that no person must be denied educational opportunity to the maximum of his/her ability.

The National Policy Framework for Teacher Education and Development in South Africa (2006:16-17) states that both conceptual and content knowledge and pedagogical knowledge are necessary for effective teaching, together with the teacher's willingness and ability to reflect on practice and learn from the learners' own experience of being taught. These attributes need to be integrated, so that teachers can confidently apply conceptual knowledge-in-practice. All teachers need to enhance their skills, not necessarily qualifications, for the delivery of the new curriculum. A large majority need to strengthen their subject knowledge base, pedagogical content knowledge and teaching skills.

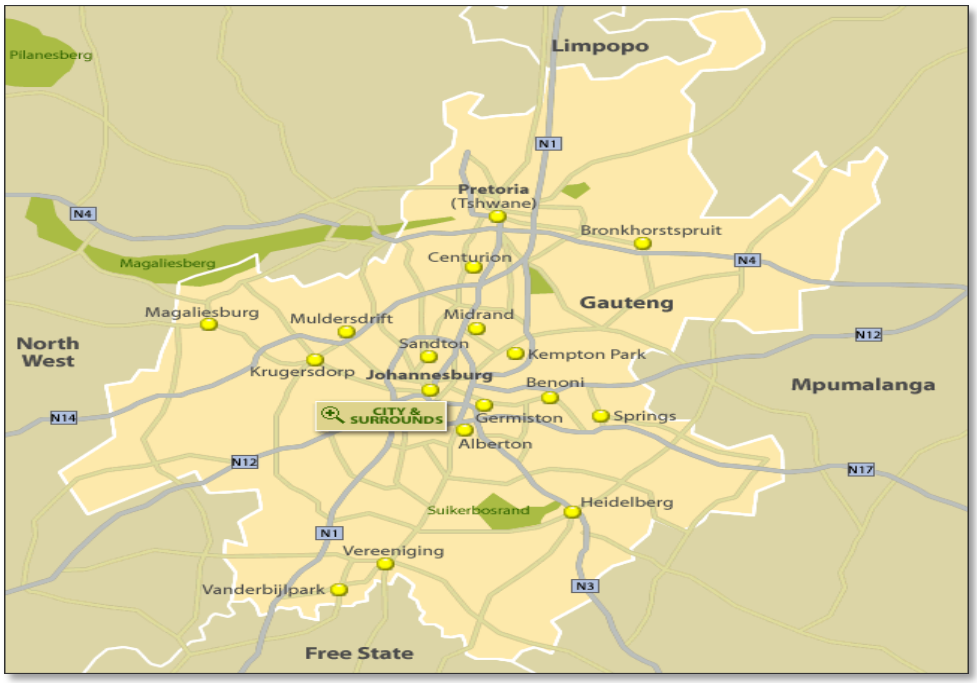

Figure 1

Map of Gauteng Province: South Africa (Source : www.southafrica.info/about/geography/provinces.htm)

Teaching and learning today happens in a world of rapid curriculum developments thus encompasses complex skills that need to be continually adapted to new circumstances. Globalisation and the growth of the fast-changing knowledge economy mean that people require upgrading their skills throughout their adult lives to cope with life both in their work and private lives (Laal, 2011:470). There is substantial evidence that educator professional development (EPD) aimed towards management of curriculum implementation forms an integral part of teaching and learning and

of education. Hence Section 5(ii) (bb) of the SACE Act emphasises the standards of programmes of pre-service and in-service educator education.

EPD is increasingly placed in the context of lifelong learning by the international literature on social policy and by the literature of educational research. According to Lunenberg et.al. (2017), models of professional development need not only to pay attention to the context (organization, institute, school) in which individual teacher educators work, but also to acknowledge that teacher educators have different professional learning needs depending on their positions in their careers and their biographical experiences and aspirations.

However, professional development has led to improvements in educators' knowledge, instruction, skills, practice, and student outcomes (Pitsoe & Letseka, 2014:372). Lifelong learning of educators is about providing second chances to update basic skills and to offer learning opportunities at more advanced levels to all levels of educators and is more than training or continuing education as it should be accessible to all regardless of age and status (Soni, 2012:05; European Commission, 2007:02; Nesbit, Dunlop & Kennedy, 2007:35).

One would imagine how successful management of curriculum implementation of National Curriculum Statement (NCS) to Curriculum and Assessment Policy Statement (CAPS) change must accompanied by proportionately high-quality EPD towards successful and improved learner achievement. CAPS was introduced in Grade R-12 not as a new curriculum but as the curriculum that can be accessible to educators.

It is widely recognised that EPD is a key mechanism for improving classroom instruction and student achievement as curriculum management is imperative for school principals through their possession of motivational and inspirational skills. EPD for educators is aimed at adequately to undertake their essential and demanding tasks and assist to enhance their professional competence and performance continually (Department of Education, 2006:4). EPD is increasingly placed in the context of lifelong learning by the international literature on social policy and by the literature of educational research. EPD may also provide empowerment, validation and leadership opportunities for those educators looking to share their experiences with their peers (Muhs, (2019: 56).

However, professional development has led to improvements in educators' knowledge, instruction, skills and practice and student outcomes (Pitsoe and Letseka, 2014:372). Lifelong learning of educators is about providing second chances to update basic skills and to offer learning opportunities at more advanced levels to all levels of educators and is more than training or continuing education as it should be accessible to all regardless of age and status (Soni, 2012:05; European Commission, 2007:02; Nesbit, Dunlop & Kennedy. 2007:35).

The challenge in seeking to improve the quality of teaching is to make overall sense of different ideas and programmes that attempt to influence the working lives of educators (Moon, 2013:28). Many educators have felt threatened by curriculum reform due to the knowledge and skills needed for successful curriculum implementation. The following challenges were recognised as some of the major ones: policy overload, inadequate orientation, training and development of educators, shortage of personnel and resources to implement and support the new curriculum and limited support to schools from systems of the Provincial Education Departments (Ndou, 2008; Department of Basic Education, 2009).

Zepeda (2012:51) is of the view that effective professional development needs to be situated within the school as a proactive process not as a "fix-it" intervention merely to remediate perceived weakness in weaknesses in educator performance. Educator Professional Training (EPT) must lead to better instruction and improved student learning thus improved performance when it connects to curriculum materials that the educator uses. According to De Simone. (2020), school leaders and teacher coaches can use this knowledge to guide educators to experiences that are likely to result in the development of data-use skills to aid in classroom instruction.

Hope (1999) further suggested that orientating new teachers to the school and to the principals' expectations require systematic contact to assist in teacher's professional growth and should include (a) intervening to diminish teacher isolation, (b) facilitating mentoring and collegial relationships, (c) maximizing potential success through the teaching assignment, (d) offering professional development opportunities, (e) being accessible, and (f) explaining the evaluation process.

Wang and Odell (2002) are of the view that "principals should also understand that not all teacher education programs are extensive enough to effectively address or change the learned dispositions and attitudes of teacher education students. It is therefore imperative that sectional heads in DCS context (principals) must play vital role towards facilitating mentoring arrangements towards professional and personal needs of new educators.

Therefore, professional development must be grounded in a carefully conceived and clearly stated sense of purpose and to be embedded in the core beliefs that are under constant scrutiny (Zapeda, 2012:4). Moon (2013:34) is of the

view that continuous professional development requires self-concept and belief that it is never too late to learn and to improve. Therefore, EPD must be embedded on professional knowledge, improved professional skills, clarification of professional values, morals, ethical and effective, efficient and valuable educating.

Theoretical Foundation

The concept of professional development is guided and influenced by the contingency viewpoint and it rejects the notion that a viewpoint constitutes a "one-size-fits-all" approach (Black, 1999: 10). EPD is a situational variable with reference to its characteristic features and the view of knowledge, constructivist professional development appears to be compatible with the beliefs and assumptions of the emerging worldview.

Educators are therefore needed to consolidate learning but are also required and expected to be keeping motivation alive and for adapting to changes of which it might be seem challenging. Constructivist professional development has the metaphorical descriptive features of a holon (Black 1999: 10). The holon provides the basis for a new principle in the holistic world-view, namely that the whole is always greater than the sum of its parts and, paradoxically, the whole is contained in each part while no whole is complete in itself.

Furthermore, the changed curriculum and pedagogy of EPD will require new policies that foster new structures and institutional arrangements for teachers' learning. At the same time, there is need to undertake a strategic assessment of existing policies to determine to what degree they are compatible with the vision of learning as constructed by teachers and students, as well as with a vision of professional development as a lifelong, inquiry-based and collegial activity. Development policy are emerging, the hard work of developing concrete exemplars of the policies and practices that model "top- down support for bottom-up reform" has only just begun (Darling-Hammond & McLaughlin, 1995).

Darling-Hammond and McLaughlin (1999) claim that new approaches are needed for the professional education of teachers and that they require new structures and support systems. New initiatives cannot promote meaningful or long-term change in teachers' practices by themselves, if they are embedded in a policy structure that is at odds with the vision of student and teacher learning that reforms seek to bring alive.

Many of the modernist assumptions on which traditional professional development is based, no longer hold water in our present-day world and this has resulted in philosophers questioning modern issues, using a different paradigm. This situation requires that professional development, in a constructivist setting, be approached from a holistic or situational approach perspective.

Professional development is very essential for teachers as it inculcates curiosity, motivation, and new ways of thinking. It becomes most influential when it is adopted on continuous bases with well-planned trainings. It is recommended that proper planning may be done for professional development trainings. It may be stated by way of conclusion that teacher professional development is of utmost importance in ensuring quality in the educational programs.

The emergent paradigm appears to have a significant number of implications for professional development and, more specifically, with regard to skills, such as classroom management and leadership, policy implementation, curriculum issues, inter- relationships with the organization and quality assurance in outcomes-based classrooms.

As professional teachers we are encouraged to use these constructivist approaches and utilize a range of activities, interactions, discussions and group work to support effective learning (Walmsley, 2012). It is therefore a challenge to DCS ensure that their educators are trained and developed to enhance and fit their educational mandate.

Problem of the Study

The main problem of the study is that;

- How does the DCS manage EPD towards management of curriculum implementation, respectively, at the selected correctional services schools in the Gauteng Region?

In order to help answer the main research problem, the following sub-problems were investigated:

- What does effective EPD towards management of curriculum implementation involve?
- What constitutes the roles of curriculum coordinators and SMT's as managers of EPD?
- What challenges, if any, does the implementation of EPD in DCS have and how can the obstacles be addressed?
- What form of EPD is necessary for the successful management of curriculum implementation?
- What recommendations can be made, in the form of guidelines, to enhance the effectiveness EPD?

Method

Research Model

The qualitative component of the research was primarily applied at obtaining rich, in-depth data using face-to-face techniques with suitable participants in their natural settings that are Correctional Centres through a case study. Giorgi (2009: 122) is of the view that "What one seeks from a research interview in phenomenological research is as complete a description as possible of the experience that a participant has lived through". Yazan (2015: 138) is of the view that, the researcher brings a construction of reality to the research situation, which interacts with other people's constructions or interpretations of the phenomenon being studied.

Participants

The targeted population were educators and School Management Teams (SMT's) of schools in Correctional centres, Gauteng Region whereby a non-probability purposeful sampling was used.

The choice sampling of the sampling method was based on a precise judgement about a feature of central interest of the researcher and provision of rich data on a group of educators in Gauteng Region and in this case, ten (10) educational managers and ten (10) educators were selected purposefully. Interviews do not only yield a great deal of information but also allow the researcher to access participants' beliefs, feelings, opinions, motives, current and past behaviours (Babbie & Mouton, 2001).

Table 1

Correctional Centres, Gauteng Region

Management Area	Correctional Centres	No of SMT, Gender & coding	No of Educators & Coding
Baviaanspoort	Emthonjeni, Maximum & Medium B	02 males (M1 & M2)	02 (1 male 1 Female) E1 & E2
Boksburg	Med A	01 male M3	01 male E3
Johannesburg	Female, Medium A & B	02 (1 male 1 Female (M4 & M5)	02 (1 male 1 Female) E4 & E5
Kgoši Mampuru	Central Correctional, Female	01 Female M6	01 Female E6
Krugersdorp	Med A	01 Female M7	01 male E7
Leeuwkop	Maximum & Med C	01 male M8	01 Female E8
Modderbee	Med A	01 male M9	01 Female E9
Zonderwater	Maximum & Med A	01 Female M10	01 male E10

Data Collection Tool

According to McMillan and Schumacher (2010:367), qualitative data analysis involves an inductive process of examining, selecting, categorising, comparing, synthesising and interpreting data for plausible explanations to address the principal aim of the study. Therefore, interviews were audio-recorded and transcribed verbatim. The researcher listened to the audiotapes several times to get a global sense of what the interviewees were saying and on how they relate their experiences. (Interview questions at appendix 1 and 2).

Data Analysis

This was followed by delineating the transcribed interviews into meaningful units, before regrouping the units into clusters of meaningful units, and then transformed into descriptive expressions before synthesising them into general descriptions that reflected the participants' experiences. The system of coding used ensured that there was no link between the data and the participants or between the data and the setting, thereby ensuring anonymity and confidentiality of participants (McMillan & Schumacher 2010:121).

In order to comply with ethical consideration and protection there was no link between the data of participants throughout the project. Elements of privacy and anonymity analysis were adhered to, whereby interviews with the educators labelled as E1- E10 thus education managers as M1- M8 in Gauteng Region of different Correctional Centres.

Nine (09) basic research questions based on the main and sub-research questions as were posed to participants M1-M8. What surfaced quite prominently during interviews with managers were their different backgrounds in relation to nature and scope of schools in different Management Areas regarding the programs offered to offenders. All participants agreed and view educator professional development as helping educators to have deeper knowledge, understanding and skills about curriculum implementation.

Participant's experiences and the level of rating EPD in Gauteng Region indicates that DCS efforts if any are not satisfactory and this ignites dissatisfaction thus self-exit and low moral thus a negative impact towards learner achievement. Participant's experiences and the level of rating EPD in Gauteng Region indicates that DCS efforts if any are not satisfactory and this ignites dissatisfaction thus self-exit and low moral thus a negative impact towards learner achievement.

Procedure

The interview process as data collection strategy was conducted on a period of ten days it the use of a voice recording device only. Correctional Centre's are strictly security incline areas hence taking of pictures or videos are not allowed.

Ten school management teams (SMT) or educational managers were purposefully selected and therefore, presumed to be responsible for managing educational programs involved educators' EPD for the implementation of curriculum policy in their respective management areas. SMT's in a correctional setting are Assistant Director's (ASD) and Sectional Heads (SH).

Ten school educators: One educator was sampled from each of the six participating correctional services schools in each management area and two educators from bigger management area schools. Again, the principle of gender sensitivity and representation was applied by selecting five male and five female educators per sampled school for in-depth study.

Educators offer different educational programs are offered differing from one Correctional Centre to the other there are challenges faced of which they might have a negative impact towards provision of such programs. Educators indicated a particular school environment based on their day-to-day experiences whereby a lot of improvisation, infrastructure, subject specific personnel and sacrifice towards rendering educational programs were presented. The laudable proposals by educators towards EPD run a risk of being deterred by a set of DCS bureaucratic procedures, unless a conducive environment is generated towards encouraged ongoing school-based professional development program.

The only form of development outlined is through an invitation from DoE as DCS does not have a programme of developing its own educators to be in par with their DoE counterparts of which it poses question on how do those educators keep-up with the latest curriculum trends expectations. EPD is not prioritized and lack of support by DCS according to the experiences and views of DCS educators in Gauteng Region.

Majority of educators experienced lack of support from their managers in relation to their professional development path to the point where educators realized that SMT's of DCS in Gauteng Region do not have the knowledge of implementing the process. Participants experienced a vacuum between them and their managers in terms of communication and decision-making processes about their professional development and growth hence the request for consultative process from managers.

Results and Discussion

One of the aims of establishing Correctional Centres is to provide rehabilitation and to increase the likely hood of successful reintegration and provision of an effective environment that reduces the risk of reoffending. Many offenders have education and skills levels below average standard are more likely to be unemployed who has an impact on averting re-offending. Educators must have the expertise through continuous development provide motivation to offenders to study through the experiences of discipline, instilling confidence and stability.

DCS, Gauteng Region is regarded having the highest offender population in South Africa; the purpose of education in Correctional Centres is possibly to discourage re-offending behaviour through providing avenues for future success (White Paper on Corrections). Most importantly, it is believed that opportunities for personal growth and development will enable offenders to participate in needs based educational programmes both vocational and academic. Some offenders turn to vocational education because it has the potential of developing skills which can lead to future employment upon release.

Educators in DCS perceive themselves as 'different' and 'excluded' individuals as compared to others involved in educators employed by Department of Education. In Correctional Centres there are tensions between providing security that is regarded as the priority on the one hand, and developmental programmes including education on the other hand. Adey and Smethem (2005) indicated that "if professional development initiatives do not have the infrastructure to 'work', they will become an obligation and a burden, rather than a learning experience".

Some of the senior security personnel in Correctional Centres view educational programmes as a luxury or not crucial, stating that offenders do not deserve such privileges of which education is a right according to South African Constitution. However, participants are of the view that participation in educational programmes can have positive

effect in correctional lifelong learning programmes and services, for instance reducing recidivism better functioning of the institution.

In this study most of the respondents shared the same sentiment that the management of educator professional development by DCS, Gauteng Region appears to be overlooked due to a lack of support, finance and resources. Respondents outlined the fact that there are less personnel and academic support structures thus making DCS schools to be regarded as a place to keep offenders busy. Educator shortage and specialisation resulted in the use of offenders with post matric qualifications to be used as teachers hence they are not registered as educators cannot be held accountable and that does have negative impact on provision of quality education and the profession.

> **E7** "*Education is not an isolation thing it's a community of practice as you cannot do it on your own. So workshops are critical, roadshows are vital to know what you are doing to follow the right standards…*"

Educators also face enormous workplace challenges, pressures and speedy shifts orchestrated by constant technological innovations and the demands of the 21st century whereby DCS demanded more efficiency from their employees. There was an expectation from DCS by DoE to meet revised curriculum reform of which the level of EPD towards building capacity and programme innovation enhancement appears limited.

> **E1** "*…we offer different programmes in the Correctional Centre, have AET (adult education & training)… level 1-4... also have TVET educational program that cater Business that is Report 191 and it caters N4-6 and underneath we have different programmes chosen and also Engineering studies also report 191 from N1-6."*
>
> **E9** "*NCV, TVET, Business studies and tertiary students.*"
>
> ***M4*** "*At times you don't get 100% assistance in terms of meeting, workshops, up-dates in terms of certain learning areas…*"

The Gauteng Region is therefore expected to employ creative approaches to update educator's knowledge and build capacity through continuous professional development. Educators' professional development (EPD) as a continuous process is a major focus within the school improvement because of the belief that offender learning success are of the result of its effectiveness. The study concludes that educator quality and effective teaching are important in improving teaching and learning goals in the school system.

> **E4** "*I think the state is not equivalent to the Department of Basic Education (DBE). I think DCS can try and establish structures they are using, if you look DBE they are having a …for curriculum to be effected/implemented they are having structures of the school, HoD and Subject advisors, teacher development people who are responsible for teachers updated with curriculum development. So, if [the] DCS can adopt some of the structures to support teachers in Correctional Services.*"
>
> ***M3****…challenges, the university decided to go electronically and our policies are still saying no to laptops, internet etc."*

Educators' and managers' responses indicated that, in general they were interested towards EPD workshops with a positive mind of learning new teaching approach, peer motivation, collegial group learning and subsequent cooperation as contributing to staff development aimed towards improved schools.

> **E4** *…need some sort of support as the curriculum keeps on changing as a result of that people/tutors/educators must be supported, trained as far as changes are about… to say the Department of Basic Education they constantly develop their teachers as far as implementation of curriculum…"*
>
> ***M6 "****… liaising with DoE in all the training… to work hand in hand with the DoE and then if you got a very good relationship with DoE they will normally take our teachers on board"*

Little or less explicit attempt was made in the EPD programme to illustrate the problems of individual educators working in respective Correctional Centres. Provision of workshops and/or peer collaboration towards EPD was vied as an essential element but there was no conclusion drawn about the extend of such collaborations in order to develop a sense of personal and learner achievement. Fung (2000:154) cited Bell & Gilbert (1994) that "teacher development is a societal activity which should be theorised in terms of social constructivism and that social interaction promotes learning of socially constructed knowledge and personal construction of meaning".

> **E1** "*…now I am in prison we are not developed as they look at security as a core. …educators are not developed as I am two years in DCS; I have never received any training concerning development of education.*"
>
> **E8** "*At this stage the state is very low because we have to equip us with what we have*"

M2 "*Based on my experience, I have never received much support. It's only there is a problem someone will come and want answers. There is no support structure; … they just want somebody to work but you don't get proper orientation that now you are at Correctional Centre, these are the expectations…*"

Also, EPD should not be underestimated and overlooked in building educators' capacity in a DCS education system because of its uniqueness. It is suggested that more extensive research, related to all DCS regions of South Africa is imperative to further test the findings of this study. In a nut shell, the study shows that EPD in a DCS context is required in order to meet offender's constantly changing educational needs and societal expectations.

E2, E3, E4 & E8 "*Educators can develop themselves by registering with universities because at the end of it, it's up to you to develop yourself as the department is not giving any support.*"… *you have to apply for course at own* expense *with Higher institutions.*"… *"I think self-study and registration with any high institution.*"

M5 "*…workshop will be organised for you in conjunction with SACE. As a Region they need to talk to the District or Provincial around or call an Imbizo for the Gauteng Management Area and invite those from Education to come and give us some sort of workshop in order to be in line with the latest developments". …TVET administrator, they can break down to the level of districts so that we do not work from the level of the provincial office.*"

Conclusion and Recommendations

This study' goal is in planning and developing an effective in-service development programme as it is important to note that recent reviews of continuous and consistent EPD indicates that DCS in Gauteng is ineffective in bringing about the required change in the teaching practices of educators. As a result of this research, some suggestions can be made for practitioners and future research.

Recommendations for Applicants

- Educators need new knowledge, skills and abilities as ingredients for their well-planned professional development towards curriculum management and implementation. Therefore, career lifelong learning programmes as the demands on education are ever-changing.
- Educators in DCS require a specialised professional development programme as it results in specialised knowledge they need as they are dealing a special category of individuals, namely, offenders.
- In order to enhance educator's professional dignity and competence, DCS as an employer must cater for professional development needs and interests as the employer also makes demands to educators to perform their professional responsibilities.
- It is therefore recommended to DCS, Gauteng Region that priority should be geared towards EPD for both formal and vocational educators in relation to personnel management development plan compiled annually where by consolidating educator's developmental needs to be indicated. Personnel administration measures policy (1999:7, (e) (ii)) outlines the fact that "one of the responsibilities of the school principals is the development of staff training programmes, both school-based, school focused and externally directed and to assist educators in developing and achieving educational objectives in accordance with the needs of the school".
- Educators, through EPD carefully crafted policy by DCS, must take charge of their self-development by identifying the areas in which they need to grow professionally. Educational managers could monitor and evaluate educators to decide what kind of professional development programme they need and further encourage them to attend such programmes that match their needs.
- Educator's professional training and practical teaching experiences are needed to create the effectiveness and efficiency of the DCS schools and environment whereby educators can be attracted and retained.
- Educational managers must provide management and leadership to educators and society in relation to provision of needs-based education for offenders through provision of a vision for high expectation and improved educational programmes by overseeing development, management and evaluation of the curriculum through a carefully designed EPD.
- SACE as educator's professional body needs to be actively engaged by DCS as they promote professional ethics and the concerns of the profession of which EPD is one of those concerns.
- Active engagement with DoE (Funza Lushaka Bursary Scheme), SACE and DCS might further assist by giving advice regarding the distribution of educators of which that might address the shortage of specialisation in some of the fields that offenders' needs.

- Section 29(1) (a-b) of that South African Constitution must be applied decisively and carefully to accommodate and apply Section 9 of the White Paper on Corrections where it states that educational programmes must cater the needs of offenders.
- Continued and systematic research must be activated towards EPD as obsolete concepts and/or actions must be continuously replaced as educational programmes are dynamic and globally inclined.

Recommendations for Further Research

Although the current study has to a certain extent achieved its goals and objectives that we outlined in Chapter 1, the researcher is of the view that further research could be necessary to improve some of the unintended oversights of this study. That can be through further contributions that can strengthen the task of managing and implementing EPD in DCS, Gauteng Region.

Therefore, the following areas can be taken into consideration for additional investigation:

- How to impart EPD programme that transforms information into knowledge. doubt into confidence and poverty into wealth?
- Context of imagined future that all of us will work and live the up to the vision of reconstructing DCS education system as practically as that of DoE.

The researcher does not, however, imply that these recommendations should be implemented in their original form but the intention is that DCS: Gauteng Region should customise the guidelines according to their own unique situation of which it is security inclined and the overall needs and expectations of educators. Recommendations stated can therefore be used as useful and proposed guidelines to the betterment of DCS education system in Gauteng Region.

Limitations of Study

The researcher identified the following as some of the possible limitations that are related to this study:

An approach of designing this study quantitatively appeared as a compelling limitation to the current study. The findings are limited and confined value for scientific generalisation because they focus on experiences and in-depth understanding of the dynamics of a particular case: EPD towards management of curriculum implementation: A case study in correctional centres Gauteng Region, South Africa.

The use of purposeful approach also constituted a major limitation to the current study. The study delimited its focus to gaining information from anticipated information-rich sources surveyed educationists and educational managers in Gauteng Region. There is a possibility that many information-rich samples may have been overlooked and excluded from this sample, for example, offender facilitator community. Presumably, more and different findings might have existed and surfaced if the study was extended to offender facilitators, external education service providers, DBE subject specialists and probably DCS human resource development directorate as they are responsible for personnel development.

Few educators in Gauteng Region confined the researcher to opt for interviews as the only source of data collection strategy, therefore forcing the researcher to a limited scope. Unavailability of some of the anticipated participants citing busy schedules as their explanation towards that and lack of interest observed contributed as a limitation to that study. The researcher is an educator in Gauteng Region of which on its own can take a form of a limitation. The position of the researcher therefore can possibly have an influence on the views and perceptions of both fellow educators and managers in DCS. Furthermore, variation of power relation could be detected during data collection stage as with fellow educators' interviews were dominated by features of collegiality and some form of expectation for immediate change to the educational practices of DCS education system. As for managers, the interview questions were somehow viewed as a form of challenging their managerial skills and practices and furthermore as a fault-finding mission.

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I would like to thank the Department of Correctional Services for granting me permission to conduct this study. School managers and educators who participated in this study for permitting me to conduct face-to-face interviews with them.

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Appendix 1
Interview Schedule For The SMT's

Interview Form

Dear SMT member
I want to thank you for participating in this study. The purpose of this discussion is to get detailed information about your overall impressions regarding educator professional development (EPD) towards the management of curriculum policy in Gauteng region Correctional Services schools. I therefore regard you as someone who can provide such detailed, rich and valuable information in this study.

However, please note that, although you are regarded as an individual you are likely to provide detailed information on the topic and your participation is completely voluntary. You are under no obligation to participate in this discussion. You may also withdraw your participation at any time for any reason without penalty.
If you do participate, please allow me to assure you of your anonymity and the confidentiality with which your views, comments and opinions will be treated. So please feel free to participate with ease. I really do value your honest contribution.

The voice recorder will be switched on during the interview to ensure that all the information is captured. Please do not hesitate to ask any question on what I have just explained.

Do you agree/disagree to participate in a tape-recorded interview?
If you are willing to participate in the interview kindly note and remember the following:

- You are allowed to ask me to repeat or rephrase a question, where necessary.
- Please answer questions as honestly as possible, and note that there is no right or wrong answer but only your honest opinion will be appreciated.

Please tell me about your experiences on a need to **educator professional development towards management of curriculum implementation in Correctional centres of Gauteng region schools** by answering the following questions:

Basic Interview Questions
Q1. What is the nature and scope of schools in correctional centres in Gauteng Region?
Q2. In your opinion how do you understand educator professional development (EPD) towards curriculum implementation?
Q3. Can you please share your views on how you perceive the role of curriculum coordinators and School Management Teams (SMTs) in managing the EPD towards curriculum implementation?
Q4. Who are different stakeholders and what roles do those stakeholders play in the EPD at correctional centres in Gauteng Region?
Q5. hat challenges, if any, do you think your curriculum coordinator and SMTs experience in managing EPD; and which strategies are being and/or can be applied to address them sufficiently?
Q6. As far as you are aware, how do the Regional and/or National Head Office provide support to Management Area offices and schools regarding managing EPD for curriculum implementation?
Q7. How do you perceive the effectiveness of your role in managing the EPD?
Q8. What is the state of professional development in the correctional centres in Gauteng Region educators?
Q9. In your opinion, what should be done to enhance the effectiveness of managing EPD towards management of curriculum implementation at Correctional Centres of Gauteng Region?

It was an informative experience interviewing you.

Thank you for your time and for your invaluable contributions.

Appendix 2
Interview Schedule for the Educators

Interview Form

Dear Educator
I want to thank you as a group for participating in this study. The purpose of this focus group discussion is to get detailed information about your overall impression regarding educator professional development (EPD) towards the management of curriculum policy in Gauteng region Correctional Services schools. You have been therefore selected to participate in this study so as to provide detailed, rich and valuable information.

However, please note, that although you are regarded as an individual you are likely to provide detailed information on the topic and your participation is completely voluntary. You are under no obligation to participate in this discussion. You may also withdraw your participation at any time for any reason without penalty.

If you do participate, please allow me to assure you of your anonymity and the confidentiality with which your views, comments and opinions will be treated. So please feel free to participate with ease. I really do value your honest contribution.

The voice recorder will be switched on during the interview to ensure that all the information is captured.
Please do not hesitate to ask any questions regarding what I have just explained.

Do you agree/disagree to participate in a tape-recorded interview?
If you are willing to participate in the interview kindly note and remember the following:

- You are allowed to ask me to repeat or rephrase a question, where necessary.
- Please answer questions as honestly as possible, and note that there is no right or wrong answer but only your honest opinion will be appreciated.

Please tell me about your experiences on a need to **educator professional development towards management of curriculum implementation in Correctional centres of Gauteng region schools** by answering the following questions:

Basic Interview Questions
Q1. What is the nature and scope of schools in correctional centres in Gauteng Region?
Q2. In your opinion how you understand by educator professional development (EPD) towards curriculum implementation?
Q3. What is the state of professional development in the correctional centres in Gauteng Region educators?
Q4. In your own opinion how can educators develop themselves professionally?
Q5. Can you please share your views on how you perceive the role of School Management Teams (SMTs) in managing the EPD towards curriculum implementation?
Q6. What challenges, if any, do you think your SMTs experience in managing EPD; and which strategies are being or can be applied to address them sufficiently?
Q7. As far as you are aware, how do the Regional and/or National Head Office provide support to schools regarding managing EPD towards curriculum implementation?
Q8. In your opinion, what should be done to enhance the effectiveness of managing EPD towards management of curriculum implementation at Correctional Centres of Gauteng Region?

It was an informative experience interviewing you.

Thank you for your time and for your invaluable contributions.

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Research Article

Implementation example of TPACK model in health sciences education: Exploring of the students' views on clinical simulation in the acupuncture programme at a South African university[1]

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Abstract

Students' competencies in clinical practice is vital in health sciences. Clinical simulation is one approach used to support students' learning in clinical practice. There is a lack of research on clinical simulation in acupuncture programmes in the African context. This paper explored the experiences of students' views towards clinical simulation in the acupuncture programme to strengthen clinical teaching using the Technological Pedagogical Content Knowledge Framework as a theoretical lens. A qualitative research approach with an interpretivist paradigm was adopted. A single case study design was selected. Six undergraduate students voluntarily agreed to participate. The data were analysed inductively using the thematic analysis approach. Findings revealed that students were optimistic about clinical simulation because it assisted them in their practice. The findings highlighted students' views regarding the lack of knowledge and skills among instructors and poor infrastructure. The study also found that students gained more confidence in the clinical simulation since they were aware that the patients are not harmed. It is recommended that clinical simulation should be included and standardised in the acupuncture curriculum. To improve clinical simulation, the authors recommended that clinical simulations should be carefully planned and coordinated; training facilities needed upgrading to accommodate Covid-19 regulations and a detailed handbook on clinical simulation should be developed to standardise the simulation process.

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Introduction

Experts in health sciences place much emphasis on students' competencies in clinical practice to ensure that they (students) are competent, confident and capable of performing their clinical duties. Therefore, educators in the fields of health science endeavour to strengthen students' learning through various pedagogical approaches. Clinical simulation, according to Bewley and O'Niel (2013) is one approach that has been widely used in recent decades for medical training in different fields; since it provides real clinical experiences to students (Kapucu, 2017). It is an experimental tool to depict a 'real-life' situation. In this study, standardised patients were used in the clinical simulation of the acupuncture programme. The Covid-19 pandemic has encouraged alternative approaches to teaching and learning in educational institutions around the world. Globally, many educational institutions are facing rapid

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challenges to migrate from regular contact classes to online teaching and learning. According to Zalat, Hamed and Bolbol (2021), they found that most educational institutions have adopted the online or virtual teaching and learning approach. However, Ting et al. (2020), argue that online teaching cannot replace contact classes for programmes that require practical training (clinical practice). An educational institution in South Africa (SA) implemented online teaching and learning for its acupuncture programme. Students were introduced to clinical simulation for the first time. This paper explored students' views and experiences of the clinical simulation in the acupuncture programme.

Figure 1 below shows acupuncture education at the identified higher education institution (HEI).

The simulation centre and teaching clinic at the identified HEI

Students were practicing acupuncture techniques at the simulation centre at the identified HEI

Figure 1

Acupuncture Education at the Identified Higher Education Institution

To delve deeper into the student's lived experiences, the author's primary research question was formulated as follows: What were students' views and experiences of the clinical simulation in the acupuncture programme at the higher education institution? The authors agreed with Tosterud (2015) that educational experiences in other medical disciplines are of great importance to be used as references in a specific field; however, these experiences cannot be applied directly to other disciplines or contexts, for example, acupuncture. Regarding clinical simulation research in South Africa, no studies were conducted with acupuncture students. As a result, there is also a lack of existing literature of the practice in the country. Therefore, this study is significant to explore students' views and experiences of the clinical simulation in the acupuncture programme during the Covid-19 pandemic at an HEI in SA.

The authors approached a HEI in Gauteng province since the identified HEI provides an acupuncture programme in their curriculum. The authors were of the opinion that a clinical simulation was an effective approach in clinical training. The rapid shift to online teaching placed challenges on educational programmes that required practical training, especially the acupuncture programme and therefore it was necessary to implement clinical simulation to support students. Although the HEI implemented clinical simulation to its students, Ting et al. (2020) and Chick et al. (2020) both argue that most HEIs are not prepared for online teaching and learning due to various challenges such as readiness; infrastructure and staff competencies and skills.

A detailed literature review was presented and the theoretical framework was explained with justifications. The authors then explained the detailed research methodology that was employed in this study. The focus was on a qualitative case study design to elicit the views and experiences of students on clinical simulation. Finally, a critical discussion of the results of this study was presented.

Literature Review

Explanation of Clinical Simulation

Cook et al. (2011) define simulation as a tool, device, and environment (that) mimics an aspect of clinical care. Clinical simulation is a model that is used to replicate real-world healthcare scenarios in an environment that is safe for education and experimentation purposes. It is an education model of a phenomenon or activity that allows students to rehearse behaviours without placing their patients at risk or harm (Kapucu, 2017). Persico (2018) states that there are different forms of simulations, for example, the use of manikins, standardised patients, role-playing, skill station and technological-based critical thinking. In support of the previous statement Martinez et al. (2020) add that simulation is an activity that discusses content knowledge of a specific modality in a clinical context. They further emphasise that this activity takes place in a clinical setting, allowing students to apply theory into practice.

Figure 2 illustrated a contact clinical simulation activity at the HEI.

Figure 2

A Contact Clinical Simulation at the HEI (one standardised patient was acting as a real patient at the simulation centre. Students were acting as clinicians to perform a consultation, physical examination and case discussion.)

So et al. (2019) point out that clinical simulation assists students in acquiring critical thinking in clinical practice and also encourage them to participate in clinical decision making. Martinez et al. (2020) agree with So et al. (2019) that clinical simulation is an effective method to deliver and enhance clinical content knowledge. The application of clinical simulation in educational programmes in the field of health sciences is of great significance. The authors concur that clinical simulation is a pedagogical approach to bridge theoretical content knowledge and actual clinical practice (real-life situations). In this paper, clinical simulation refers to an activity that focuses on promoting students' clinical critical thinking and decision-making skills, which takes place in a clinical setting using standardised patients. This activity can be either in a physical clinical setting or virtual clinical practice.

There are many benefits to adopt simulation as a clinical training approach. So et al. (2019) highlight that student can acquire clinical experiences without attending actual clinics. They can do this by employing simulation in a programme. Munroe et al. (2016) affirm that clinical simulation promotes learning outcomes and patient care. The authors agree that this is of great importance, especially during the Covid-19 pandemic, to minimise infection and health risks. The clinical simulation also provides a safe, professional environment where students are allowed and given an opportunity to learn from their mistakes without causing any harm, hurt or injury on their patients and to themselves (Munroe et al. 2016; Amod & Brysiewicz, 2017; So et al. 2019). Although clinical simulation has many advantages, the authors are of the view that each simulation should be well designed to ensure new information integrates into students' existing knowledge. This view is supported by Tosterud's (2015) who states that the content knowledge in a simulation activity must be at an appropriate level that allows students to develop from their previous experiences. So et al. (2019) further states that clinical simulation provides an opportunity that is not available in the working world, such as apprenticeship, and at the same time provides an opportunity to analyse critical but rare cases.

Importance of Clinical Simulation

Clinical simulation is a valuable approach to promote students' learning with regard to the content related to clinical practice. Similarly, Martinez et al. (2020) are in agreement with Munroe et al. (2016) who agree that clinical simulation is widely accepted in various modalities in healthcare education because it encourages students' engagement and enhances learning outcomes. They state that using clinical simulation as a pedagogy will allow students to gain experiences in clinics that are considered critical in the field of health sciences. It is crucial for students to gain adequate and appropriate clinical experiences to become competent and confident practitioners within a safe and conducive environment. This practice is necessary when there is a lack of training facilities or staff for the specific modality. This view concurs with Bogossian (2017), who points out that clinical simulation promotes effective teaching in a clinical setting which can be employed as a replacement of the clinical training due to the shortage and reluctance of registered professionals.

Persico (2018) indicates that most students are challenged to gain clinical experiences due to the increasing shortage of professionals and limited clinical placements within healthcare facilities. Simulation provides students with authentic clinical exposure, which is critical in the healthcare field (Goris, Bilgi & Bayındır, 2014). Both Amod and Brysiewicz (2017) and Kapucu (2017) assert that clinical simulation is a powerful strategy to fulfil this goal since the simulation aims to promote the efficiency, effectiveness and the safety of patients. Kapucu (2017) further concurs that

during a simulation activity, students are able to learn from their mistakes without causing any harm to patients. Clinical simulation also encourages peer and collaborative learning within a safe and conducive environment. The authors agree that this is of particular significance since no harm to patients is one of the essential ethical requirements in health sciences.

Views of Clinical Simulation

Clinical simulation is a critical approach in health sciences education to promote learning outcomes, for example in acupuncture, when face-to-face teaching and learning cannot take place during Covid-19. It intends to provide lived experiences to students in an authentic situation as genuine clinical practices. The clinical simulation centre should emulate the hospital setting and environment in which students can participate. This environment must include all the necessary equipment and infrastructure. It must replicate the 'real-life' situation. This view concurs with Munroe et al. (2016) and So et al. (2019), who state that the institution should take various factors that may potentially affect the real experiences into considerations, such as the design of different spaces, equipment and noise insulation. On the other hand, the process of a clinical simulation in a physical facility involves standardised patients who would require proper training to represent an authentic situation. So et al. (2019) state that the training for standardised patients must replicate the 'real situation.' These researchers also emphasise that ensuring appropriate training for standardised patients has a high financial constraint to the institutions implementing clinical simulation.

It may be difficult for many institutions to afford the high cost of extra facilities, equipment, and training for staff and standardised patients, despite the benefits of simulation. For instance, the application of high technologies, such as virtual simulation programmes, as a replacement for physical simulation will benefit students and staff from the safety of Covid-19. This view is further supported by Weston and Zauche (2020), who agree that virtual simulation programmes are increasingly accepted and utilised by many institutions since it is an effective approach to improve students' clinical experiences. However, as argued by Bogossian (2017) and So et al. (2019), the cost of clinical simulation may be a threat to some institutions. Furthermore, institutions must ensure that there are appropriate debriefing sessions after each simulation.

Researchers agree that post-simulation debriefing between instructors and students is of great importance for students to gain an in-depth understanding of the topic presented (Munroe et al. 2016; So et al. 2019). This will require that instructors understand the content knowledge of what should be articulated during the simulation activities. This view is further supported by Motola et al. (2013), who emphasise the importance of instructors' knowledge on specific content in order to provide feedback to students during the debriefing after the simulation. If instructors possess inadequate content knowledge, Munroe et al. (2016) further point out that simulation may contribute to increasing anxiety among instructors and students.

These researchers all agree that clinical simulation is an effective strategy to strengthen students' competencies in clinical practice. However, there are several challenges in the implementation of simulation, such as the lack of qualified instructors and high costs. The authors are of the opinion that the high cost is particularly critical among African countries where poverty is prevalent (Mellor, 2014; Thou, 2018).

The Influence of Technology in the Clinical Simulation

Many countries have instituted the cancellation of contact classes in HEIs in order to prevent the further spread of the pandemic and have opted for online or virtual classes. Aristovnik et al. (2020) report that 86.7% of contact academic activities were cancelled and education institutions made the transition from contact to online teaching and learning. The South African President announced a national lockdown on 23 March 2020, which symbolised the urgent implementation of online teaching and learning [National Institute for Communicable Diseases (NICD), 2020]. Paideya (2020) concurs with Padilha et al. (2019) who state that the 21st century students are a digital generation who grew up with technologies. These students are able to access information using information and communications technologies. The authors agree that the use of technology for clinical simulation, such as virtual simulation, is of great significance during the Covid-19 pandemic since it minimises the risks of being infected. This is also a fundamental approach to accommodate the Covid-19 regulations in SA (Thaba-Nkadimene, 2020).

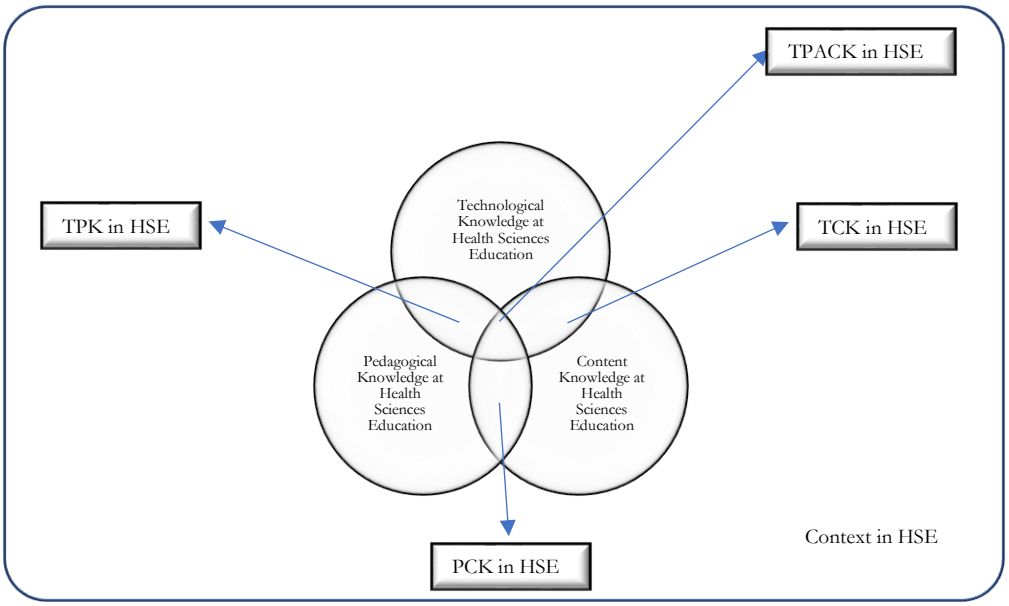
However, "digital inequality" is a real situation in the world which means that not all students have internet access and acquire computer skills. This is particularly critical in South Africa. What's more, both Thaba-Nkadimene (2020) and Hedding et al. (2020) report that virtual simulation as a form of online study has been negatively influenced by the lack of laptops and internet access. In SA, some HEIs are experiencing many challenges and cannot transform to online learning with a simple step, especially those inherited disadvantaged HEIs from apartheid (Thaba-Nkadimene, 2020). Thaba-Nkadimene (2020) further asserts that the infrastructure plays a critical role in ensuring distance study, while SA is still experiencing poor infrastructure in many regions.

Theoretical Framework

This study was anchored with the Technological, Pedagogical and Content Knowledge (TPACK) model proposed by Mishra and Koehler (2006). The reason being that this paper focused on students' views and experiences of clinical simulation as a pedagogical approach in the identified acupuncture programme. Due to the influence of the COVID-19 pandemic, technologies were expansively used in educational programmes (Chick et al. 2020). The TPACK model is widely utilised in the field of education to promote effective teaching, which allows researchers to understand the phenomena from different perspectives, such as technological knowledge, pedagogical knowledge and content knowledge (Koehler & Mishra, 2009; Venketsamy & Wilson, 2020). This would further validate the findings and recommendations of this study in order to strengthen clinical practice of the acupuncture programme for the 21st century through clinical simulation. Both Cohen et al. (2018) and Yin (2018) articulate that a theoretical framework helps investigators render research questions testable, and ensure the extension of knowledge to research inquiry, indicating which findings and conclusions appear to be valid and reliable.

The authors opined that integrating technologies in the acupuncture programme will strengthen teaching and learning. Hannaway (2019) agrees with Mishra and Koehler (2006) that digital technologies are an integral part of teaching and learning for the twenty-first century. For this reason, various scholars and researchers have used the TPACK model in order to integrate technologies in education and promote effective teaching (Venketsamy & Wilson, 2020).

The TPACK model proposes the effective integration of the knowledge of technology, pedagogy and content knowledge into teaching and learning. There are three core components to TPACK: pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK) (Figure 3) (Mishra & Koehler, 2006; Koehler & Mishra, 2009). The primary claim of the model is that the appropriate combination of these components for teaching, learning and assessment generates another four other types of knowledge, namely content knowledge (what); pedagogical knowledge (how), and technological pedagogical content knowledge (which technology/ies) (Mishra & Koehler, 2006; Hannaway, 2019). The model presents technology as the third core domain of teacher knowledge, along with content and pedagogy (Harris et al. 2017; Hannaway, 2019). Harris et al. (2017) further argued that various other blended knowledge domains could be derived from the three domains, such as technological content knowledge (TCK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK) and TPACK.



HSE: Health Sciences Education **TPK**: Technological Pedagogical Knowledge **PCK**: Pedagogical Content Knowledge **TCK**: Technological Content Knowledge **TPACK** : Technological Pedagogical Content Knowledge

Figure 3

Adapted TPACK Model for Health Sciences Education by Researchers

In this paper, the authors utilised the TPACK model to analyse students' views and experiences of the clinical simulation.

Research Problem

The main problem of the research focused

- What are students' views and experiences of the clinical simulation in the acupuncture programme at the HEI?

Sub-problems

- What are the opinions of acupuncture students about the benefits of supporting the acupuncture programme with clinical simulation?
- What are the views of acupuncture students about the difficulties/obstacles in supporting students' learning using clinical simulation?

Method

Research Design

The authors opted for a qualitative descriptive approach in this paper to explore participants' views and experiences on the clinical simulation in the acupuncture programme. They were of the opinion that this approach is suitable to be utilised in this paper since it provides an opportunity to gain an in-depth understanding of the identified phenomenon (Creswell, 2014; Maree, 2020). The interpretivist paradigm was employed in this study since it is a subjectivist epistemology that relies on the researcher's comprehension when making sense of data (Yin, 2018). This paradigm allowed the authors to explore and understand participants' lived experiences on the clinical simulation during the Covid-19 pandemic within the acupuncture programme. The authors used a single case study design for this study since it allowed for an in-depth exploration of the selected phenomenon (Cohen, Manion & Morrison, 2018; Yin, 2018).

Participants

Purposive sampling technique was used in this study since this approach was most appropriate to access participants who were the students registered in the identified programme (Cohen et al. 2018). The sample of this study included six (6) Bachelor of Health Sciences in Complementary Medicine (BHsCM) students who were in their third year of study. This group was purposively selected because they were the only group of students who participated in clinical simulation in the acupuncture programme. The inclusion criteria were as follows: they had to be registered in the third year of BHsCM; they had to have participated in the clinical simulation programme and they were willing and consented to voluntary participation. The authors invited participants by displaying a research invitation notice on the campus student's notice board. The poster was displayed for a period of two months. Only Six (6) students agreed to participate in this study by signing the research consent forms (see Table 1). Pseudonyms were used in the reporting phase of the study. The table below represented the codes used for each participant to ensure their anonymity and confidentiality.

Table 1

Participant's Information

Participants	Gender	Age
P1	F	22
P2	M	24
P3	M	25
P4	F	22
P5	M	21
P6	F	23

Data Collection Tools

Data collection, as defined by Cohen et al. (2018) and Creswell (2014), is a systematic process of gathering information to answer research questions and general findings. For the purpose of this study, the authors employed semi-structured interviews with an online text-based open-ended questionnaire (Appendix 1). This approach ensured anonymity and any contact with the students, thus preventing the spread of the Covid-19 pandemic (Cohen et al. 2018). The questionnaire was available for participants to answer during a period of two months from 15 October 2021 to 15 December 2021. The data was transcribed and organised into themes and subthemes for thematic analysis.

Data Analysis

The data were analysed inductively according to the guideline of the six-step framework of thematic analysis, proposed by Creswell (2014). This approach assisted the researchers in making sense of the data transcripts and identifying critical themes. Creswell (2014) states that thematic analysis is a process of identifying similar and dissimilar opinions in qualitative studies. Qualitative validity criteria, including credibility, transferability, dependability, and confirmability, were ensured in this study by means of employing techniques of member checking, debriefing between authors and auditing by a second coder.

Ethical Committee Permission

Ethical clearance was approved by a Research Ethics Committee at a public university (Reference: EDU137/21).

Results

This study explored students' views and experiences of the clinical simulation in the acupuncture programme at an HEI in SA during the Covid-19 pandemic. During the data analysis, two major themes emerged which are presented below. Direct quotes are included in this section. Figure 4 illustrated a summary of the codes of themes and subthemes.

Theme 1: Students' Views of the Clinical Simulation

The findings of this study identified that students experienced both benefits and challenges in the clinical simulation in the acupuncture programme within the HEI in a South African context.

Sub-theme 1: Benefits of Clinical Simulation

Findings of this study revealed that all participants had positive views on the clinical simulation in the acupuncture programme. They agreed that clinical simulation effectively strengthened their knowledge, skills and confidence in clinical practice. All participants concurred that the simulation had been an integral part of their learning which assisted them in understanding the weak components in their content knowledge. The simulation encouraged their engagement in the study. They all recommended formalising more simulation sections into their curricula.

To this, P4 stated:

> "*I feel the simulation is very helpful since it allowed us to gain practical experiences and build confidence simultaneously, which I believe this experience will be beneficial when we start seeing patients and help boost independence.*" P1 wrote: "*I learnt so much about the acupuncture clinical practice by attending the simulation. Now, I won't make those mistakes in the future when I practise independently.*"

P5 indicated:

> "*I feel more comfortable practising in the simulation before seeing patients in the clinic because I can be sure that there won't be any severe consequences, even I had some mistakes in the process, although I wish there won't be any mistake*."

P6 highlighted: "*The simulation exposed us to real acupuncture practice*." P2 added: "*I really enjoy the simulation in our acupuncture programme since it is beneficial and much of assistance to do what you always read about*."

P3 revealed that

> "*I feel that I will be confident when seeing real patients in the clinic since I have practised exactly the same procedure in the simulation centre. I won't be stressed in looking for equipment or figuring out how to use different devices that are required for the practice in the clinic*."

P2 stated: "*I like the layout of the simulation centre because it makes me feel like a real doctor seeing patients in the clinic*."

Participants also recognised the importance of post-simulation debriefing with instructors. For example, both P3 and P2 agree that the discussion after the simulation is very helpful. This debriefing allowed them to recognise the misunderstandings in the learning. They both asserted that it was of great significance to have this section with experienced instructors who could answer their questions or confusion from both theoretical and clinical practice perspectives.

No participants in this study expressed that they were experiencing anxiety or increased stress levels.

Sub-theme 2: Challenges in the Clinical Simulation

Despite the advantages of the clinical simulation, findings of this study identified a number of challenges when conducting the clinical simulation.

According to P6, she was not comfortable in the limited space where the simulation activity took place. She felt that there were too many students in a confined space, and this had exposed them to the risk of Covid-19 infection.

Participants in this study neither reported experiencing the internet connection problem during the virtual simulation nor could not afford the devices, such as laptops or cellphones. However, there was still poor satisfaction on the virtual simulation that was expressed by participants.

When answering the question: Please describe your experiences on the virtual simulation in the acupuncture programme; P1, P4 and P5 all expressed that

> they understood the need of employing virtual simulation in the acupuncture programme in this year (2021), which was due to the influence of Covid-19 pandemic. They agreed that the virtual simulation was interesting. However, they all indicated that the virtual simulation was not real, and they didn't feel the same when

compared with the physical situation on campus. They would prefer to have contact simulation on campus if they could.

According to P2, "*I enjoy contact simulation; I feel that the course can benefit from more contact simulations*." P3 wrote, "*I have enjoyed the virtual simulation. However, I would prefer more contact simulations on campus. But it is unrealistic due to Covid-19*."

Theme 2: Incompetence of Instructors and Standardised Patients

Findings of this study also identify that competencies of instructors and standardised patients played a significant role in ensuring the successful implementation of the simulation. The incompetence of instructors and standardised patients also negatively affected students' satisfaction towards the simulation. Both P3 and P5 indicated on their forms that the instructor sometimes could not provide satisfactory and correct answers to students if the questions were not on his memo. They realised that they had learnt incorrect information from the instructor. They further affirmed that this situation negatively affected their study. They expressed their concerns about the content which confused them immensely.

According to P2:

"*During the simulation, the standardised patient does not understand what he should or should not say in the consultation. There was once that the standardised patient gave all answers according to the memo before any inquiry from me. This indeed disappointed me.*"

Summarily: Graphically

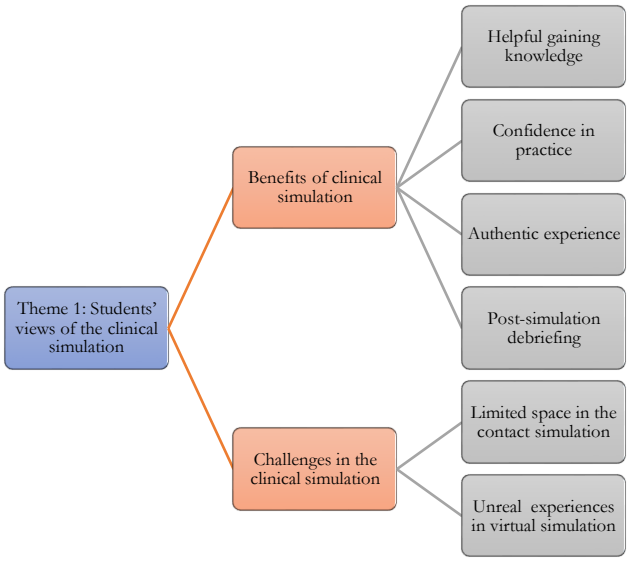


Figure 4

Codes of Theme 1 and sub-themes: Students' Views of the Clinical Simulation

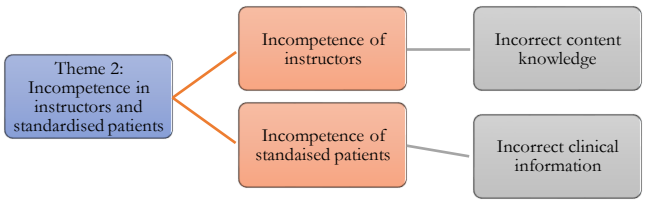


Figure 5

Codes of Theme 2 and sub-themes: Students' Views about Incompetence in Instructors and Standardised Patients

Discussion and Conclusion

Importance of Clinical Simulation In Acupuncture Programmes

Studies revealed that clinical simulation had been widely accepted in professional education in the fields of health sciences (Amod & Brysiewicz, 2017; Kapucu, 2017; Martinez et al. 2020). Researchers agree that clinical simulation effectively strengthens clinical teaching and learning (Munroe et al. 2016; Martinez et al. 2020). So et al. (2019) concur with Amod and Brysiewicz (2017) who affirm that clinical simulation is an effective pedagogical approach to facilitate students' learning (Munroe et al. 2016). These researchers agree that clinical simulation enhances teaching and learning effectiveness by means of developing students' competencies in clinical practice. In this study, the authors concurred that simulation promoted effective teaching and learning. This finding made contribution to reveal the effect of clinical

simulation in the acupuncture programme in the South African context. This was of significance since there was a lack of literature that reflects South African students' views on clinical simulation in acupuncture programmes. According to the TPACK model, the lectures are recommended to select the appropriate pedagogical approaches for delivering specific content knowledge (Koehler & Mishra, 2009; Hannaway, 2019). The authors were of the view that it was of great importance for lecturers to acquire adequate PCK and TPCK, which would assist them in promoting the effective delivery of specific CK.

Scholars assert that the clinical simulation allows students to make mistakes and learn from their own mistakes while ensuring safe practice (Amod & Brysiewicz, 2017; So et al. 2019). In this study, the authors concurred that the clinical simulation provided an opportunity for students to witness the consequence of mistakes in clinical practice without any harm to patients.

The authors were of the opinion that the real environment would assist students in acquiring authentic clinical experiences. This would further contribute to students' confidence when faced with the actual practice since students were familiar to the environment. Findings from this study supported the opinion that participants appreciated the real clinical setting in the simulation facility since it provided authentic lived experiences. The findings of this study were in agreement with Munroe et al. (2016) and So et al. (2019), who both confirm that the design of the simulation facility is recommended to be the same as hospitals in the working world. This will assist students in gaining clinical experiences that are similar to clinical practice, although this may increase the financial constrain to the institutions (Bogossian, 2017; So et al. 2019).

Barriers in Instructors' and Standardised Competencies in Clinical Simulation

The post-simulation discussion is of paramount importance, as asserted by Munroe et al. (2016) and So et al. (2019) since this process strengthens students' knowledge and understanding of situations. Finding from this study supported this view that students recognised the importance of post-simulation debriefing. The authors agreed that post-simulation discussion (debriefing) ensured students acquire adequate content knowledge according to the simulation plan. This view agrees with Motola et al. (2013), who highlighted the importance of well-trained instructors for the clinical simulation. However, this debriefing would require training for instructors or employing registered clinicians who were practising. Both approaches would significantly increase the financial constrain to institutions, especially in SA, where the economic situation is still a critical issue (Mellor, 2014; Thou, 2018). The authors were of the opinion that this barrier can be bridged by developing a handbook of acupuncture clinical simulation by documenting detailed guidelines of requirements in each simulation plan with standardised CK in each section. These will include the aim and purpose, the explicit content, and the outcomes of the simulation (Munroe et al. 2016).

The authors believed that there was a lack of instructors who would be able to facilitate the simulation since the debriefing requires both adequate content knowledge and clinical experiences. So et al. (2019) state that instructors should be released from their duties to attend the training course with clinicians, increasing the burden on both hospitals and educational institutions. The findings of this study were in agreement with Persico (2018), who specified that the professionalism of standardised patients or instructors may significantly affect the success of the simulation. It was critical for instructors to have adequate CK and standardised patients were well trained to understand their roles in the simulation. The instructors' inadequate CK in a particular field will significantly affect the delivery of the simulation. For this reason, both So et al. (2019) and Munroe et al. (2016) affirm that it is of great importance to provide proper training to both instructors and standardised patients. According to the TPACK model, the authors agreed that all instructors should be in possession of adequate CK and have an in-depth understanding of the CK in order to achieve the best teaching outcomes. This view was in agreement with Hannaway (2019) and Venketsamy and Wilson (2020), who highlighted the importance of appropriate and adequate CK in teaching.

Findings from this study disagreed with other studies in the literature which argued that students might experience an increased stress level during the simulation (Munroe et al., 2016). No participants in this study expressed that they were experiencing anxiety or increased stress levels. The possible reason for the low stress and anxiety level could be due to the support the students received from the instructors. The findings of this study further confirmed the importance of CK, TK, PK and other interacted knowledge in the delivery of the acupuncture programme through planned clinical simulation. Selecting an appropriate pedagogical approach for particular CK in the acupuncture programme will further promote effective teaching and improve students' experience.

Influence of Online Technology in Clinical Simulation

Higher education in the twenty-first century is profoundly influenced by the development of technology (Padilha et al. 2019; Aristovnik et al. 2020). Globally, many HEIs embrace technologies in the process of transforming their

modes of delivery to accommodate students during the Covid-19 pandemic lockdown (Thaba-Nkadimene, 2020). As revealed by Thaba-Nkadimene (2020) and Hedding et al. (2020), many South African students experience negative effects of online teaching and learning due to the poor infrastructure in some regions in the countries and the high cost of devices. Participants in this study neither reported experiencing the internet connection problem during the virtual simulation nor could not afford the devices, such as laptops or cellphones. This might be because that the identified HEI in this study was in an urban region where infrastructure was well developed. However, there were some participants who were dissatisfied with the planning and organisation of the virual clinical simulation. The findings of this study revealed that participants were not satisfied with the virtual simulation since they felt it was not real and that they wanted to experience the 'real-life situation'. This is understandable since HEIs are in a lockdown mode and real-life clinical practices were impossible.

The use of technology will definitely promote teaching and learning effectively according to the TPACK model, as articulated by Venketsamy and Wilson (2020) and Mishra & Koehler (2006). For this reason, technologies are well accepted in many educational programmes in various fields. However, the authors were of the view that it was crucial for lecturers to select particular technology and pedagogical approaches when delivering specific CK. This would require lecturers to acquire an in-depth understanding of the advantages and disadvantages of each technology that was adopted. Lecturers should employ appropriate technology for specific CK in a particular context.

So et al. (2019) agrees with Munroe et al. (2016) that the layout of the simulation centre should be the same as clinics in a real situation. In this study, the authors agreed that it was essential for intuitions to offer proper facilities for simulation activities. This would further promote the successful delivery of the clinical simulation and improve students' satisfaction.

Conclusion

Clinical simulation is an effective approach to enhance students' learning to ensure their competencies in clinical practice (Kapucu, 2017; O'Niel, 2013). It enables students to gain authentic clinical experiences and skills which are critical in achieving learning outcomes of the acupuncture programme (O'Niel, 2013). The authors believed that students' competencies was of great importance to optimise patients' care in clinical practice. It was of particularly significance in the acupuncture programme to promote students' learning in SA; since clinical simulation benefits HEIs where there was a lack of training capacity, namely on-site staffing and facilities. Despite technologies have been widely accepted in the field of education globally (Hannaway, 2019), the use of technologies in clinical simulation should be well designed by taking into consideration specific content knowledge.

This paper highlighted students' views and experiences on the clinical simulation in the acupuncture programme in the South African context. The findings of this study were considered to be of great significance since it was the first research to investigate South African students' views and experiences on the delivery of the acupuncture programme in a particular context. This study also made contributions through its findings by revealing students' attitudes towards clinical simulation in the acupuncture programme. The findings highlighted that clinical simulation was an effective method to strengthen effective teaching. However, some disadvantages should be addressed, as specified in the recommendation.

Recommendation

The findings in this study reveal that students appreciated this mode of teaching and learning-clinical simulation. For the successful delivery of the clinical simulation in the acupuncture programme, the authors agreed on the following recommendation.

For Applicants (Curriculum Developers, Educators)

- Clinical simulation is an effective strategy in the delivery of acupuncture CK. It is recommended that this teaching and learning strategy should be included and standardised in the acupuncture curriculum (Munroe et al. 2016).
- Due to the lack of appropriate training and inadequate CK among instructors, it is recommended to develop a handbook for acupuncture clinical simulation with detailed guidelines as support for instructors, which will ensure the proper CK is delivered in each section and the learning outcomes are met.
- A lack of simulation facility. It is recommended that institutions provide proper facilities for clinical simulation to accommodate the Covid-19 regulations, further ensuring students and staff safety (Munroe et al. 2016; So et al. 2019).

- Although virtual simulation was adopted in some HEIs, it is recommended to be used as a supplementary approach to teaching which should only contribute a limited portion of clinical simulation. Programme, such as acupuncture, which require physical practice cannot be replaced by technologies completely. In this respect, it can be used to prepare a blended learning curriculum.

Recommendations for Further Research

Since this study was limited to a small sample size, the researchers believe that this study should be explored with a large sample size at more higher education institutions. They further recommend that this study should be conducted at an international university or universities. The identified acupuncture programme was integrated into a four-year Bachelor of Health Sciences in Complementary Medicine programme, which included Homeopathy and Phytotherapy. Further studies should also be conducted to investigate the effectiveness of clinical simulation in promoting teaching and learning of other integrated modalities in complementary medicine since this study focused particularly on acupuncture.

Limitations of the Study

This study was limited to exploring students' experiences on clinical simulation in the acupuncture programme at one HEI in Gauteng Province in SA, therefore the results limited comparisons. Another limiting factor was the small sample size in this study. The researchers believe that since the sample size was small, the findings may yield different results with a large sample. Further studies are recommended to include a larger sample size to yield different results and recommendations; to investigate other technological and pedagogical approaches which can benefit the effective delivery of the acupuncture programme within the African context.

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Appendix 1

Online Text-based Semi-structured Interview Form

Instructions

The purpose of this interview is to explicit your views and experiences of the clinical simulation in the acupuncture programme. Please complete this form in detail. If you need more space, you can add more lines. There are no right or wrong answers to these questions.

Thank you for your time.

Semi-structured Interview Form

Q1. Describe your experiences of the clinical simulation in the acupuncture programme.

Q2. What are the benefits of employing clinical simulation in the acupuncture programme.

Q3. How can the clinical simulation strengthen your clinical practice skills? Explain.

Q4. Please describe your experiences on the virtual simulation in the acupuncture programme (advantages and disadvantages).

Q5. How would you like to be supported in the acupuncture programme to improve your skills in clinical practice?

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Research Article

Primary school teachers' opinions on social justice in life studies lessons and in-class practices

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Abstract

Education is of great importance for the inclusion of persons in society. While education is so important, unfortunately, not all students can benefit from education opportunities offered equally. Problems experienced in reaching quality education that put students at a disadvantage situation can be listed as social differences, gender, language, ethnicity, family structure, socioeconomic status, and having special needs. This study aims to examine teachers' opinion to some students' situation about their disadvantageous in the classroom and how the primary school teachers minimize this disadvantage and furthermore what they do to about social justice in the classroom environment. For this aims, five schools with disadvantaged students were selected to determine the participants of the study, and 10 teachers who voluntarily agreed to participate in the study were selected from the teachers in these school. In this study, case study design, one of the qualitative research methods, was preferred and interview method was used for data collection via semi-structured form. This research was conducted in the academic year 2021-2022. As a result of the study was determined that the teachers' work for disadvantaged students focused on " peer collaboration", "forming heterogeneous groups" and "respecting different cultures". It was stated that when they made these practices, the problems of the students decreased and they improved academically and socially.

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Introduction

In today's rapidly changing and developing world, persons need to keep up with this change and development. In general, it can be said that some basic behaviors such as adapting to the environment in which individuals live, communicating with their environment, being in cooperation, are skills that have become a necessity in the 21st centuryIt is important for individuals to acquire these skills at an early age for consistent behaviors. For this reason, the lessons that students take in the first years of school life become even more important. The basic course in which the basic rules of social life and behavior patterns are taught is the life studies lesson in primary school. The life studies lesson taught in the first three years of primary school plays a very important role in gaining these skills. A child who has just started primary school leaves his/her home for the first time and comes to school, a place where he/she can interact socially. In this new environment, it helps the student in terms of adaptation to the environment, thanks to the content of the life studies lesson (Gündoğan, 2019). Life studies lesson has been defined in different ways by many people in the literature. Tay (2017), defines it as a lesson that helps the child to know himself/herself, gains the ability to adapt to the globalizing world, and tries to teach children the knowledge of life. Based on this definition, we can

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express the life studies lesson as life itself. Thanks to the Life studies lessons, the child not only experiences situations that he/she may encounter in real life, but also becomes individuals who are prepared for these and similar situations. In this context, the life studies lesson has an important place in the adaptation of the individual to the environment in which he lives, in the training of individuals who are blended with the values such as knowledge, skills, attitudes and behaviors required in world citizenship (Gündoğan, 2019). Life studies lessons is also a life lesson in which world citizenship brings about respect for culture, cultural awareness and being together with different cultures. The cultural dimension of the life studies lesson has made the concept of multiculturalism compulsory in education.

Multiculturalism

Multiculturalism can be defined as the awareness of race, language, religion, ethnicity, social class and other cultural elements (Johansson, 2022). Multicultural education does not only give equal education opportunities to students from different races, languages, ethnicities and cultures, but also strives to change the school environment in which education will take place (Banks, Cookson, Gay, Hawley, Irvine, Nieto, Schofield & Stephan, 2001). According to Gay (1994), multicultural education is; it is a thought and education reform movement and process that aims to change the structure of educational institutions so that all students have an equal chance of academic success. The multicultural education process is seen as a strategy that develops students' critical thinking skills, enables them to learn by doing and experiencing, and provides a direct proportion between this and academic success, and prepares students for the situations required by the 21st century (Bigatti, Gibau, Boys, Grove, Ashburn-Nardo, Khaja & Springer, 2012). When we examine the definitions of different authors, it is seen that multicultural education has a structure that takes into account individual differences. Because no student is exactly alike. Each student's knowledge and skills, interests, wishes, expectations, ways of working, in short, everything is different from the other. People are affected by every element of society. For this reason, we need to take into account the changes that occur due to cultural differences in the preparation of the learning environment (Çoban, Karaman & Doğan, 2010). In other words, it is seen that the authors agree on such stuaitons as respect for human rights and freedoms, tolerance towards cultural differences, equal opportunities in education, planning and preparing programs to teach cultural diversity, and creating a different perspective etc in multicultural education.

Education is of great importance for the inclusion of persons in society. While education is so important, unfortunately, not all students can benefit from education opportunities offered equally. Problems experienced in reaching quality education that put students at a disadvantage situation can be listed as social differences, gender, language, ethnicity, family structure, socioeconomic status, and having special needs (Ross, 2003). In the studies conducted, it has been seen that students who are disadvantaged due to their social differences cannot achieve the desired academic success and fail in many social issues (Chiu ve Walker, 2007; Çiftçi & Çağlar, 2014; Enslin, 2006; Sart, Barış, Sarıışık & Düşkün, 2016). It is necessary to provide social justice in order to minimize this situation of students who are disadvantaged due to their social differences (Furman & Shields, 2005). The Turkish Language Association (TDK) (2014) defines the notion of social justice as "a set of policies aimed at creating a just, egalitarian, participatory and harmonious society". In shortly, social justice includes the efforts to ensure that the student takes part in a democratic and fair educational environment, where he or she equally benefits from the education and training that other students benefit from, regardless of their social environment or difference (Koçak & Bostancı, 2019). Theoharis (2007), on the other hand, explains social justice in a way that includes developing a culture that will include marginalized students first and then all students, and the activities and plans to be carried out to include all students.

When the literature is examined, the notion of social justice in education; it is tried to be explained with concepts such as justice, multiculturalism, equality and democratic society (Tomul, 2009). The notions of social justice and multicultural education are similar in ideas that equal educational opportunities should be provided to all students from different races, social groups and ethnicities (Banks, et al., 2001). Besides this similarity, multicultural education aims to provide communication and interaction between different groups; social justice in education, on the other hand, aims to eliminate or minimize the negative effect of the disadvantageous situation in education on academic and social success (Bohn & Sleeter, 2000). For social justice, "being just" is an invariable truth. However, "treating everyone equally" goes against the idea of social justice (Furman & Shields, 2005). Furman and Shields (2005) emphasize that teachers have great importance in both academic success of students and in raising awareness of the democratic environment. For this reason, teachers, who carry out education and training activities, have a great importance in applying social justice in education. Disadvantage due to social differences is a major obstacle to getting qualified education. There is a link between the provision of social justice in education and the educational climate created by the teacher in the classroom environment. Aronson & Laughter (2016) emphasizes that solutions to the problems of

marginalized groups who are disadvantaged in accessing education can only be found according to the experiences in the implementation process. Tomul (2009), on the other hand, sees social justice in education as an area for eliminating the situations experienced by disadvantaged groups.

Teachers have a great responsibility in providing and implementing social justice (Karacan, Bağlıbel & Bindak, 2015). Teachers need to know about social justice in order to fulfill this responsibility and they must also behave accordingly. There are three important points to ensure social justice in the classroom. These points are the distributive, relational and cultural dimensions of social justice. Distributive justice focuses on the equal distribution of what is available to every person in the society. Relational justice means that all social classes have the right to have a say in the decisions taken about them, while cultural justice focuses on the implementation of all practices and studies with respect to different cultures (Gewirtz & Cribb, 2002). In order to ensure social justice in the classroom, teachers should consider all dimensions of social justice and look at events from a holistic perspective. Shields (2013) emphasizes that social justice in education can be achieved not only with democratic values but also with an egalitarian education that emphasizes academic success. As stated above, the distributive, relational and cultural dimensions give the teacher important responsibilities to ensure social justice in the classroom environment. In this context, teachers have responsibilities such as developing a critical perspective against unfair situations, instilling the awareness of being respectful to cultural differences, giving students the right to speak on issues that concern them, and granting all students the right to equal and fair education (Çoban, Karaman & Doğan, 2010; Koçak & Bostancı, 2019). The notion of social justice, by its nature, is related to the content of the life studies lesson. Because life studies lesson is directly related to social life. Thanks to this relationship, the child is prepared for situations that may arise in real life. It can overcome the negativities created by the differences existing in the society with the awareness of social justice. In the formation of this awareness, the life studies lesson is seen as very important.

Problem of Study

In this study, it is aimed determine to teachers' opinion to some students' situation about their disadvantageous in the classroom and how the primary school teachers minimize this disadvantage and furthermore what they do to about social justice in the classroom environment. In order to achieve this aim, answers were sought to the following questions:

- According to teachers' opinions, what are the main problems that disadvantaged students experience in the classroom environment?
- What do teachers do in the classroom to ensure social justice in the classroom environment?
- What are teachers' opinions about the importance of education in promoting social justice?
- What are the teachers' evaluations of life studies lesson textbooks in terms of social justice?

Method

Research Design

In this study, case study design, one of the qualitative research methods, was preferred. A case study is an approach that examines a phenomenon or event in depth, explains the current situation (Yıldırım & Şimşek, 2021), and examines a current situation in real life where the boundaries between an event and context are not clear (Yin, 2014). Especially in recent years, case studies have been used frequently in educational studies. The reason for this serious trend is that the case study provides opportunities to examine, analyze and make inferences about the subject without interfering with the researcher's subject (Akar, 2019). The most important characteristics that determine the case study, which Merriam (1988) defines as a holistic description and analysis of a person, an entity or a social unit are accessibility to different information sources, observability and in-depth data acquisition and analysis (Duff, 2008; Woodside, 2010). In this research, primary school teachers' practices related to social justice in life studies lessons were wondered and the case study design was preferred because it was aimed to describe and analyze these practices in depth.

Participants and Sampling

Criterion sampling technique, one of the purposeful sampling methods, was used to determine the participants of the study. Based on our existing knowledge, samples are selected from the units that we think can provide the data we need in the study and that we anticipate in the purposive sampling method (Gezer, 2021). Purposive sampling methods are analyzed as subheadings that outlier situation, maximum variation, criterion, homogeneous sampling etc. In this study, criterion sampling was used. Criterion sampling; It is the examination of situations where the units to be selected can provide rich data (Patton, 2002) that meet a number of criteria (Yıldırım & Şimşek, 2021). One of the defining features of the case study is that the situation under study is examined in itself due to its unique characteristics (Ersoy,

2016). For this reason, five schools with disadvantaged students were selected to determine the participants of the study, and 10 teachers (coded as P1, P2, P3…) who voluntarily agreed to participate in the study were selected from the teachers in these school. In determining the participants of this study, factors such as gender, professional seniority, and education level are also taken into account, and the participants are listed in Table 1.

Table 1

Structure of Participants

Participants Codes	Gender	Seniority years	Graduation level	Class grade
P1	Male	12-17	Undergraduate programs	1st grade
P2	Male	18-...	Graduate programs	2nd grade
P3	Female	0-5	Undergraduate programs	3rd grade
P4	Female	6-11	Undergraduate programs	1st grade
P5	Female	0-5	Undergraduate programs	2nd grade
P6	Female	0-5	Undergraduate programs	3rd grade
P7	Female	0-5	Undergraduate programs	2nd grade
P8	Male	12-17	Undergraduate programs	1st grade
P9	Female	0-5	Graduate programs	2nd grade
P10	Male	12-17	Undergraduate programs	1st grade

Data Collection

Semi-structured Interview Form

Interview method was used for data collection in this research. The interview method is a systematic data collection technique in social sciences, based on a conversation between the researcher and the participant about the researched subject. The main purpose of this technique is to learn what the participants think about the researched subject. It provides the opportunity to learn the behaviors that cannot be directly observed, as a primary source, from the participants themselves in the interview (DeMarrais, 2004; Rugg ve Petre, 2007; Patton, 2015; Merriam ve Tisdell, 2016). There are three types of interviews commonly used in social sciences as structured, semi-structured and unstructured. In this study, semi-structured interview was preferred. In the semi-structured interview, which aims to collect data with a flexible approach and includes standard questions, the order of the questions may change depending on the flow of the interview or some questions may not be asked depending on the situation. Similarly, more detailed information may be requested from the participant. At the same time, in this interview method, additional questions can be used if needed, for questions that the participants do not understand or have difficulty in answering (Batdı, 2021). The questions in the semi-structured interview form used as a data collection tool in this study were sent to 5 academicians who are experts in their fields via e-mail and their opinions were requested. 4 academicians responded to this request and the questions were rearranged according to the expert opinions and the final form of the interview form was given. However, after the interviews with the participants, the recorded data were read to the participants again and confirmed. Similarly, these data are given in the findings section of the research without being interpreted as a direct quote. In this way, it was tried to increase the validity and reliability of the research. Example for the one of the interview questions; What are the problems that disadvantaged students experience in the classroom? The last version of Semi-structured Interview Form attached the appendix (See Appendix 1).

Data Analysis

The data collected in the research were analyzed by content analysis technique. In short, content analysis can be defined as creating themes and sub-themes with codes based on data (Yıldırım & Şimşek, 2021). The main purpose of content analysis is to provide an understanding of the studied phenomenon (Batdı, 2021). In the analyzed data, words and word groups that are close to each other are determined and placed in categories related to the subject in line with the literature (Silverman, 2013). In other words, in content analysis, codes, themes and patterns are determined as a result of systematically classifying the data (Batdı, 2021). All qualitative data collected in this study were first scanned carefully. All of the data were read, analyzed and coded. Based on the coding, categories and themes were reached.

Findings

Theme 1. Problems of Disadvantaged Students

Teachers' opinions on the problems of disadvantaged students are presented in Table 2.

Table 2.

Teachers' Opinions on the Problems of Disadvantaged Students

Codes	Frequencies (f)
Inability to adapt to the school environment	10
Not understanding what is told	4
Inability to communicate	6
Dificulty in discipline	2
Socioeconomic difficulties	1
Not feeling comfortable	3
Not being able to express oneself	4

It has been determined that primary school teachers generally state that students have problems in "adapting to the school environment". In addition, the problems faced by disadvantaged students are as follows: "not being able to communicate", "not understanding the subject", "not being able to express oneself", "not feeling comfortable", "difficulty in discipline", "socioeconomic difficulties". Teachers' opinions on the subject are given below through direct quotations:

"They are shy both in understanding the subject and participating in social activities in their friend environment." (P1)

"They experience problems such as inability to communicate, indifference of parents, difficulty in discipline, absenteeism, inability to fully adapt to their peers, and not feeling psychologically comfortable." (P2)

"Students who do not speak Turkish and who are considered inadequate in terms of family features and socioeconomic status may experience adaptation problems with their peers in the classroom environment. It may take time for inclusive students to mingle with their peers and for their peers to become socially accepted." (P3)

"Students who cannot speak Turkish have problems in communicating with their friends in the classroom and school environment." (P4)

"They may have compatibility issues. They have difficulties in activities. Foreign students have communication problems with their friends" (P5)

"My socioeconomically poor students have difficulties in obtaining the necessary materials in the classroom. At the same time, my foreign students have difficulties in adapting to the Turkish education system and in the classroom." (P6)

"They feel socially alone. They lag behind their peers. Behavior problems arise after a while." (P7)

"They are having adaptation problem in the classroom. I observe a constant state of anxiety. They have problem in socializing. They are shy and introverted. They have learning difficulties." (P8)

"First of all, they have communication problems. For example, when I think about foreign students in the classroom, they have disadvantagous due to language. Since they do not speak Turkish fluently, their ability to express themselves remains weak. For this reason, they cannot establish bonds with both the teacher and their peers. They exhibit timid behavior" (P9)

Figure 1
Codes on the Theme of "Problems of Disadvantaged Students" Created by Content Analysis of the Interviews

Theme 2. Social Justice Providing and Used Methods

The teachers' opinions on social justice providing and used methods are presented in Table 3.

Table 3.
Codes of Social Justice Providing and Used Methods Theme

Codes	Frequencies (f)
Heterogeneous Group	6
Communicating with parents	1
Making students express themselves	3
Providing or creating peer support	5
Focusing on values education	2
Empathising	1
Listening to students	2

Primary school teachers stated that they try to provide equality between students by arranging students or peer group in a heterogeneous way. In addition, "communicating with parents", "making students express themselves", "providing or creating peer support", "focusing on values education", "empathising", "listening to students" He stated that they included practices or methods such as " in their lessons.

> *"In order to bring students together for group activities, I pay attention to the heterogeneity of the peer group rather than the academic success of the students. In other words, there are students from all levels or cultures in the group I created. In this way, I ensure the fusion within the group more quickly" (P1)*

> *"First of all, I have frequent meetings with parents. Since students have difficulties in communicating, I do a lot of practice with them. I encourage them to speak in front of their peers. I want other students to support them as well. If there are different talents, I am working to reveal them. I keep in touch with the counseling service. I do my best not to make them feel like foreigns." (P2)*

> *"I give students the opportunity to engage more in social interaction. For this, I focus on the physical layout of the classroom. I give importance to peer support in lessons." (P3)*

"I make layout in the seating arrangement in a way that everyone gets together. I provide peer support to prevent them from being alone during school time." (P4)

"While doing the activities, I distribute the students from different cultures into the activity groups, so that the students are active." (P5)

"I do in-class activities to complete the missing aspects of students from different cultures. For example; I am doing reading practice with my foreign students who do not know how to read and write and speak Turkish." (P6)

"I try to keep everyone close to each student in classroom to increase communication between student from different culture." (P7)

"I focus too much on personal and social values. I attach importance to the notions of sharing, equality, collaboration and solidarity. I also focus on developing empathy skills." (P8)

"My first expectation from students from different cultures is the ability to express themselves. Because people who can express themselves and convey their feelings and thoughts to the other party can truly be an individual. That's why I try to listen and understand my students. I take care to work with heterogeneous groups in the classroom. I always give feedback when they are successful or unsuccessful." (P9)

"I usually do some activities such as give task student from different culture during breaks time, give equal rights to speak, play games, include them in the circle of friends etc. These examples can be increased. For example, engage in peer work, monitor conversations and behaviors during breaks, and take precautions against negative situations." (P10)

Figure 2
Codes on the Theme of " Social Justice Providing and Used Methods " Created by Content Analysis of the Interviews

Theme 3. Social Justice and Education

Teachers' opinions about the importance of education in promoting social justice are follows.

Table 4.

Codes of Social Justice and e-Education Theme

Codes	Frequencies (f)
Adapt to environment	5
Equality	3
Muticulturalism	4
Just and democratic society	7

"The sense of social justice has a positive effect on student behavior. It enables students to adapt to the environment more quickly and to produce solutions to problems more quickly." (P1)

"Social justice in education is very important. Because, thanks to social justice, every student gets educated they deserve." (P2)

"Social justice creates an environment suitable for the coexistence of different cultures in the education process. It provides to students meet better and to mingle different groups with each other." (P3)

"Unfortunately, the notion of social justice has no use in the educational process. Because it can not provide keeping close between different groups. Each student communicates with their own ethnic and origin group" (P4)

"A fair social equality and a democratic environment can be created through education. Education plays an important role in establishing social justice. Because through education, positive attitudes can be developed in people." (P5)

"Social justice and education are inseparable. Educated people believe in the necessity of social justice. Those who believe in social justice also know that education is very important for social peace." (P6)

"Education gives people the skill to respect. It provides the knowledge of living together. Students who gain these will also gain a sense of justice." (P7)

"Education is of great importance in ensuring social justice. We, the teachers, behaving fairly in the classroom will also contribute to the development of our students' sense of justice." (P8)

"The notion of social justice means that the different groups of the society are balanced in stile of their living. From this point, it reminds us of equal opportunity in education. Equality of opportunity provides that people's skills can be developed in the best way without any discrimination and barriers." (P9)

"If there is no social justice in education, you will only just care about their academic skills, not their behavior. If building positive behavior is the first thing to consider, it will not be possible without social justice. Social justice is essential for a calm and peaceful classroom environment." (P10)

When the opinions of the teachers given above through direct quotations are examined, it is seen that the teachers think that education and social justice are related concepts in general. Teachers stated that thanks to education, the process of students' adaptation to the environment and their self-expression became easier, and equality of opportunity was provided in education. They also stated that in a classroom environment where there is social justice, it becomes an easy and appealing situation in education.

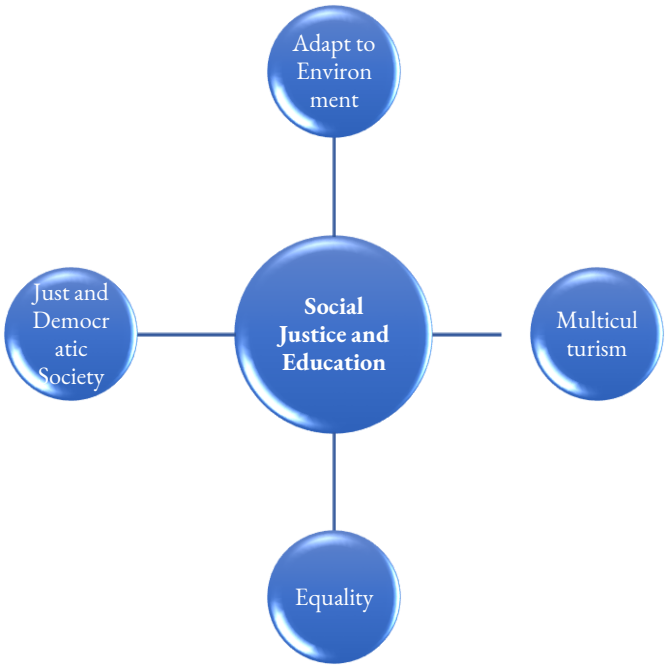

Figure 3
Codes on the Theme of " Social Justice and Education " Created by Content Analysis of the Interviews

Theme 4. Life Studies Lessons and Social Justice

The teachers' opinions on how they evaluate the Life Studies lesson textbook and the curriculum in terms of social justice, when they consider it in all its dimensions, are as follows:

Table 5.

Codes of Life Studies Lessons and Social Justice Theme

Codes	Frequencies (f)
Inadequate	7
Diversities	3
Justice and Equality	5
Universal values	4

> "*I generally focused on the life studies lesson topics from an academic point of view; I've never looked at it in terms of social justice." (P1)*
>
> *"The Life studies lesson textbook seems really suitable for all students. But It may not be suitable for students whose financial situation is not good in the slums. Because cultural differences can be effective in this." (P2)*
>
> *"I think the books are not enough for students from different cultures." (P3)*
>
> *"I find books superficial in terms of depth of knowledge. Does not reflect real life and living conditions." (P4)*
>
> *"Considering students from different cultures, I think that it is not suitable for social justice and equality." (P5)*
>
> *"I think that the Life Studies textbook appeals to all students in terms of social justice. It is necessary to include more universal values and issues that focus on being a good person." (P6)*
>
> *"Different cultures or different individual characteristics are included in the book. This aims to provide children with respect to diversities at an early age." (P7)*
>
> *"I think it is sufficient. The notions of social justice and equality are emphasized directly and indirectly in textbook. I really like this year's books." (P8)*
>
> *"When I evaluate the life studies lesson textbooks in terms of social justice and equality, I see respect for diversities reflections. I think that the topics covered in the book are universal. For example, there is the topics that in the book very important such as "we introduce ourselves", "our personal differences", "my opinions are valuable" and addressing these topics shows us that social justice is reflected." (P9)*
>
> *"The textbook is not very important to me. What matters is teacher behavior in educational process. One good move can be worth a whole book. Commonly The book is read and talked about it. But the behaviors that learned never forget." (P10)*

When the opinions and thoughts of the teachers were examined, it was observed that the teachers generally found the life studies lesson textbook and program appropriate in terms of social justice and equality; but some teachers stated that they found the book and the program superficial or inadequate. According to the teachers in-class practices and social justice for aims of lesson were included in textbook. But some teachers, who stated that this situation did not exist throughout the book, stated that social justice for aims of lesson about real life were not sufficient. Teachers, who found the textbook sufficient, in terms of social justice stated that they liked the textbook because it generally included universal values. However, they stated that they liked the book because it included in-class practices that would teach respect for diversities and reflect social justice to the all of students.

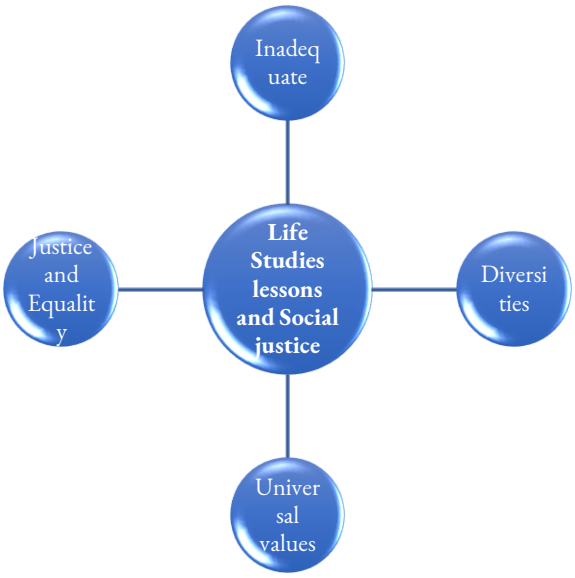

Figure 4
Codes on the Theme of " Social Justice and Education " Created by Content Analysis of the Interviews

Results and Discussion

In this study, it is aimed determine to teachers' opinion to some students' situation about their disadvantageous in the classroom and how the primary school teachers minimize this disadvantage and furthermore what they do to about social justice in the classroom environment. For this purpose, findings related to the disadvantaged students, classroom problems of disadvantaged students, in-class methods and techniques used by classroom teachers to minimize these problems, life studies lesson and social justice concepts were determined and examined via content analysis.

According to the results of the research, teachers stated that disadvantaged students generally have difficulties in classroom educational activities and in the school environment. The majority of teachers think that these difficulties experienced by students affect their academic and social lives quite negatively. They stated that these students generally isolate themselves from the classroom, pay attention to something else by not being focused in the lesson, and are students with low self-confidence. As a result, these students show many undesirable behaviors. In the study conducted by Özcan, Balyer and Yıldız (2018) in schools located in disadvantaged regions, it was determined that similar results were obtained with this research. According to the data obtained in the aforementioned study, it is stated that the problems of disadvantaged students include lack of self-confidence, lack of motivation, lack of aims, not being interested in the topics of the lesson, coming to the lesson unprepared, not defending their rights when they are wronged and absenteeism. Additionally, language-related problems prevent disadvantaged students from both developing academically and communicating with other students (Kirişçi, 2014). In the literature, it has been stated that the biggest problem for disadvantaged children is the language problem, and because of this problem, they have difficulties in expressing themselves, understanding what they read, writing, and understanding what is told (Tamer, 2017; Erdem, 2017; Kultas, 2017, Parlakkaya, 2014; Akalın, 2016; Sarıtaş vd., 2016; Özdemir, 2016). Nar (2008) stated that students have difficulties educationally because of speaking different languages at home and at school.

On the other hand, teachers stated that they support disadvantaged students and be interested in students in the classroom. In addition, teachers also stated that they made these disadvantaged students feel valued without marginalizing them via democratic desicion-making in classroom. Similarly, teachers stated that they give responsibility to students so that social justice can develop more among students. Some teachers stated that the disadvantaged students became equal with other students thanks to the activities they carried out in the classroom, and the teachers also stated that in this way, the disadvantaged students developed both socially and academically. Gürgen (2017) yaptığı çalışmasında öğretmenlerin dezavantajlı durumda olan ve olmayan öğrenciye eşit bir şekilde davrandıklarını belirtmiştir. Gürgen (2017) stated that teachers treat disadvantaged and non-disadvantaged students equally, but Özcan, Balyer and Yıldız (2018) stated that in schools where disadvantaged students are concentrated, practices such as home visits and awarding are included in order to increase student success, and these provide successful results. According to Tomul (2009), with the provide the social justice in education, students are prepared for life and develop

themselves socially. Gürgen (2017) states that teachers should adopt social justice in order to create a democratic classroom environment that can appeal to students from different cultures.

The life studies lesson is the most appropriate course that can help ensure social justice. Because the realities of life are presented with a standardized planning via the content of the life studies lesson. Thanks to this course, teachers can eliminate the disadvantage among students and provide social justice. However, many of the teachers participating in the research find the life studies lesson and book insufficient in this respect. When we look at the literature, we come across similar findings. It is seen that the concept of justice is rarely included in the life studies and primary school social studies textbook (Erbaş, 2021; Erbaş & Başkurt, 2021). This constitutes a major obstacle to the achievement of the purpose of the life studies lesson. In order to eliminate these obstacles, especially life studies lessons and books should be presented to students with contents that covers and accepts every member of the society.

Recommendations

Recommendations for the Researcher

Since this study was limited to 10 teachers in five school in the province, it is recommended that further studies of a similar nature be carried out with a larger sample of teachers in all districts in the province. The author envisage findings dissimilar due to the cultural diversities.

This study was conducted as qualitative research on a small group. For this reason, research can be conduct as a quantitative research with a larger group.

Recommendations for the Applicants

Cultural activities should be included in life studies lessons so that disadvantaged students in the classroom interact more with other students. In addition, in-class materials from the cultures of diverse students should be brought to the classroom in life studies lessons. In this way, students from different cultures can focus more on the lesson. Moreover, teachers should be focusing on Increase cultural studies for diverse students in life studies lessons.

Limitations of Study

The research was limited to a tiny sample 10 teachers in five school in one district in the Gaziantep Province in Turkey. The author believes that the findings in other studies can revealed poor cultural interaction among diverse invidiuals. The obtained data in this study is based only on teachers' opinions.

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Appendix 1.
Semi-structured Interview Form

Semi-structured Interview Form
for Preservice Teacher about Social Justice Instruction at Class

Questions

Q1. What are the problems that disadvantaged students experience in the classroom?
Q2. What do you think about the importance of education in promoting social justice?
Q3. What methods or practices do you use to ensure social justice in the classroom?
Q4. When you consider with all its dimensions of the life studies lesson curriculum and textbook you are using, how do you evaluate the curriculum and the textbook in terms of social justice and equality perspectives?

Thanks

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Research Article

Determining self-efficacy levels of the English language teachers for the education of gifted students[1]

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Abstract

Gifted student education has been the centre of many studies until now. Even though there was an amount of studies examining gifted education there was limited amount of studies related to self-efficacy levels of English Language Teachers for gifted students. Therefore, the aim of this study is to determine the self-efficacy levels of English Language Teachers towards gifted student education and examining teachers' age, professional seniority levels and gender variables. This study was carried out with 352 volunteer English Language Teachers (291 women, 61 men) who worked in the 2020-2021 academic year in the Educational Institutions related to the Ministry of National Education in Turkey. As a result, it was found that self-efficacy beliefs of English Language Teachers towards education of gifted students in both sub-dimensions and total scores of the scale were around 80 out of 100. Therefore, it was revealed that teachers' self-efficacy beliefs were high. Also, the results of the analysis showed that self-efficacy beliefs of English Language Teachers towards the education of gifted students increased with the age variable. In addition to these results, it was found that the self-efficacy beliefs of English Language Teachers increased as their teaching Professional seniority levels increased. Lastly, there was no significant difference in the whole scale and its sub-dimensions related to gender variable. In addition to that, literature review of the studies about teachers' professional seniority and gender variables revealed that, a consensus could not be reached. In order to eliminate this ambiguity, further studies are needed on this subject. On the other hand analysis of the scale revealed that items with the lowest average on the scale showed that, self-efficacy scores of English teachers in subjects such as behaviour control, implementation of the Individual Education Program and classroom control were lower than the other items.

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Introduction

To this day, many definitions have been made by academicians to explain the word gifted. According to the literal meaning, the word "gifted" refers to individuals that are bestowed special talents by God (Akarsu, 2004). In a more academical context, gifted student is an individual who demonstrates above-average skills in one or more of the physical, social, emotional or cognitive contexts compared to their peers (Stephens & Karnes, 2000). Education of gifted individuals is one of the issues that have been emphasized both in Turkey and abroad in recent years. The concept of gifted individuals doesn't only cover academic success thus a gifted individual may have talent in art, leadership, sports or many other fields (Reynolds & Birch, 1988).

Giftedness can manifest in more than one area; Talent above the average in areas such as perception, analysis skills and language skills, which develop under the influence of environmental factors and the mental characteristics that an individual brings with heredity, may indicate giftedness (Baykoç, 2010). Throughout history, studies on the education of gifted individuals have attracted the attention of researchers (Karnes, Stephens, & James, 2000). It is also important to consider the education of gifted individuals within the framework of foreign language education.

In the international academy context, the concept of gifted individuals have been defined as individuals who have superior skills compared to their peers, have talents or abilities in multiple areas such as creativity, art, academic and leadership, and can analyze information faster than their peers (Renzulli, 1986; Wagner & Sternberg, 1982). Studies that examine gifted education revealed gifted individuals need special training to support their development. Therefore, review of the educational context mentions the qualifications of the educational staff involved in the education of these individuals are also important (Piske, Stoltz, & Machado, 2014).

The adequacy of normal education programs in meeting the educational needs of gifted individuals is questioned since the education programs for gifted individuals should be versatile and have features that will support the mental development of these individuals; so that gifted individuals can use their skills more effectively (Steiner & Carr, 2003). Knowledge and competencies of educators are considered just as important as education programs for gifted education. The concept that expresses teachers' knowledge and competencies is associated with self-efficacy. According to Bandura (1977), self-efficacy is expressed as an individual's ability to direct his behaviours towards a determined goal to be successful. Bandura (1993) stated that individuals with high self-efficacy have more strategically flexible, cognitively skillful and motivational functions compared to other individuals. Studies have revealed that individuals who have the ability to successfully cope with various stressful situations are individuals with high general self-efficacy; therefore, they perform their duties more effectively (Schwarzer, 1992). Caprara, Barbaranelli, Steca, and Malone mentioned (2006), that there is a relationship between teachers' self-efficacy beliefs and student satisfaction. Thus, educators with higher general self-efficacy levels can complete challenging tasks more effectively (Schwarzer & Hallum, 2008).

The concept of teacher self-efficacy has been defined as specific to the field, task and context rather than a general self-confidence structure (Bandura, 1997; Tschannen-Moran, Hoy, & Hoy, 1998). Although studies have been conducted in different disciplines related to teacher self-efficacy, it has been observed that there are limited amount of studies on the self-efficacy of English teachers regarding the education of gifted students.

Darling-Hammond, Flook, Cook-Harvey, Barron, and Osher (2020) stated that when children are supported within all areas of their development, individuals improve their abilities, confidence and motivation. This finding supports the idea that when the language skills of gifted individuals are supported, their linguistic abilities will improve.

Considering the effect of teachers' self-efficacy on the quality of teaching process, it is important to determine the professional self-efficacy of English teachers for the education of gifted individuals. Examining the professional skills and abilities of teachers in foreign language education is of great importance in the training of these students so that gifted individuals who represent us in many global and local areas do not have foreign language problems in their future lives.

Problem of Study

- What is English Language Teachers' level of self-efficacy regarding gifted students?

Sub-problems

- What is English Lanugage Teachers' level of self-efficacy regarding gifted students according to age variable?
- What is English Lanugage Teachers' level of self-efficacy regarding gifted students according to professional senioarity variable?
- What is English Lanugage Teachers' level of self-efficacy regarding gifted students according to gender variable?

Method

Research Design

In order examine the general perceptions of English teachers regarding the education of gifted individuals, this study was carried out in survey method. Survey method is preferred to investigate the relationship between two or more variables in the same population (Karasar, 2011; Leedy & Omrod, 2010). To add more this study was conducted to investigate English Language Teachers' perceptions on gifted education according to gender, age and professional experience.

Participants

Questionnaire items were added to the prepared scale and it was opened to the participation of English teachers via e-survey. The scale was presented to the participation of teachers between 27.05.2021 and 04.06.2021 and the analysis was carried out with the data obtained from 352 people.

The participants of this study took part in this study on a voluntary basis. Since the data were collected over the internet, it was obtained by simple random sampling. The scale developed by the researchers, "The Self-Efficacy Scale for Gifted Students for English Teachers", was used to collect data. The stages of preparation of the scale are presented below.

Data Collection Instrument

Self-Efficacy Scale for Education of Gifted Students-English Teachers (SESEGF-ELT)

In this study, "Self-Efficacy Scale for Gifted Students" developed by the researchers was used to collect data. Scale consists of two dimensions; Preparation (4 items) and Classroom (4 items) and a total of eight items (Appendix 1 and Appendix 2). For the validity analyzes of the scale two data sets obtained by randomly dividing the data obtained from 352 individuals by approximately 50% is used. The two-factor structure obtained by Exploratory Factor Analysis (EFA) was subjected to Confirmatory Factor Analysis (CFA) with the other data set. As a result of the analysis, X2/sd=2.94, TLI=.92 and CFI=.95 values were obtained. Accordingly, the model is within acceptable limits (Brown, 2006; Hu and Bentler, 1999; Schumacker and Lomaks, 1996; Sümer, 2000). ; Thompson, 2004). The Cronbach's Alpha coefficients calculated from the EFA data set of the scale for Preparation, Classroom and the whole scale are .89, .83 and .88. The Cronbach's Alpha coefficients calculated from the DFA data set of the scale for the Preparation, Classroom and the whole scale were found to be .86, .78 and .87. These values show that the internal consistency coefficient is acceptable (Özdamar, 2004).

Data Analysis

In the study, the mean and standard deviation of the items, dimensions and the overall scale were calculated. In order to interpret the self-efficacy levels of the teachers towards the gifted, the average of the dimensions and the scores obtained from the total scale was interpreted by dividing it by the number of items. In this study, teachers' self-efficacy was examined in terms of age, seniority and gender variables. No grouping was made for age and seniority. For this purpose, the mean and standard deviation of both variables were calculated. For the age variable, the mean was 37.16 and the standard deviation was 8.09. The standard deviation was considered as the cutoff point. Ages between 1 standard deviation below the mean (37.16-8.09=29.07) and 1 standard deviation above the mean (37.16+8.09=45.25) were identified as "medium", those below 1 standard deviation (less than 29.07) were identified as "young" and ages above the standard deviation (over 45.25) were identified as "advanced age".

A similar situation was also applied for the seniority variable. For descriptive statistics, the distribution of the total scores according to the variables of the study was examined, and normality tests were evaluated depending on the group

size. Kruskall-Wallis test was used when one-way analysis of variance was not provided in the seniority variable in cases where normality was provided. In order to find the source of the significant difference in the analysis of variance, LSD was used if the variance was homogeneous, and Tamhane test was used when it was not. In order to find the source of the significant difference in the Kruskall-Wallis test, Bonforonni correction was made and the Mann-Whitney U test was performed. The Mann-Whitney U test was performed when the t-test was not provided in cases where normality was achieved in the gender variable. A significance value of .05 was accepted in all analyzes. The effect size Cohen d coefficient (Lenhard & Lenhard, 2016) was calculated for the results that were significant.

Findings

In order to obtain data about the general distribution of teachers' self-efficacy, descriptive statistics of each item were made and presented in the table.

Table 1

English Language Teachers' Self-efficacy Levels for Gifted Education According to SESEGF-ELT Items

Items	N	Min	Max	Mean	SD
I can notice my gifted student in English classes.	352	50.00	100	86.40	13.27
I can prevent the negative behaviours of my gifted student that disrupt the positive classroom atmosphere in the English lessons.	352	20.00	100	78.42	15.93
I can make my gifted student value learning English.	352	40.00	100	83.90	14.28
I can eliminate the situations that cause my gifted student to not be in harmony with his/her classmates in English class.	352	30.00	100	77.10	16.04
I can differentiate the forms of assessment for my gifted student in English class.	352	10.00	100	82.59	17.42
I can prepare an Individualized Education Program (IEP) for my gifted student.	352	10.00	100	83.43	19.59
I can apply the Individualized Education Program (IEP) that I have prepared for my gifted student.	352	10.00	100	80.33	19.31
I can develop teaching materials for my gifted student in English class.	352	20.00	100	82.41	17.86

As seen in Table 1. first three items with the highest mean in the scale emerged as item 1, item 3 and item 7. On the other hand, the items with the lowest average were determined as the 2nd item, 5th item and 8th item. When these items were examined, it was found that the self-efficacy scores of English teachers in subjects such as behaviour control, implementation of the Individual Education Program and classroom control were lower than the other items. Therefore, these issues can be addressed in the future as an in-service training for English teachers.

Table 2

English Language Teachers' Self-efficacy Levels for Gifted Education According to SESEGF-ELT Scales Sub-Dimensions

Sub-scales of SESEGF-ELT	N	Minimum	Maximum	Mean	Standard Deviation	Total Item Numbers
Classroom /Instruction Dimension	352	166	400	325.82	47.32	81.46
Instructional Preparation Dimension	352	100	400	328.77	63.01	82.19
SESEGF-ELT Scale Total	352	340	785	654.60	97.75	81.82

According to Table 2, it is seen that the self-efficacy beliefs of English teachers towards the education of the gifted are around 80 out of 100 in both sub-dimensions and total scores of the scale. Therefore, it can be stated that teachers' self-efficacy belief scores are high.

In order to determine whether the self-efficacy beliefs of English teachers for the education of the gifted differ significantly according to age groups, it was examined whether the groups met the normality assumptions. As a result of the analysis, it was determined that the normality assumptions were not met. Therefore, the Kruskall-Wallis test was applied and the results were presented in Table 3.3.

Table 3

English Language Teachers' Self-efficacy Levels According to Their Ages

Sub-scales	Age groups	N	Rank Average	Chi-square
Classroom	Young	57	161.94	5.251
	Middle Aged	247	174.19	
	Advanced Aged	48	205.67	
Preparation	Young	57	150.73	4.401
	Middle Aged	247	181.03	
	Advanced Aged	48	183.77	
Total	Young	57	152.79	5.095
	Middle Aged	247	177.99	
	Advanced Aged	48	196.98	

As seen in Table 3 self-efficacy beliefs of English teachers towards the education of the gifted increased with age in terms of both sub-dimensions and the average rank of the total scores. As a result of the analysis, no significant difference was found between the mean rank of the groups.

In order to determine whether the self-efficacy beliefs of English teachers for the education of the gifted differ significantly according to professional seniority, it was examined whether the groups met the normality assumptions. As a result of the analysis, it was determined that the normality assumptions were not met. Therefore, the Kruskall-Wallis test was applied and the results are presented below.

Table 4

English Language Teachers' Self-efficacy Levels According to Their Professional Seniority

Sub-scales	Seniority Groups	N	Rank Average	Chi-Square
Classroom	Low Seniority	55	169.18	4.758
	Middle Seniority	254	172.75	
	High Seniority	43	207.99	
Preparation	Low Seniority	55	155.23	3.418
	Middle Seniority	254	178.62	
	High Seniority	43	191.20	
Total	Low Seniority	55	158.54	4.681
	Middle Seniority	254	175.87	
	High Seniority	43	203.17	

As shown in Table 4, it is seen that the mean ranks in both sub-dimensions and total scores increase with the the level of seniority. However, as a result of the analysis, no significant difference was found between the groups.

In order to understand whether there is a significant difference between self-efficacy scores according to gender, the normality assumption was checked and it was determined that the entire scale and its sub-dimensions did not meet the normality assumptions. As a result, Mann-Whitney U test was performed and the results are given in below.

Table 5

English Language Teachers' Self-efficacy Levels According to Gender

Sub-scales	Gender	N	Rank Average	Row Sum	Mann-Whitney U Values
Classroom	Female	291	175.23	50990.50	8504.5
	Male	61	182.58	11137.50	
Preparation	Female	291	180.45	52512.00	7725
	Male	61	157.64	9616.00	

Total	Female	291	178.08	51820.50	8416.5
	Male	61	168.98	10307.50	

As seen in Table 5 examination of class sub-dimension revealed that while the average rank of the men is high, the mean rank of the women in preparation and total is higher. As a result of the analysis, no significant difference was found according to gender in the whole scale and its sub-dimensions.

Discussion and Conclusion

In this study, the level of self-efficacy beliefs of English teachers towards the education of gifted students and the differences according to age, professional seniority and gender were examined. his study was carried out with the participation of 352 volunteer English teachers working in Turkey in the 2020-2021 educational. In this study with the survey method, the data was collected with the scale "English teachers' self-efficacy in teaching gifted students" that researchers developed.

The study first aimed to determine the level of self-efficacy beliefs of English teachers towards gifted education. As a result, teachers' self-efficacy perceptions were determined high in terms of items, dimensions and in the whole scale. Considering that teachers' self-efficacy beliefs positively affect their classroom management skills (Poulou, Reddy, & Dudek, 2018), it can be said that the high self-efficacy beliefs of English teachers regarding gifted students are related to teachers' ensuring that gifted students are successful.

Studies show that teachers with high self-efficacy levels experience professional satisfaction more compared to other teachers; moreover, it was also stated that teachers with high self-efficacy levels experienced lower levels of work-related stress (Caprara, Scabini, & Barni, 2011). Considering the positive effects of supporting and increasing teachers' self-efficacy levels on both teachers and students, teacher self-efficacy still emerges in the field as a subject that needs to be studied (Bandura, 1977).

To add more, studies related to literature mention that variables such as age and professional experience are among the factors that determine teachers' self-efficacy (Shaukat, Vishnumolakala, & Bustami, 2018). As the second aim of the study, the self-efficacy values of English teachers were examined in the light of the age variable. As a result, it was determined that as the age of the teachers increased, their self-confidence scores towards self-efficacy beliefs also increased. Considering these findings, it can be said that the self-efficacy of English teachers increase as they get older.

Third aim of the study was to examine the professional seniority of teachers. As a result of the analysis, no differentiation was observed between self-efficacy scores according to seniority levels. In a previous study, it was stated that teachers' self-efficacy is in a non-linear relationship with professional experience (Klassen & Chiu, 2010). As defined by Wolters and Daughtery (2007) when teachers' professional experience increases, their self-efficacy levels also increase. Studies on the relationship between professional experience and teacher self-efficacy show that a clear consensus on the subject has not been reached. Therefore, further investigation on this subject should be done in the future.

The final purpose of the study was to examine teachers' self-efficacy scores according to the gender variable. As a result of the analysis, it was seen that there was no significant difference according to gender groups. These findings are similar to the study of Odanga, Raburu, and Aloka (2015).

Limitations and Recommendations

In previous studies, it has been stated that supporting students academically, emotionally and socially contributes to their abilities, their confidence and motivation (Darling-Hammond, Flook, Cook-Harvey, Barron, & Osher, 2020). The results obtained in this study show that these students can have a significant support in their abilities, confidence and motivation, since they indicate that teachers have high self-efficacy and therefore have a high potential to support gifted individuals academically, emotionally and socially. It is thought that this study, which was prepared to determine the self-efficacy levels of English teachers, may be effective in preventing the inadequacies that may be experienced in the education of gifted students. Identifying the subjects teachers show low self-efficacy scores and providing in-service training on these subjects can play an important role in the education of gifted students.

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Appendix 1

Self-Efficacy Scale for Education of Gifted Students-English Teachers (SESEGF-ELT)

Self-Efficacy Scale for Education of Gifted Students-English Teachers (SESEGF-ELT)		
Age: **Gender**: Female ( ) Male ( ) **Year of employment**:		
Explanation: This scale is developed to determine self-efficacy levels of English Language Teachers regarding gifted student education. Please read the sentences below carefully and identify a number between 0 to 100 for each item. You can refer to the scale below to determine the number. **Never** **Sometimes** **Always** %0 % 10 %20 %30 %40 %50 %60 %70 %80 %90 %100		
No	Items	Percentage
1	I can notice my gifted student in English classes.	
2	I can prevent the negative behaviours of my gifted student that disrupt the positive classroom atmosphere in the English lessons.	
3	I can make my gifted student value learning English.	
4	I can eliminate the situations that cause my gifted student to not be in harmony with his/her classmates in English class.	
5	I can differentiate the forms of assessment for my gifted student in English class.	
6	I can prepare an Individualized Education Program (IEP) for my gifted student.	
7	I can apply the Individualized Education Program (IEP) that I have prepared for my gifted student.	
8	I can develop teaching materials for my gifted student in English class.	

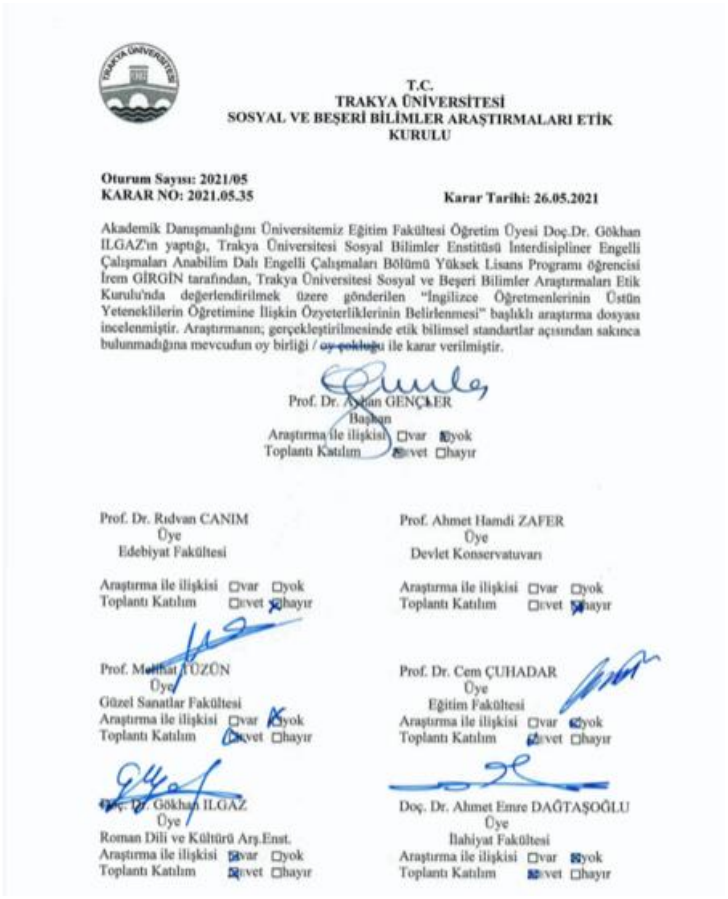
Appendix 2

Self-Efficacy Scale for Education of Gifted Students-English Teachers (SESEGF-ELT) – Turkish Version

İngilizce Öğretmenlerinin Üstün Yetenekli Öğrencilere İlişkin Özyeterlikleri Anketi ve Ölçeği		
Yaşınız: ..... **Cinsiyetiniz**: Kadın ( ) Erkek ( ) **Meslekte Çalışma Yılınız**:.....		
Açıklama: Bu ölçek İngilizce öğretmenlerinin üstün yeteneklilere ilişkin öz-yeterliklerinin belirlenmesi amacıyla geliştirilmiştir. Aşağıda üstün yeteneklilere ilişkin öz-yeterlik seviyelerini içeren bir dizi cümle yer almaktadır. Her bir cümleyi okuyup yeterliliklerinizi tanımlama oranını bırakılan boşluğa yazınız. Oranları aşağıda verilen ölçekten yararlanarak saptayabilir ve istediğiniz sayıyı yazabilirsiniz. Aşağıdaki durumlarla ilgili olarak kendi durumunuzu oran(%) olarak yazınız. Asla Bazen Her zaman %0 % 10 %20 %30 %40 %50 %60 %70 %80 %90 %100		
No	Maddeler	Yüzde
1	İngilizce dersinde sınıfımdaki üstün yetenekli öğrencimi fark edebilirim.	
2	İngilizce dersinde sınıfımdaki üstün yetenekli öğrencimin olumlu sınıf atmosferini bozan olumsuz davranışlarını engelleyebilirim.	
3	Üstün yetenekli öğrencimin İngilizce öğrenmeye değer vermesini sağlayabilirim.	
4	Üstün yetenekli öğrencimin İngilizce dersinde sınıf arkadaşları ile uyum içerisinde olmamasına neden olan durumları ortadan kaldırabilirim.	
5	İngilizce dersinde üstün yetenekli öğrencim için değerlendirme biçimlerini farklılaştırabilirim.	
6	Üstün yetenekli öğrencim için Bireysel Eğitim Programı (BEP) hazırlayabilirim.	
7	Üstün yetenekli öğrencim için hazırladığım Bireysel Eğitim Programını (BEP) uygulayabilirim.	
8	İngilizce dersinde üstün yetenekli öğrenci için öğretim materyali geliştirebilirim.	

Appendix 3

Ethical Committee Permittance



T.C.
TRAKYA ÜNİVERSİTESİ
SOSYAL VE BEŞERİ BİLİMLER ARAŞTIRMALARI ETİK KURULU

Oturum Sayısı: 2021/05
KARAR NO: 2021.05.35 **Karar Tarihi: 26.05.2021**

Akademik Danışmanlığını Üniversitemiz Eğitim Fakültesi Öğretim Üyesi Doç.Dr. Gökhan ILGAZ'ın yaptığı, Trakya Üniversitesi Sosyal Bilimler Enstitüsü İnterdisipliner Engelli Çalışmaları Anabilim Dalı Engelli Çalışmaları Bölümü Yüksek Lisans Programı öğrencisi İrem GİRGİN tarafından, Trakya Üniversitesi Sosyal ve Beşeri Bilimler Araştırmaları Etik Kurulu'nda değerlendirilmek üzere gönderilen "İngilizce Öğretmenlerinin Üstün Yeteneklilerin Öğretimine İlişkin Özyeterliklerinin Belirlenmesi" başlıklı araştırma dosyası incelenmiştir. Araştırmanın; gerçekleştirilmesinde etik bilimsel standartlar açısından sakınca bulunmadığına mevcudun oy birliği / ~~oy çokluğu~~ ile karar verilmiştir.

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Research Article

Preservice early childhood teachers' science conceptual changes with STEM-based science activities

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Abstract

Developing positive attitudes towards science and scientific process skills at an early age enables children to become more successful in the fields of science. However, in order to provide this education in early years, it is necessary to use scientific concepts correctly and appropriately by teachers and parents. This study investigated the effects of STEM-based science education practices on the science conceptual changes of preservice teachers. One-phase experimental embedded pattern design, one of the mixed-method research, was used in the study. The study group consisted of 20 (16 women, 4 men) preservice teachers (PST) who were enrolled in an undergraduate course titled Science Activities for Preschoolers. In addition, data were collected from the Science Concepts Form, STEM-based science activities plans, and application videos. The study results showed that STEM-based science activities positively impacted the science-related conceptual changes of preservice teachers. Especially, preservice teachers' conceptual changes were increased in stone and soil, living and non-living thnigs, and force, motion and balances concepts. Furthermore, it has been determined that this program supported teachers in correcting misconceptions in different science subjects (ex. Earth and space science, life science, physical science) and using concepts correctly. The study results suggested that STEM-based science education practicess are important for teacher's science understanding and using in classroom.

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Introduction

In recent years, educators across the globe have emphasized the importance of teaching STEM (science, technology, engineering, and mathematics) related subjects to children across all grade levels (Breiner, Harkness, Johnson, & Koehler,

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2012; Bybee, 2013; English, 2016). While STEM reform efforts were initially aimed at older students at the elementary, middle, and high school levels, the emphasis has now been expanded to include younger students, including those attending preschool or kindergarten (McLure et al., 2017). This shift in emphasizing STEM education in early childhood was, to a certain extent, a consequence of the publication of two policy reports in the United States (US) by the National Science Foundation (NSF). The "Early STEM Matters: Providing high-quality STEM experiences for all young learners" (Early Childhood STEM Working Group, 2017) and "STEM Starts Early: Grounding Science, Technology, Engineering, and Math Education in Early Childhood" (McClure et al., 2017) stressed the importance of beginning STEM education at an early age. These reports also included recommendations for policy, research, and practices designed to enhance early childhood STEM education.

According to the Early Childhood STEM Working Group (2017), four basic principles should be adhered to in order for early childhood STEM education to be effective: i) children need adults to develop their natural STEM inclinations; ii) representation and communication are central to demonstrating STEM learning; iii) Adults' beliefs and attitudes about STEM education affect children's beliefs and attitudes about STEM; iv) STEM education is not culturally neutral. An earlier report (National Research Council [NRC], 2011) maintained that preschool teachers should have a solid understanding of STEM education. This, they claim, is necessary to design appropriate learning experiences to help students actively participate in STEM education. Nevertheless, according to Park and colleagues (2017), even though preschool teachers are aware of STEM education's importance, many reports challenges when it comes to teaching STEM in the classroom. These challenges include a lack of time as well as a lack of knowledge about STEM topics. This situation is partly due to inadequate professional development and support within preschool teacher education programs. Thus, the Early Childhood STEM Working Group (2017) recommendation was that preschool teachers should be prepared both pedagogically and professionally regarding the related subject matter. In sum, preschool teachers' ability to effectively apply STEM teaching practices relies upon their understanding of STEM pedagogy and the relevant subject matter, including science conceptual understanding.

This study aimed to investigate the effects of STEM-based science education practices on the development of preservice early childhood teachers' science conceptual understanding. In the following section, we outline the importance of STEM education and science education for young children. Then we discuss the preparation of early childhood teachers to provide them with more science experiences to improve their science conceptual understanding.

Importance of STEM Education

It is maintained (e.g., Jones, Lake, & Dagli, 2005; Seffeldt, Galper, & Jones, 2011) that using a STEM approach can support critical developmental skills in young children, such as critical thinking, problem-solving, and executive thinking. Beyond these more general skills, STEM teaching and learning can help children acquire scientific process skills and positive attitudes towards science (Furtak, Seidel, Iverson & Briggs, 2012; Leuchter, Saalbach & Hardy, 2014; Trundle & Saçkes, 2012). However, according to Çorlu and colleagues (2014), STEM education's effectiveness relied on a theoretically grounded infrastructure and determined at the application level. For example, in a study of STEM education, Strong (2013) found that children developed basic science skills such as observation, experimenting, and the ability to identify different variables. However, supporting developing such skills in young children is only possible if the teacher has relevant professional training. Beyond training, having an appropriate STEM curriculum as well as the support of parents and families is also essential (Uyanık-Balat & Günşen, 2017).

Science Education

For a preschool teacher to deliver lessons that include well-designed science activities for young children, she should have a good understanding of science concepts. Carrier (2013) noted that "Teachers must have a clear understanding of science vocabulary in order to communicate and evaluate these understandings with students" (p.405). Carrier (2013) also concluded that the extent to which preservice teachers use science vocabulary in a lesson is related to their background and experience. Indeed, several reports (e.g., NRC, 2003) suggested a need for teacher preparation programs to improve preservice teachers' science content knowledge and pedagogical teaching strategies. It follows that preservice

teacher education programs that focus on STEM-based science education should positively influence preservice teachers' use and application of science concepts and their attitudes toward science.

This perspective is supported by Starr and colleagues (Starr, Hunter, Dunkin, Honig, Palomino, & Leaper, 2020), who noted that "STEM courses are often the gatekeepers to STEM careers" (p. 3). Thus, a STEM emphasis in early childhood teacher education would lead to young children engaging in developmentally appropriate STEM activities in the classroom. Also, using science practices in the classroom can help build future teachers' self-efficacy beliefs about science and scientific knowledge (Starr et al., 2020). This is important given that, according to the literature, it is well established that the majority of preschool teachers hold negative attitudes towards science and thus use fewer science activities in the classroom (Eshach, 2003; Gelman & Brenneman, 2012; Greenfield et al., 2009; Kildan & Pektas, 2009). In addition, most preservice and in-service preschool teachers feel uncomfortable teaching science in early childhood classrooms due to their lack of knowledge about science concepts. Therefore, a promising approach and to overcome this obstacle to effective science teaching is to provide preservice teachers with classroom teaching experiences. Therefore, in the current study, drawing on the work of Carrier (2013) and Putman (2012), classroom teaching experience is considered as a potentially effective way to improve prospective teachers' science teaching skills in the broad science categories of earth and space science, life science, and physical science.

Earth and Space Science

Typically, in early childhood, the topic of earth and space science draws on children's natural interest in object and events in the world around them, such as soil, rocks, rain, snow, clouds, rainbows, the sun, moon, and stars (NRC, 1996). In addition, according to the NRC (1996), children must understand the properties of materials, objects in the sky, and changes in the earth and sky (NRC, 1996). Although such topics can be considered complex or challenging, according to Lind (2010), early introduction of such content is essential for children to learn about their world and prepare for their future understanding. The challenge for preschool teachers is to prepare developmentally appropriate activities to support children's understanding of these concepts. Beyond hands-on activities, they should also encourage children to talk about what they observe and be curious about pattern changes.

Life Science

Life science is a popular topic in early childhood that provides children with opportunities to build on their knowledge of animals, plants, life cycles, and habitats. According to Charlesworth and Lind (2010), "Children display an eagerness to learn about the living things around them" (p. 508). Therefore, preschool teachers need to support the development of children's understanding of life science concepts. This entails planning appropriate classroom activities and developing questions and evaluation strategies (Charlesworth & Lind, 2010). Nevertheless, the extent to which preschool teachers can do this depends on their understanding of these concepts.

Physical Science

Children seem to be interested in physical science (Simsar, 2018), possibly because physical science experiences are often fun and exciting for them (Charlesworth & Lind, 2010). According to the NRC, this broad category includes (1996) topics such as the properties, position, and motion of objects, light, heat, electricity, and magnetism. Teaching such topics to young children should rely on first-hand experiences using natural objects and visual materials. For preschool teachers to plan appropriate activities, they would first need to "brainstorm strategies to prepare children to understand physical science topics such as magnets, light, and electricity" (Charlesworth & Lind, 2010, p. 523). Preschool teachers' understanding of science concepts, such as the states and shape of matter, light and shadows, force, motion and balance, blocks, magnets, and simple machines, shapes can significantly influence this process.

Preparing Preservice Early Childhood Teachers

Given the recent increased emphasis on improving STEM education, it is necessary to increase early childhood teaching and learn in the relevant disciplines such as science. This can be challenging because, according to recent research, most early childhood teachers feel less confident and prepared to teach science content (Barenthien, Oppermann, Anders, & Steffensky, 2020; Banilower et al., 2013; Early et al., 2010; Greenfield et al., 2009). As a result, science is not frequently

taught in early childhood classrooms. For example, in a national sample of K-3 teachers, 41% of participants reported not teaching science every week (Banilower et al., 2013). Likewise, Tu (2006) worked with early childhood teachers and noted that most participants (86.8 % of participants) did not provide time for science activities. Greenfiel et al. (2009) described it as particularly problematic in preschool classrooms, which can only be remedied by providing professional development (Gerde et al., 2018; Gropen, Kook, Hoisington, & Clark-Chiarelli, 2017). Such training should be designed to help teachers develop their abilities to plan and deliver appropriate science activities. Such skills, however, are rooted in preservice teachers understanding of basic science concepts. Indeed, it is maintained that "a critical focus of preparing ECE teachers to teach science must be to help them understand what constitutes science and strategies for teaching it." (Barenthien et al., 2020, p. 208). This focus is also crucial because early childhood teachers' science background experiences can significantly impact their science teaching self-efficacy beliefs.

While there are various approaches to preparing early childhood teachers to teach science, researchers maintain that it should be practice-based and emphasizing the development of pedagogical knowledge. For example, in a recent study, Carrier and Grifenhagen (2019) designed a science methods course that focused on science vocabulary instruction strategies and science lessons taught to peers. As a result, the researchers concluded that preservice teachers' science vocabulary knowledge had increased by the end of the semester but that there were some inconsistencies regarding their science vocabulary experiences (Carrier & Grifenhagen, 2019). Likewise, teachers' instructional strategies are another factor that can impact students' science vocabulary learning.

The Current Study

The importance of teacher education and training in STEM-related disciplines has been highlighted in recent research studies (Çolakoglu & Gökben, 2017; Dilet et al., 2020; Furtak et al., 2012; Leuchter, Saalbach & Hardy, 2014; Uyanık-Balat & Günşen, 2017. Preschool teacher education in STEM teaching, for example, is associated with more positive attitudes toward the fields of science, mathematics, engineering, and technology (Furtak et al., 2012; Leuchter, Saalbach & Hardy, 2014; Uyanık-Balat & Günşen, 2017). Yet, other research studies reveal some shortcomings and challenges concerning the preparation of preservice teachers in STEM teaching and learning in Turkey (Çolakoglu & Gökben, 2017). One crucial challenge is that preschool teachers tend to have negative attitudes toward science and related fields, and consequently, they use fewer science activities in the classroom (Eshach, 2003; Gelman & Brenneman, 2012; Greenfield et al., 2009; Kildan & Pektas, 2009). However, supporting the development of efficacy beliefs cannot be done in isolation. There also has to be an emphasis on relevant content as well as practical experiences. For example, researchers in one study found that teachers were uncertain about supporting students who had difficulties understanding science concepts (Seah, 2016). Therefore, researchers stated that preservice teachers need science method courses that will support them in order to be able to help children's understanding and learning of science concepts (Carrier & Grifenhagen, 2019).

Problem of Study

Therefore, the current study sought to document preservice teachers' conceptual understanding following their engagement in a STEM based teacher education program. Guiding the study was the following overarching research question:

- What is the effect of a STEM education program on preservice teachers' understanding of earth and space, life, and physical science concepts?

Method

Research Model

The study was designed as a one-phase experimental embedded design which, according to Creswell (2012), is an approach that is used to "collect quantitative and qualitative data simultaneously or sequentially but to have one form of data play a supportive role to other forms of data" (p. 544). Moreover, in such studies, qualitative data can be collected before and after the experiment (Creswell & Plano Clark, 2007). In the current study, quantitative data were collected

before and after the participants engaged in classroom-based STEM activities, and qualitative data were collected during the treatment phase. Such an approach meant that the qualitative data were embedded in the design (Creswell, 2012) and that both data types could be independently analyzed. A visual schema of the design is illustrated in Figure 1.

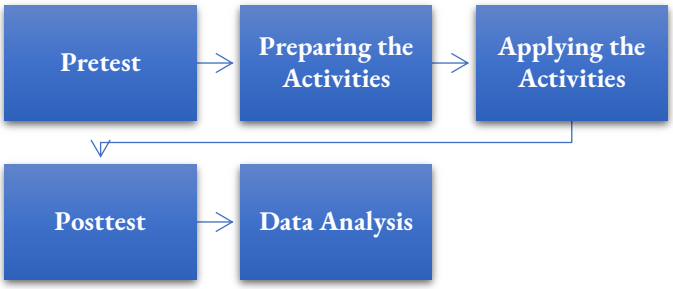


Figure 1

Schematic Representation of the Research Process

Participants

A stratified purposeful sampling approach was used to select the study participants. According to Suri (2011), such an approach is "useful for examining the variations in the manifestation of a phenomenon as any key factor associated with the phenomenon is varied" (p. 70). The study group consisted of 20 (16 women, 4 men) preservice teachers (PST) who were enrolled in an undergraduate course titled "*Science Activities for Preschoolers."*This four-credit course was a mandatory course for undergraduate students who were majoring in early childhood education. The two critical components of the class were two hours of instruction addressing theoretical aspects and two hours engaging in practical science activities. Thus, the course's emphasis was on conceptual understanding and the design of developmentally appropriate STEM-based science activities for young children.

Although 38 students were enrolled in the course, there were several with incomplete data, and therefore they were not included in the study sample. Thus, the 20 PST who participated in the study were those who had completed all of the relevant activities and the video recordings. All of the participants had previously taken early childhood science-related courses. In addition, most (80%) had participated in some type of classroom-based teaching experience. Relatedly, they reported that they had some experience in planning science activities for preschool-aged students. Nevertheless, according to the participants, their knowledge of STEM education in early childhood education was quite limited.

Instruments

Use of Science Concepts

For this study, an instrument titled "Use of Science Concepts" was created. This consisted of 19 questions in three categories: earth and space science, life science, and physical science. First, the earth and space category consisted of 6 questions addressing concepts concerning *Natural Phenomena, Planets, Weather Phenomena, Stone and Earth, Gravity, and the Night-Day Cycle.* Then, there were seven questions in the life science category addressing *Food Chain, Animals, Plants, Living and Non-living things, Body Organs and Their Functioning, Different Habitats, and Different Senses.* The final six questions addressed concepts concerning the *States of Matter, the Shape of Matter, Light and Shadows, Force, Motion and Balance, Blocks, Magnets and Simple Machines, and Kitchen Activities*.

The following are examples of individual items:

- That are the first five (5) concepts/words that you would think of if you were engaged in preschool science activities concerning *Natural Phenomena?*'
- What are the first five (5) concepts/words that you would think of if you were engaged in preschool science activities concerning the *States of Matter*?
- What are the first five (5) concepts/words you would think of if you were engaged in preschool science activities concerning *Light and Shadows.*'

Instrument validity was established by having three educators, each with expertise in preschool education, science education, measurement and evaluation, review of the questions.After the final version of the instrument were used in the study after fixing the unclear sentences. The instrument was administered on two occasions during the semester; once at the beginning of the semester and then during the final week of the semester.

Procedures

All of the participants participated in a ten week-long course on science-based STEM education for early childhood teachers. The class was organized around both traditional classroom teaching as well as classroom-based practical activities. The content focused on the topics of earth and space science, life science, and physical science. During the first class session, the participants were administered an instrument titled "Use of Science Concepts". For the practical application part of the program, the participants engaged in a series of 6-7 hands-on science-based STEM activities.

Given that the participants were all in an early childhood preservice teacher education program, the focus of the class activities was on activities that could be used with either preschoolers or kindergartners. However, during the class sessions, the PST's also developed their STEM activities that would be appropriate for teaching young children in preschool or kindergarten. Each of the preservice teachers developed a total of 19 different STEM activities. Of these, six were based on earth and space science, seven were on topics related to life science, and the last six activities centred on physical science. Video recordings of the students demonstrating the activities were subsequently analyzed to identify how they had interpreted and applied different science or STEM-related concepts.

Data Analyses

In this research, the extent to which preservice teachers were able to specify different science concepts was identified based on their responses to the "Use of Science Concepts" instrument. This instrument allowed the researchers to identify the concepts that the PST's were able to identify concerning each overarching theme. Then, the concepts noted by each PST were used as codes in analyzing the video recordings of the science-based STEM activities. For example, if a PST had written "earthquake", "soil", "sun", etc., in response to the prompt "natural phenomena", these were then used as codes in analyzing the activity plans and video recordings. This approach allowed the researchers to determine the extent to which the PST's had applied the concepts in each of the 19 activities. Then, by using both pre and post data from the use of concepts instruments, changes in the extent to which the PST's understood and applied the various concepts could be determined.

Results

The current study sought to document changes in PST's knowledge and application of STEM/science-based concepts. First, the participants' various terms identified in the pre and post-tests were organized around relevant themes, sub-themes, and concepts. These are reported in a series of tables. Also included in the tables are the total number of times the concepts had been identified and the number of times the related codes were applied when analyzing the participant's activity plans. In addition, six randomly selected activities from the application videos are shared under each theme to illustrate how the relevant concepts and terms were used. These results are organized around several overarching concepts, including earth and space science, life science, and physical science.

Theme 1. Earth and Space Science

Conceptual changes in preservice preschool teachers towards STEM-based science education to teach the theme of Earth and Space Science are reported in Table 1.

Table 1

Conceptual Changes of Pre-service Teachers on the Theme of Earth and Space Science

Theme	Sub-Themes	Pre-Test			Post-Test		
		Science Concepts	**Codes**	**f**	**Science Concepts**	**Codes**	**f**
Theme 1. Earth and Space Science	**Natural Phenomena**	Earthquake (10), Soil (9), Volcano Eruption (8), Tsunami (6), Erosion (5), Flood (4), Hair Dryer (3), Landslide (3), Plants (2), Earth (2), Sun (2), Landslide (2), First aid kit (2), Wind (2), Shake (2), Water (2), Earth (2).	**17**	**66**	Landslide (9), Rocking (7), Water (7), Volcano and Volcano eruption (6), Protection of Soil and Soil (5), Erosion (4), Flood (4), Earthquake (3), Lava (3)), Hose (3), Tree and Afforestation (2), Fire (2), Importance of Plant Growing (2), Wave (2), Sea (2), Natural Disaster (2), Sky (2), First Aid Kit (2), Sand (2), Sugar Cube (2), Temperature (2), Exercise (2), Life Triangle (2).	**23**	**77**
	The Planets	Sun (15), Moon (11), Stars (11), Earth (9), Space (8), Astronaut (3), Names of Planets (2), Spacecraft (2), Space Shuttle (2), Mars (2).	**11**	**65**	Sun (11), Earth (10), Planets (9), Space (8), Stars (8), Astronaut (6), Moon (4), Jupiter (4), Rocket (4), Spacecraft (4) , Sky (2), Venus (2), Mars (2), Light Sources (2), Solar System (2).	**16**	**78**
	Weather Phenomena	Wind (11), Rain (11), Snow (10), Cloud (4), Storm (4), Cold (4), Water (4), Hot (3), Steam (2), Hairdryer (2) The Sky (2), The Snowman (2), The Umbrella (2).	**13**	**61**	Rain (11), Snow (9), Sun (7), Cloud (6), Wind (6), Storm (5), Steam (4), Hair Dryer (3), Weather (3), Water (3) , Full (2), Weather (2), Partly cloudy (2), Boralies (2), Fog (2), Cold-hot (2), Umbrella (2).	**17**	**71**
	Stone and Soil	Sand (8), Pebble (7), Rocks (6), Red Soil (5), Clay (5), Brown Soil (4), Soil (4), Growing of Plants (2), Different kinds of stones (2) .	**9**	**43**	Soil and soil types (10), Pebble (9), Stone (8), Sand (5), Rock (4), Red soil (4), Sea shell (3), Clay (3), Hard-soft stones (3), Abrasion (2), Hot-Cold (2), Large-small (2), Desert (2), Limestone (2), Fragmentation (2), Rough-smooth (2), Colored stones (2).	**17**	**65**
	Gravity	Falling(12), Magnet(4), Gravity of Earth(4), Flying(3), Earth(2), Apple(2), Air(2), Ball throw(2), Space(2).	**10**	**33**	Falling (9), Magnet (6), Gravity (5), Space (4), Force (3), Weight (2), Earth (2), Force (2), Airspace (2), Newton (2), Flying (2), Ground (2), Gravity (2), Jumping (2), Astronaut suits (2), Balloon (2), Feather(2), Stone(2).	**18**	**52**
	Day-Night Cycle	Light-Dark (23), Sun (11), Moon (8), Earth (6), Light (6), Night-Day (5), Stars (4), Evening (2), Shadow (2), Sight (2), Getting up (2), Sleeping (2).	**12**	**72**	Light-Dark (18), Night-Day (14), Sun (12), Moon (8), Earth (7), Stars (5), Day (3), Light and light sources (3), Evening (2), Flashlight (2), Breakfast (2), Time (2), Morning (2), Sleep (2), Orbit (2).	**15**	**84**

Table 1 shows the PST's conceptual changes for six different sub-themes related to the theme of earth and space science. It is evident that 'earthquake' (10) was initially the most commonly used concept for the sub-theme, natural phenomena. However, most participants identified the concept 'landslide' (9) after completing the classroom activities. Then, for the sub-theme, planets, the most commonly identified concept was 'the sun' (15). There was, however, no pre- to post-test change for this concept. For the sub-theme, weather phenomena, the most commonly used concepts were 'wind' (11) and 'rain' (11), with "rain" also being the most commonly identified concept after completing the classroom activities. Then, when considering the sub-theme of stone and soil, the concept 'sand' (8) was initially

identified, while "soil and soil types" was the most common concepts at the post-test stage (10). For the sub-theme, gravity, the PST's identified the concept 'to fall' (12) both before and after (9) completing the class activities. Finally, when considering the sub-theme, the day-night cycle, the concept of 'light-dark (23) was most frequently identified.

The PST's earth and space activity plans were analyzed using the previously identified codes. A total of 120 activity plans were examined, and the findings are reported in Table 2. As shown in Table 2, most of the PST's activity plans were centred around two overarching concepts: 'the sun' (93.5%) and 'light & dark' (74.19%).

A sample of videos of the PST's teaching the planned activities was also examined. This in-depth analysis allowed the researchers to document how the PST's used the concepts and vocabulary (see Tables 1 & 2) when teaching activates concerning the theme of earth and space. Natural Phenomena Activity: The children and the practice teacher go to the school's sandbox and start to make a mountain by bringing the sand together.

> PT8: Kids, now everyone will make a mountain with their group. Let's start.
> PT8: Guys, let's plant these branches in the mountains we have built.
> C1: Miss, why are we planting branches?
> PT8: Let these branches be the trees on your mountain.
> C5: Miss, can I put leaves in the tree?
> C7: Miss, can I put flowers?
> PT8: You can decorate with any material you want, but I want you to decorate only one side. On the other side, there should be no trees, flowers or grass because we will use these two parts for the next experiment... (PT8 - Natural Phenomena Activity Video).

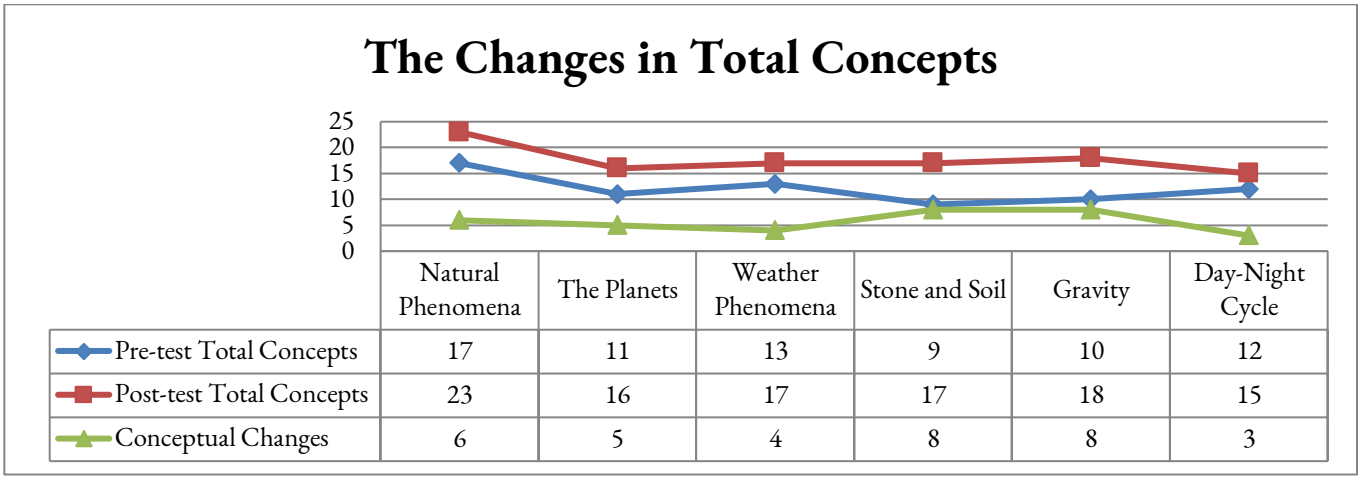
Here, the teacher tells the children about erosion and landslides and then asks them to observe what kind of landslide occurs after the rain in the mountains they have built. Children are asked open-ended questions and the reasons for their answers. In addition, it is seen that the teacher used some concepts and words related to the sub-theme, 'natural phenomena', mentioned in Table 1 during the education process.

Weather Phenomena Activity: Children sit in U shape in the classroom.

> PT3: What is the wind?
> C4: Miss, the wind is the air.
> C7: Miss, the wind shakes the branches of the trees.
> PT3: When does the wind come out? How do tree branches move when the wind blows? How does the wind whistle?
> C5: When it gets cold.
> C13: In the evening...
> PT3: Have you ever seen a windmill?
> All Children: Noooo!.
> PT3: Let's make a windmill together now. Then let's examine how they move outside (PT3 - Weather Phenomena Activity Video).

At the end of the activity, the children observe the windmills outside and talk about the effect of the wind on other objects. Here, it was found that the teacher also mentioned several concepts and words on the theme of 'weather phenomena'.

Detailed analysis of the changes in the total concepts and codes in Table 1 is given in Figure 2 and Figure 3.

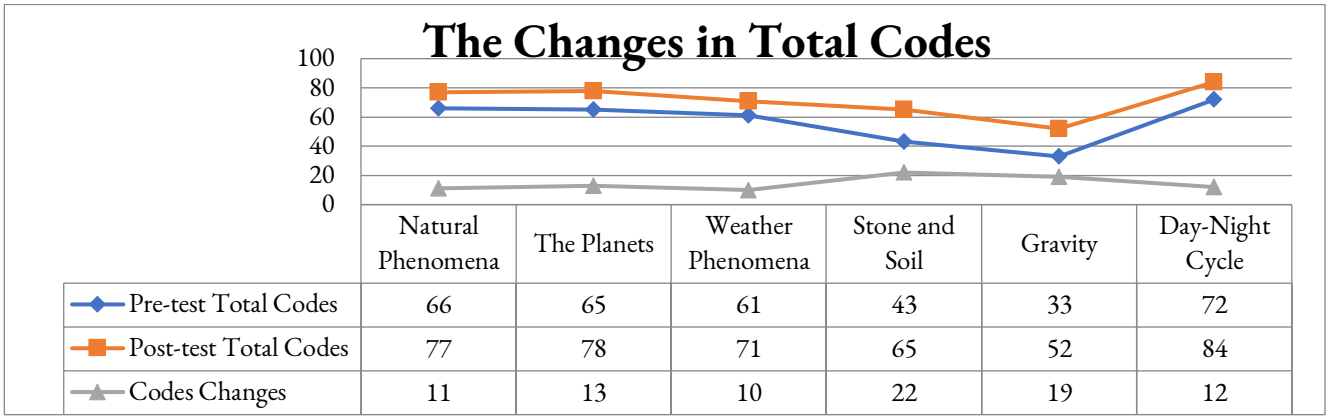


	Natural Phenomena	The Planets	Weather Phenomena	Stone and Soil	Gravity	Day-Night Cycle
Pre-test Total Concepts	17	11	13	9	10	12
Post-test Total Concepts	23	16	17	17	18	15
Conceptual Changes	6	5	4	8	8	3

Figure 2

Pre-test and Post-test Results of Teacher Candidates' Conceptual Changes Related to Earth and Space Science Theme

The science-related conceptual changes in preservice teachers towards the theme of earth and space science are shown in Figure 2. In Figure 2, when the conceptual changes regarding the theme of earth and space science are examined, it is observed that the most changes occur in the sub-themes of gravity (8) and stone and soil (8), while minor changes occur in the sub-theme of the day-night cycle (3).



	Natural Phenomena	The Planets	Weather Phenomena	Stone and Soil	Gravity	Day-Night Cycle
Pre-test Total Codes	66	65	61	43	33	72
Post-test Total Codes	77	78	71	65	52	84
Codes Changes	11	13	10	22	19	12

Figure 3

Pre-test and Post-test Results of Pre-service Teachers' Codes Changes Related to of Earth and Space Science Theme

The changes in total code that occurred in the preservice teachers regarding the theme of earth and space science are illustrated in Figure 3. The figure shows that for the sub-theme of earth and space science, the most changes in total code occurred in the sub-theme of stones and soil (22), while the least changes occurred about weather phenomena (10) and natural phenomena (11). In general, the data analyses suggested that the STEM-based science activities positively affected the PST's understanding of the theme of earth and space science.

Theme 2. Life Science

The PST's conceptual changes that relate to the overarching theme of life science are reported in Table 3.

Table 3

Conceptual Changes of Pre-service Teachers on the Theme of Life Science

Theme	Sub-Themes	Pre-Test			Post-Test		
		Science Concepts	Codes	f	Science Concepts	Codes	f
Theme 2. Life Science	Food Chain	Nutrition of people (9), Plants (4), Animal nutrition (4), Animals (4), Meat (3), Carnivorous (3), Healthy nutrition (3), Water (3), Cow (2), Fruit (2), Herb (2), Herbivorous (2), Milk (2),	13	43	Feeding of humans (5), Herbivores (5), Animals (4), Snake-mouse (4), Lion (3), Food types (3), Plants (3), Cow-bait (3), Food (3) , Grasshopper-leaf (2), Natural events (2), Meat eaters (2), Mouse-cheese (2), Tiger (2), Goat-grass (2), Life (2).	16	47
	Animals	Land inhabitants (10), Floating animals (6), Air inhabitants (5), Water inhabitants (5), Floating animals (4), Fish (3), Sea inhabitants (3), Pets (3), Birds (3)), Creatures (2), Animal kingdom (2), Dog (2), Reptiles (2).	13	50	Land inhabitants (9), Aquatic inhabitants (6), Fish (5), Airborne animals (5), Marine inhabitants (4), Animals' habitats (4), Flying animals (4), Pets (3), Birds (3), Creatures (2), Hazelnut (2), Animal nutrition (2), Mammals (2), Forest animals (2), Reptiles (2), Animals living under the ground (2), Eggs (2) .	17	59
	Plants	Flowers (11), Plant growing (10), Fruits (9), Trees (6), Vegetables (6), Seeds (6), Thorns (2), Photosynthesis (2), Sun-water benefit to plants (2), Colors (2).	10	58	Plants (11), Trees (10), Fruits (9), Flowers (8), Seeds (6), Thorn (5), Vegetables (5), Germination (4), Water (4), Leaves (3), Photosynthesis (2), Sun (2), Soil (2), Foliage (2).	14	73
	Living and Non-Living Beings	Living Beings (5), Moving-immobile (5), People (5), Breathing (5), Animals (4), Nutrition (3), Plants (3), Traveling (3), Life (3), Food (3), Growth (2), Speaking and non-speaking (2).	12	43	Living and inanimate (13), Breathing (9), Movement (7), Animals (7), Plants (5), People (5), Feeding (4), Growing (4), Table (3), Dying (3), Pen (2), Speaking (2), Respiration (2), Stone (2).	15	68
	Body Organs and Functioning	Lung (5), Vision and eye (5), Heart and heartbeat (5), Vessels (3), Circulatory system (3), Sensory organs (3), Digestive system (3), Mouth (2), Urinary system (2), Nose (2), Bean-Kidney like metaphors (2), Health (2), Walking (2).	13	36	Eyes and eyes (8), Heart (8), Lung (6), Respiratory system (4), Brain (3), Touch (3), Hearing (3), Stomach (3), Organ pictures (3), Tasting (3), Intestines (2), Nose (2), Movement of joints (2), Function of the ear (2), Breathing (2).	17	55
	Different Habitats	Sea creatures (7), Forest and forest creatures (7), Cities (5), Homes (4), On land (4), Living (4), Village / town (3), Lake creatures (3), Water inhabitants (3), Creatures (2), Sky (2), Airborne inhabitants (2), School (2), Earth (2).	14	48	Animal habitat (6), Humans and habitat (6), Land inhabitants (5), Plants habitat (4), Water inhabitants (4), Sea creatures (3), Pets (3), Fish (2) , Living in the air (2), Birds' habitat (2), Forest (2), Soils (2), Living space (2).	14	44
	Different Senses	Touching (7), Seeing (5), Sniffing (5), Bitter-sweet-sour (4), Sour (4), Smell Experiments (4), Tongue (3), Sweet-salty (3), Tasting (3), Salted (3), Soft-hard (3), Friends Recognition Experiments (2), Spices (2), Nose (2), Objects in Various Tissues (2), Skin (2), Ear (2) , Fruit (tasting) (2), Hard (2), Sound (hearing) (2), Taste Tests (2).	19	62	Sour (9), Bitter (7), Sniffing-nose (7), Taste (7), Dessert (7), Salty (6), Touching (4) Seeing (4), Nose (3), Tongue (3)), Hearing-ear (3), Smell (3), Hard objects (for touch) (3), Sweet foods (3), Soft and hard tissues (3), Mouth (2), Sour food (2), Hand (2), Thin (2), Ear (2).	21	84

The most common concept for the sub-theme of the food chain was 'nutrition of people' (9), while 'nutrition of people' (5) and 'herbivores' (5) were the most commonly used concepts after the activities. When the sub-theme of animals was examined, the most commonly used concept was 'terrestrial animals' (10), which remained the same (11) after the activities. When the responses to the sub-theme of plants were observed, the most commonly used concept was initially stated as 'flower' (11), but later it turned out to be "plants" (11) after the activities. The most emphasized concept for the sub-theme of living and non-living beings was 'living beings' (5), but later it turned out to be "living and non-living beings" (13). In terms of the sub-theme of body organs and functioning, the most frequently mentioned concept by preservice teachers was initially "lung" (5), but later it turned out to be "vision and eye" (8). When the responses to the sub-theme of different habitats were examined, the most commonly used concept was initially stated as 'living organisms living in the sea' (7), but later it turned out to be 'habitat of animals' (6). Finally, the responses to the sub-theme of different senses revealed that the most commonly used concept was 'tactility' (7), but it turned out to be 'sour' (9).

Table 4

The Concepts in the Learning Plans of the Pre-service Teachers' About the Theme of Life Science

Theme	Codes	f	%
Theme 2. Life Science	Bitter-Sweet-Sour	23	60.53
	See	19	50.00
	Fruits	19	50.00
	Trees	18	47.37
	Sniffing	17	44.74
	Flowers	15	39.47
	Land Lives	15	39.47
	Heart	13	34.21
	Animals	12	31.58
	Seeds	12	31.58
	People	11	28.95
	Plant Growing	10	26.32
	Moving-Nonmoving	9	23.68
	Aquatic Inhabitants	9	23.68
	Living Things	7	18.42
	Taste	7	18.42
	Dessert	7	18.42
	Lungs	6	15.79
	Vegetation	6	15.79
	Animals' Habitat	6	15.79
	Vegetables	6	15.79
	Salty	6	15.79
	Living in the Air	5	13.16
	Breathing	5	13.16
	Habitat of Plants	4	10.53
	Touching	4	10.53
	The Respiratory System	4	10.53
	Food Types	3	7.89
	Nutrition	3	7.89
	Veins	3	7.89
	Sea Creatures	3	7.89
	The Circulatory System	3	7.89
	Our Sensory Organs	3	7.89
	Meat	3	7.89
	Carnivorous	3	7.89
	Pets	3	7.89
	Birds	3	7.89
	Healthy Eating	3	7.89

One hundred and forty activity plans prepared by preservice teachers for the theme of life science were examined with the thematic coding method, and the results are shown in Table 4. Table 4 demonstrates that the most common concept used by preservice teachers was 'bitter, sweet and sour (60.53%) at first, but later it turned out to be 'to see' (50.00%) and 'fruits' (50.00%). When these findings were compared with Table 3, it was thought that the preservice teachers paid more attention to "bitter, sweet and sour" concepts because they frequently used these concepts in the sub-themes of different senses. In addition, this situation helped ensure the validity of the concepts written in the science concepts form.

The randomly chosen activity videos of the preservice teachers about the theme of life science were examined, according to which the examples of how the concepts and vocabulary were used in Tables 3 and 4 are given below.

Activity on Plants:

PT12: Guys, can you tell me what plants you see around you?
C1: Flowers
C2: Roses
C7: Red roses
C11: Violets
PT12: OK, where do you think they grow?
C3: In the garden.
C6: In the forest
C5: In the soil
PT12: Now, everyone, some plants also grow in pots. I brought you some plant seeds and some soil today. Everyone will grow them in their pots... (PT12 - Plants Activity Video).

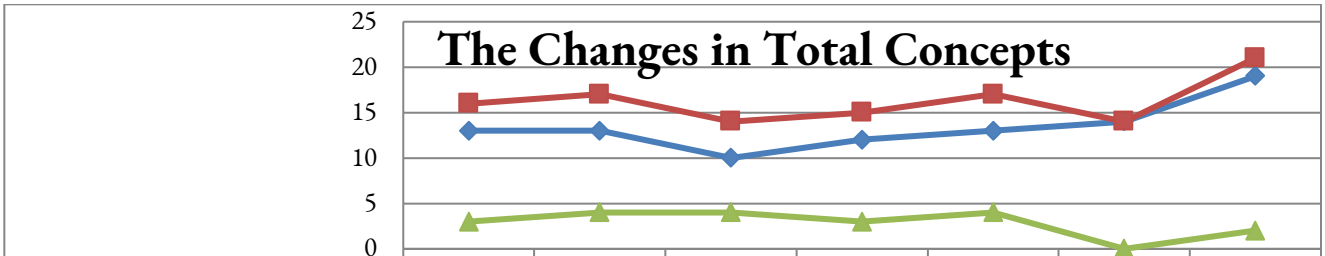
Here, the teacher makes the planting science activity after getting the preliminary information about the plants from the children. Here, chatting with children about plants will help them develop their skills in growing plants. Furthermore, when the concepts and vocabulary used are examined, it is seen that those mentioned in the theme of plants are used.

Different Habitats Activity: Children sit U-shaped, and the teacher chats with children asking questions.

PT8: Kids, where do people live?
C3: At homes
C5: In villages
C11: In apartments
PT8: OK, everyone, where do animals live?
C4: In the forest, but some live in the sea.
PT8: So, why do you think they want to live here?
C7: Because the forest is beautiful. Our house is in the woods as well.
C8: I went swimming once. Maybe they like to swim in the sea.
PT8: So, where do you think worms live?
C9: Under the ground.
PT8: Well done. It is great. How would you like it if you wanted to create a new living space for yourself? ... (PT8 - Different Habitats Activity Video).

In the first part of the activity, the preservice teachers help the children participate in the lesson by asking them the questions included in the activity plan to attract their attention to different habitats. In addition, the preservice teachers reinforce children's pre-knowledge by asking them open-ended questions about the living spaces that children will prepare. Here, it is observed that some concepts and vocabulary, which have been previously covered in the sub-theme of Different Habitats, are also mentioned.

Detailed analysis of the changes that occurred in the total concepts and codes in Table 3 is given in Figure 4 and Figure 5.

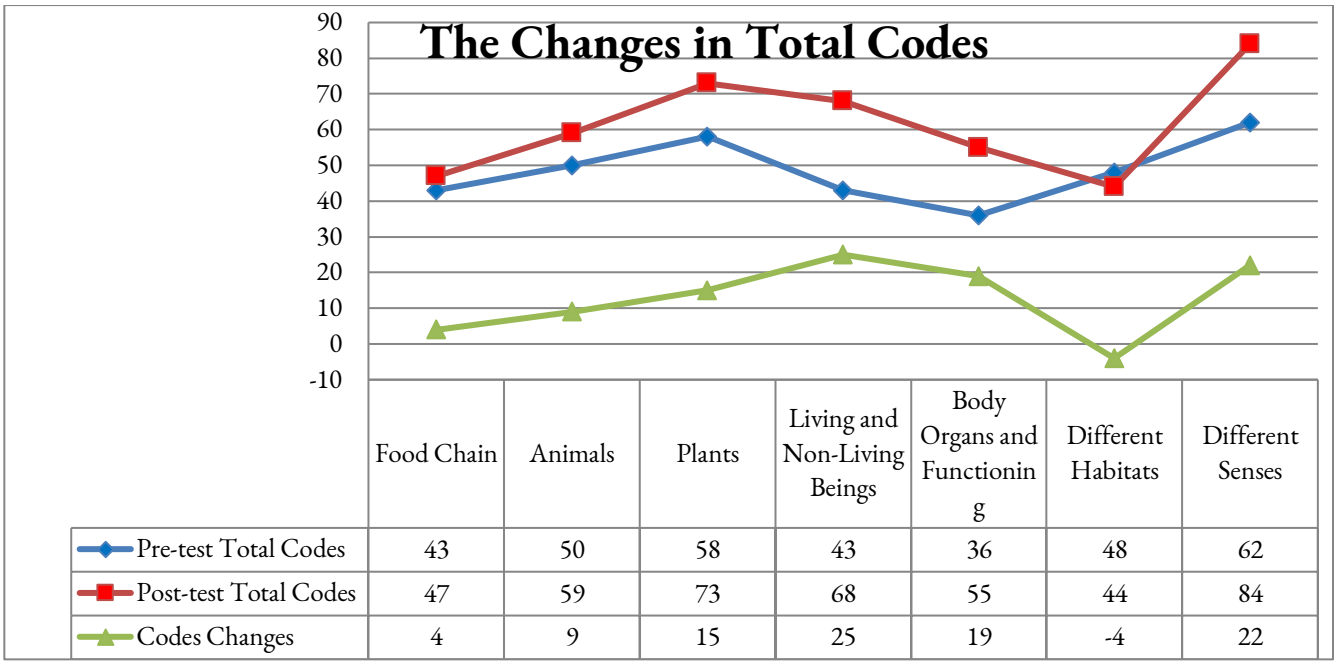


	Food Chain	Animals	Plants	Living and Non-Living Beings	Body Organs and Functioning	Different Habitats	Different Senses
Pre-test Total Concepts	13	13	10	12	13	14	19
Post-test Total Concepts	16	17	14	15	17	14	21
Conceptual Changes	3	4	4	3	4	0	2

Figure 4

Pre-test and Post-test Results of Pre-service Teachers' Conceptual Changes Related to Life Science Theme

The conceptual changes that occurred in the preservice teachers towards Life Science are shown in Figure 4. Figure 4 reveals that there is not much change in the sub-themes when the conceptual changes in the preservice teachers regarding the theme of life science are examined. Looking at the figure, the most commonly used concepts are in the sub-themes of animals (4), plants (4), and body organs and functioning (4), while the least common is in the sub-theme of different senses (2). Interestingly, it is also observed that while conceptual changes do not change numerically in the sub-theme of different habitats (0), different concepts are observed to emerge.



	Food Chain	Animals	Plants	Living and Non-Living Beings	Body Organs and Functioning	Different Habitats	Different Senses
Pre-test Total Codes	43	50	58	43	36	48	62
Post-test Total Codes	47	59	73	68	55	44	84
Codes Changes	4	9	15	25	19	-4	22

Figure 5

Pre-test and Post-test Results of Pre-service Teachers' Codes Changes Related to Life Science Theme

Total code changes in the preservice teachers regarding the theme of life science are given in Figure 5. When the total code changes for the theme of life science is examined, it is observed that the most changes occurred in the sub-theme of living and non-living beings (25), and the minor change is observed in different habitats (-4). In general, it was determined in the light of data analysis that STEM-based science activities positively affected preservice teachers regarding the theme of life science. However, as a surprising result, it was observed that the conceptual changes that occurred in preservice teachers did not change numerically in the sub-theme of different habitats. This situation is thought to be due to the fact that preservice teachers do not have sufficient knowledge on this subject.

Theme 3. Physical Science

Table 5 presents the science content knowledge of preservice preschool teachers for six different sub-themes related to the Physical Science theme.

Table 5

Conceptual Changes of Pre-service Teachers on the Theme of Physical Science

Theme	Sub-Themes	Pre-Test			Post-Test		
		Science Concepts	Codes	f	Science Concepts	Codes	f
Theme 3. Physical Science	States of Matter	Gas (7), Solid (7), Liquid (7), Water (6), Evaporation (5), Ice (5), Hardness-softness (4), Stone (3), Viscosity (2), Freezing (2) Melting (2), Weather Events (2), Condensation (2).	16	57	Liquid objects (11), Water (11), Vapor-Evaporation (8), Solid (8), Ice (6), Hard materials (4), Freezing (3), Gas (3), Balloon (2), Natural gas (2), Melting (2), Air (2), Snowflake (2), Boiling (2), Softness (2).	29	60
	Shape of Matter	Heavy-Light(14), Cold-Warm(9), Color(8), Long-Short(8), Geometric shapes(5), Soft-Hard(4), Step(2), Straight(2), Rough –smooth(2), Length(2).	10	56	Heavy-Light (14), Cold-Hot (9), Color (8), Long-Short (8), Geometric shapes (5), Soft-Hard (4), Step (2), Flat (2), Rough - Smooth (2), Length (2) Thick-Thin (2), Height (2), Heat (2) Thermometer (2).	14	62
	Light and Shadow	Flashlight (14), Sun (11), Shadow (10), Darkness (7), Moon (4), Light (4), Day and night (4), Light (4), Lamp (2), Lunchtime (2)	10	62	Light-light sources (12), Shadow (11), Daylight (9), Flashlight (5), Light (4), Darkness (3), Transparency (3), Long-Short (3), Moon (2) , Daylight (2), Lamp (2), Transparent paper (2).	12	58
	Force, Motion, and Balance	Weight (7), Balance Board (7), Strong-Weak (5), Running (5), Scales (3), Jumping (3), Pull-Push (2), Lightness (2), Moving-Still (2)), Fast-slow (2), Strong (2).	11	40	Pushing (9), Pulling (8), Moving-Still (7), Power (6), Balance board (4), Weight (3), Rope (3), Force (3), Seesaw (3), Scales (3), Standing objects (2), Fall (2), Stand on one leg (2), Height (2).	14	57
	Blocks, Magnets and Simple Machines	Magnet (5), Gravity (4), Building (4), Wooden Blocks (3), Pull-Push (3), Reel (3), Catapult (3), Electric Current (2), Thrust (2) , Legos (2).	10	46	Magnet (9), Pull-push (7), Gravity (5), Blocks (4), Building (4), Metal and non-metal objects (4), Catapult (3), Contrast (3), Similarity (2), Iron (2), Motion (2), Pole (2), Magnets (2), Board (2), Seesaw (2), Scales (2).	16	55
	Kitchen Activities	Making Dough (13), Making Cakes (7), Making Cookies (6), Ice Cream Making (5), Dish Washing (4), Pickle Making (4), Yoghurt Ferment (4), Cooking (2), Milk (2)), Dessert (2), Cleaning (2), Flour (2), Kneading (2).	13	55	Making cookies (6), Flour (6), Dough kneading (5), Popcorn (5), Ice cream (4), Cake making (4), Fruit (4), Yoghurt making (3), Dish-washing (2) , Baking powder (2), Mixing (2), Fermentation (2), Cheese fermentation (2), Baking (2), Pudding (2), Temperature (2), Sugar (2), Pickles (2), Vanilla (2), Cooking (2).	20	61

When Table 5 is examined, the most commonly used concepts for the sub-theme of states of matter are 'gas' (7), 'solid' (7) and 'liquid' (7), whereas they turned out to be 'liquid objects' (11) and 'water' (11) after the activities. When the sub-theme of the shape of the matter was examined, the most commonly used concept was observed as 'heavy-light (14), and later it turned out to be 'hot-cold (12). When the sub-theme of light and shadow was considered, the most commonly used concept or word was stated as 'torch' (14), but later it turned out to be light and light sources (12). The most emphasized concepts or words related to the sub-theme of force, motion, the balance were noted as 'weight' (7) and 'balance board' (7), but later it turned out to be 'pushing' (9). For the sub-theme of blocks, magnets and simple machines, preservice teachers stated that the concept or word they referred to most was 'magnet' (5), and it later remained the same (9). Finally, when the answers given to the sub-theme of kitchen activities were examined, the most commonly used concept or term was 'making dough' (13), but later turned out to be 'making cookies' (6) and 'flour' (6).

Table 6

Concepts Used in the Learning Plans of the Pre-service Teachers About the Theme of Physical Science

Theme	Codes	f	%
Theme 3. Physical Science	Heavy-Light	25	64.10
	Pull-Push	20	51.28
	Shadow	20	51.28
	Cold Hot	20	51.28
	Making Dough	18	46.15
	Long Short	16	41.03
	Solid	15	38.46
	Soft-Hard	13	33.33
	Light-Light Sources	12	30.77
	Sun	11	28.21
	Weight	10	25.64
	Ice	10	25.64
	Balance Board	10	25.64
	Gas	10	25.64
	Cake Making	10	25.64
	Day	9	23.08
	Color	8	20.51
	Movable - Stationary	7	17.95
	Dark	7	17.95
	Liquid	7	17.95
	Power	6	15.38
	Making Cookies	6	15.38
	That	6	15.38
	Fame	6	15.38
	Evaporation	5	12.82
	Ice Cream Making	5	12.82
	Geometrical Shapes	5	12.82
	Magnet	5	12.82
	Popcorn	5	12.82
	Moon	4	10.26
	Bright	4	10.26
	Washing Dishes	4	10.26
	Gravitational Force	4	10.26
	Ice Cream	4	10.26
	Build	4	10.26
	Wood Blocks	3	7.69
	Freezing	3	7.69
	Mixing	2	5.13
	Leavening	2	5.13

Prepared by preservice teachers for the theme of physical science, 120 activity plans were examined with a thematic coding method, and the findings are shown in Table 6. The table reveals that the most used concepts were 'heavy-light (64.10%), then 'pull-push (51.28%), 'shadow' (51.28%) and 'cold-hot (51.28%), respectively. When these findings were compared with the findings in Table 5, it was observed that the reason why the preservice teachers included the most commonly used concepts in different sub-themes as well (states of matter, force, motion and balance, blocks, magnets and simple machines) was that such concepts were the most encountered ones in the activities.

By examining the selected activity application videos of the preservice teachers about the theme of physical science, the examples of how the concepts and vocabulary in Table 5 were used are given below.

Light and Shadow Activity: "Children are in the school garden in sunny weather with their backs to the sun.

PT12: “Guys, what do you think is on the floor now?
C5: Our shadows, Miss.
C3: Miss, it always follows me.
PT12: Yes, guys, that is our shadow. Is everyone's shadow the same?

C3: Yesss!
C4: Nooo!
PT12: So why do you think everyone's shadow is different or the same?
C8: Miss, I am a girl, and my shadow is like a girl. A boy's shadow is like a boy.
C13: Miss, my shadow's hair and Ayşen's shadow are different. There are circles in her shadow. (PT12 - Light and Shadow Activity Video).

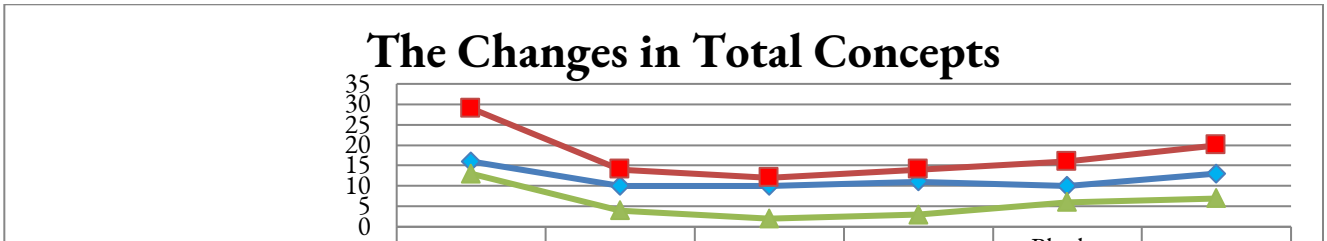
Here, it is thought that the preservice teachers' organizing a garden activity with children on the theme of light and shadow and practising the children's views on this theme will increase the efficiency of the activity. In addition, it is observed in the application videos that the preservice teachers mentioned some concepts and words under this theme.

Force, Motion and Balance Activity:

"PT19: Guys, what do you think it takes to move the ball?
C8: We need to hit the ball.
C12: We need wind.
PT19: So, guys, how does the ball move? Can we move balls and other objects by applying force or pushing and pulling?
C3: Miss, balls roll.
C1: Miss, balls spin.
C5: We need to push them, teacher.
PT19: Do you think the situation is the same when riding a bicycle? What do we need when pedalling the bicycle?
C7:We need to push them, Miss.
C2: We need to apply force, Miss. We cannot go unless we step on the pedal." (PT19: Force, Motion and Balance Activity Video).

The preservice teacher comes to the classroom with a ball in hand and gets the preliminary information about the sub-themes 'force, motion and balance' from the children; they carry out the push and pull forces experiment with moving objects (toy car, 3-wheel bike). The children are then asked to make wheeled vehicles using bottle caps, and a race is held using the pushing force of the balloon. Here, it is seen that the preservice teachers mentioned different concepts and vocabulary seen in Table 5 during the application and experiment process.

Detailed analysis of the changes that occurred in the total concepts and codes in Table 5 is given in Figure 6 and Figure 7.

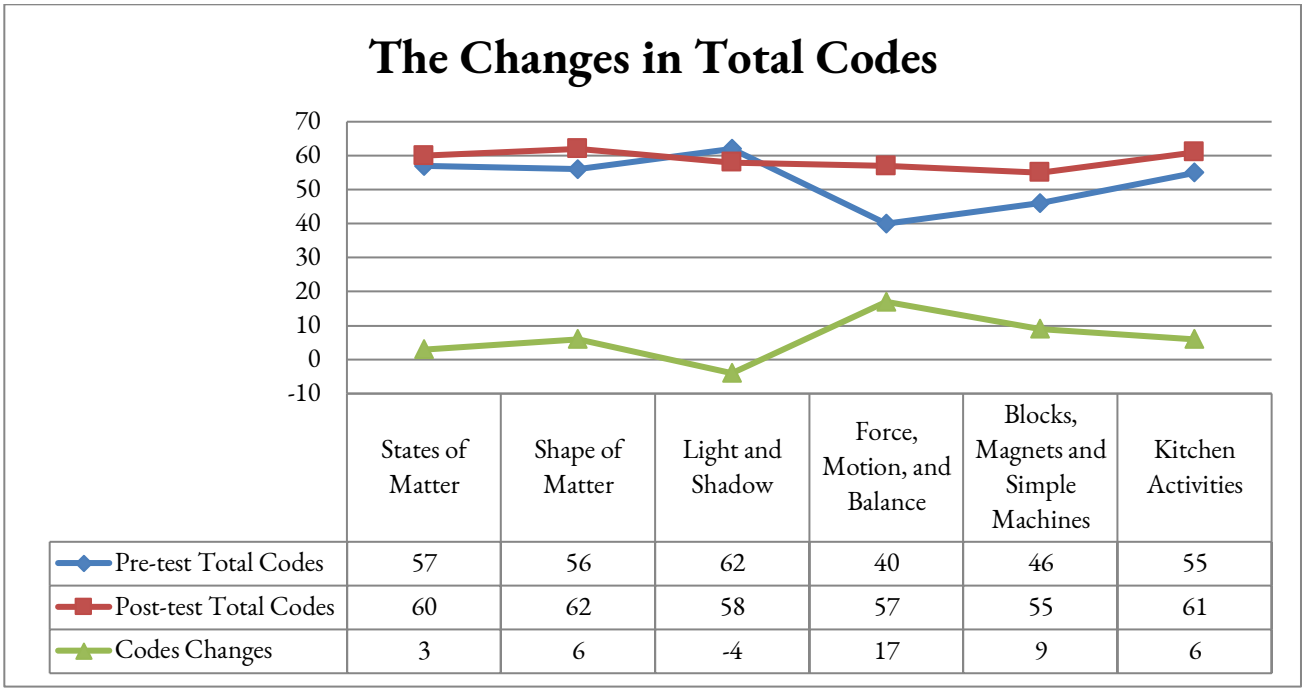


	States of Matter	Shape of Matter	Light and Shadow	Force, Motion, and Balance	Blocks, Magnets and Simple Machines	Kitchen Activities
Pre-test Total Concepts	16	10	10	11	10	13
Post-test Total Concepts	29	14	12	14	16	20
Conceptual Changes	13	4	2	3	6	7

Figure 6

Pre-test and Post-test Results of the Pre-service Teachers' Conceptual Changes Related to Physical Science Theme

The changes in the science content knowledge of the preservice teachers towards the theme of physical science are shown in Figure 6. The figure shows that when the conceptual changes regarding the theme of physical science are examined, it is observed that the most numerical change occurs in the sub-theme of the states of matter (13), whereas the least is observed in the sub-theme of light and shadow (2).



	States of Matter	Shape of Matter	Light and Shadow	Force, Motion, and Balance	Blocks, Magnets and Simple Machines	Kitchen Activities
Pre-test Total Codes	57	56	62	40	46	55
Post-test Total Codes	60	62	58	57	55	61
Codes Changes	3	6	-4	17	9	6

Figure 7

Pre-test and Post-test Results of the Total Code Changes for the Pre-service Teachers' Physical Science Theme

Total code changes in the preservice teachers regarding the theme of Physical Science are given in Figure 7. When the total code changes for the theme of physical science are examined in the figure, it is observed that the most change occurred in the sub-theme of force, motion and balance (17), whereas the minor change occurred in the sub-theme of light and shadow (-4). In general, it was found that STEM-based science activities positively affected preservice teachers regarding their understanding of the theme of physical science in the light of data analysis.

Discussion

The study revealed that STEM-based science activities conducted by preservice preschool teachers had a positive effect on their understanding of the science concepts. The findings of the study are discussed below.

Conceptual Changes in Science Concepts

In particular, preschool children should be taught many scientific concepts such as science, mathematics, technology, and engineering (Ayvacı, 2010). Therefore, researchers emphasize that STEM-based education should start early (Allen, 2016; Torres-Crospe, Kraatz & Pallansch, 2014). This study used the STEM-based science education model to develop themselves to work with preschool children towards science concepts. The study's findings revealed an increase in the science content knowledge of the preservice teachers regarding science concepts through the use of a STEM model.

Similarly, Carrier (2013) observed that science education course made a significant difference in the post-test results of preservice elementary teachers. The author stated that the main reason for the significant difference in the scientific vocabulary used by preservice teachers stems from the applications from which the preservice teachers try to use the words and suggest that there should be applications for science education courses. In another study, Santau, Maerten-Rivera, Bovis, and Orend (2014) emphasized that science concepts can be developed in preservice teachers using the 5E Teaching Model in science education. In addition, Pecore, Kirchgessner and Carruth (2013) conducted zoo-based science training with preservice teachers during the science education course and found that preservice science teachers' knowledge of science concepts developed, but no positive attitude towards science was formed. Similarly, in this study, it was found that STEM-based science education preparation and application processes carried out by preservice teachers create conceptual changes towards science concepts.

Rowe and Goldin-Meadow (2009) stated that vocabulary knowledge is an essential factor for school success, while weak vocabulary also adversely affects science teaching (Harmon, Hedrick, & Wood, 2005). In addition, Fisher and Frey (2014) stated that science vocabulary is necessary for children to understand science and scientific processes.

Nonetheless, interpreting the concepts of science will improve people's decision-making skills (Carrier, 2013). There appear apparent differences between the concepts stated by preservice teachers in pre-tests and post-tests through STEM-based science activities can be regarded as a significant factor to improve the science content knowledge of preservice science teachers. In addition, the event that a concept can be used in different areas, i.e. the concept of 'sun' used in sub-themes such as planets, light and shadow, day and night cycle, shows how preservice teachers have mastered this concept. This will only occur through the support of applied science education.

Many other studies have indicated that conceptual changes in science concepts increase in parallel with the learning levels of preservice teachers (Ültay & Ültay, 2009; Ünal, Çalık, Ayas, & Coll, 2006). So much so that teachers generally do not feel sufficient in terms of science concepts, and they, therefore, spend less time in science education (Adamson, Santau, & Lee, 2013; Griffith & Scharmann, 2008; McMurrer, 2008; Trygstad, 2013), and as a result, children's capability to develop the understanding of science concepts was negatively affected (Nilsson& Van Driel, 2010). This study found that the science content knowledge of preservice teachers could be improved with STEM-based science activities. Similarly, it can also be assumed that preschool teachers can help develop science concepts in children by including STEM-based science activities in their classrooms.

Conceptual changes are seen as one of the main factors for good science education (Duit & Treagust, 2003). Moreover, self-reflection about emotion-related behaviour is essential for scientific inquiry and to learning more broadly in science education (Kayumova and Tippins, 2016). Researchers also stated that these could be both students and their teachers' hands-on learning in science (Garner, Gabitova, Gupta, & Wood, 2018). When the findings of the study were examined, positive conceptual changes were observed in different sub-themes, such as states of matter (13), stone and soil (8), and gravity (8). This situation is thought to be important for preschool teacher candidates to provide good science education in the future.

Similarly, in the study conducted by Ültay and Ültay (2015), preservice preschool teachers who took a science education course differed according to the level of science content knowledge of preservice teachers who were teaching preservice teachers did not take this course. In fact, in a recent study, Carrier and Grifenhagen (2019) have suggested that science teaching methodology should be practised to improve the science vocabulary knowledge of preservice teachers. The researchers stated that with the practical lessons, the preservice teachers would acquire the skills to apply the words they knew and teach concepts. Similarly, it was observed in this study that the conceptual perceptions of preservice teachers about the sub-themes related to Earth and Space Science, Life Science, and Physical Science themes changed.

Earth and Space Science

In terms of Earth and Space Science, conceptual changes that occurred in preschool teachers regarding the sub-themes of gravity (8) and stone and soil (8) were found to be highest, while it was the least regarding the day and night cycle (3). In a similar study conducted by Carrier (2013), it was seen that preservice teachers used very few words (tornado) about weather events. However, in the study conducted by Harman and Çökelez (2017), it was found that preservice preschool teachers formed minor metaphors about planets (1). It is thought that this situation may be caused by the lack of sufficient conceptual skills of preservice teachers in science education about the science of earth and space.

Life Science

Food chain, animals, plants, different habitats could be assumed to be the most common topics in terms of life science concepts taught in the preschool period. The study conducted by Carrier (2013) revealed that preservice teachers' most frequently mentioned concepts were the food chain in the sea and ecosystems in the forest. In addition, it was stated that preservice teachers frequently talked about seed growing. Similarly, the study conducted by Harman and Çökelez (2017) demonstrated that the concepts that preservice preschool teachers mentioned most were found as living things (27) and then as plants (14) people (14) and animals (13). In addition, the preservice teachers were found to mention little about habitats. This study found that preservice teachers mostly mentioned food chain, different habitats, and body organs. The lack of an increase in the conceptual perceptions of preservice teachers regarding different habitats emerges as an

unexpected result in this study. This situation is thought to be due to the fact that preservice teachers consider themselves inadequate about the topic of habitats. In a study by Ültay, Can, and Ültay (2014), the authors stated that the level of content knowledge of preservice teachers, studying preschool teaching at the third grade, about the theme of 'heat temperature, was low and that in this case, preservice teachers could improve themselves through the lessons they would take for science education and their applications. Likewise, in this study, it is considered that more applied studies on different habitats will contribute positively to the conceptual changes to occur in preservice teachers in this sub-theme.

Physical Science

Carrier (2013) stated that preservice teachers mentioned enough topics such as solid / liquid, liquids and sound. In the study conducted by Harman and Çökelez (2017), it was observed that the most frequently mentioned subjects by preservice teachers were simple machines, force-motion and speed-acceleration. In this study, it was seen that preservice teachers' knowledge on the subject of states of matter and force and motion improved. In addition, it was found that the science content knowledge of preservice teachers increased about kitchen activities, which are frequently used in preschool education. In the study conducted by Ültay and Ültay (2015), it was found that preservice preschool teachers had low level of conceptual knowledge about “electricity”, “heat-temperature”, “acid-base”, “matter” and “water”. The main reason for this situation is thought to be negative attitudes of preservice teachers towards science education (Ültay and Ültay, 2015). In another study by Dönmez, Usta and Ültay (2015), the authors stated that the preservice teachers' perception of science as abstract and complex affected the situation. There are more differences in the perceptions of the concepts related to concrete themes such as states of matter (13) than other themes that showed similarity to those findings in other studies in the literature. This situation is that ought to be due to the fact that the concepts regarding the states of matter are the most frequently mentioned concepts in the process of teaching practice by preservice teachers.

Conclusion and Recommendations

This paper aimed to show relationships between STEM-based science activities and conceptual changes of preservice early childhood teachers. As a result, STEM-based science education has been found to increase the science content knowledge of preservice teachers, and it is suggested that this model can be used for a science education course in teacher training programs. In addition, in-depth conceptual analyses should be conducted by examining the preservice teachers' attitudes towards different science subjects. It is also suggested that the most frequently mentioned science themes in preschool education and the level of content knowledge of teachers who use such themes should be investigated.

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Research Article

Developing of the Creative Thinking Task for Children[1]

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Abstract

In this study, it was aimed to examine the validity and reliability of the Creative Thinking Task for Children (CTTC) developed to evaluate creative thinking skills. The study group consists of 755 participants (aged 11-14) who are attending 5th, 6th, 7th and 8th grades in the central districts of Ankara. The data were obtained with the personal information form CTTC. CTTC has a structure that is scored between 0-3 and consists of tasks. Expert opinions, exploratory and confirmatory factor analyses were used to evaluate the validity of the measurement tool, and the Cronbach Alpha Internal Consistency Coefficient was used to determine its reliability. As a result of the analysis, it was determined that the model, which consists of originality, fluency, elaboration and divergent thinking sub-dimensions and 11 items, has a structure that fits very well. Internal consistency coefficients of CTTC; .73 in originality sub-dimension, .61 in fluency sub-dimension, elaboration sub-dimension. 60, .69 for divergent thinking sub-dimension and .67 for the whole. According to the findings of the study, it can be said that the Creative Thinking Task for Children is a valid and reliable measurement tool that can be used to evaluate creative thinking skills in Turkish culture.

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Introduction

Creativity is a comprehensive concept used in many different fields such as art, science, and education. The discussions on whether creativity is a product (Taylor, 1988), a process (Slyvan, 1997; Vernon, 1989), or both are important in explaining the concept. Torrance (1974) defined creativity as "sensitivity to problems, inadequacies, lack of information, non-existing elements, incompatibilities, identifying difficulties, searching for solutions, making predictions and hypothesizes about inadequacies or changing hypotheses, choosing one of the solutions and trying, retrying, then putting forward results." When different definitions are examined, it is seen that the common points are generating new ideas (Wegerif, 2007), making new connections (Marsh, Landau, and Hicks, 1996; Rawlinson, 1995), and multidimensional thinking (Kırışoğlu, 2002). It is stated that the concept of "creativity" is used primarily in the field of

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art. Creativity is considered as the creation of a product in the field of art or the interpretation of an existing product in a different way (San, 2008). However, as a cognitive process in education, it is more suitable to use it as "creative thinking" (Hickey & Webster, 2002). The cognitive approach also treats creativity as a thinking process and tries to understand it as a cognitive skill (Sternberg & Lubart, 1999).

Guilford (1950) explained the multifaceted structure of creative thinking skills with dimensions of fluency, flexibility, originality, and elaboration, and Torrance detailed these dimensions. Fluency can be considered as vocabulary, association, idea, and expression fluency, and it is essential to generate a great amount of ideas in the relevant area in all of them. Flexibility can be explained by "adaptability," which aims to solve a problem in different ways, "redefining" which comprises using known objects for various purposes, and "spontaneous flexibility," which includes finding other ideas about a problem (Chien & Hui, 2010). Originality is the ability to generate unusual, unique, or highly personalized responses or ideas. Elaboration, on the other hand, refers to expanding, developing and elaborating ideas (Gartenhaus, 2000). Also, Guilford (1967) refers to convergent and divergent thinking as two kinds of productive cognitive skills. While convergent thinking aims to reach the most known and correct answer, divergent thinking refers to searching for an infinite number of answers by evaluating different alternatives (Fautley & Savage, 2007). In addition, in Guilford's (1967) model, creativity is considered especially in relation to divergent thinking. Guilford creativity measures usually include divergent thinking measures.In the current study, cognitive approaches that consider creativity as a process and a cognitive skill are based and a measurement tool based on Guilford's (1967) model has been developed.

Creative thinking skills can be developed and thus prevented. Identifying and removing obstacles may pave the way for development (Rawlinson, 1995). Although creative thinking skills are essential in the education process (Katz, 2009), supporting this multifaceted structure cannot be achieved by routine teaching systems (Gow, 2000). Obstacles to creative thinking appear in the literature as emotional barriers (Özden, 2000), adoption of convergent thinking (Üstündağ, 2002), characteristics of schools (Kırışoğlu, 2002) and teachers (Chambers, 1973). Creating a structure that encourages research and questioning instead of an inflexible and oppressive attitude in educational settings will eliminate creative thinking obstacles. Cowley (2005) suggests strengthening divergent thinking, experiential learning, increasing motivation, and making learning fun to support creative thinking in the classroom. Creative thinking skills differ according to age, and findings related to this emphasize the importance of regulations in educational environments. In parallel with the cognitive skills that differ with age, creative thinking skills also change (Argun, 2004; Ayman-Nolley, 1999), and these skills, which started to be observed at the age of 3-5, decrease from the age of 11 according to some findings and increase significantly at the age of 14 (Öncü, 2003). While some of the different views that emerge when evaluated in terms of the whole life state that the creative thinking in the middle age period is at the highest level (Artut, 2004), there are also studies suggesting that there is a decrease with the advancement of age (McCrae, Costa, and Arenberg 1980; Runco, 1991). Runco (1991) argues that the decline in creativity with age is associated with more traditional thinking tendency as age increases in thinking styles. However, it is more common to consider changes in creative thinking skills with individual characteristics and differences rather than age (Wu et al., 2005). For instance, parental values, openness and education level are features that predict creativity (Deng, Wang, and Zahao, 2016).

The view that creative thinking is one of every person's general skills and that it can be developed (Kale, 1993) becomes even more important when taken together with the psychometric approach. This will enable planning to determine and develop the creative thinking skills of individuals. Although tools such as "How creative are you?" (Rausdepp, 1979) based on self-report are used in measuring creative thinking skills, the use of tasks is highly accepted due to the comprehensive structure of the concept (Chien and Hui, 2010). Torrance Tests of Creative Thinking (TTCT), developed as a task, consists of verbal test and figural test and allows many answers to be given to each activity. Scoring is done according to fluency, flexibility, originality, and elaboration criteria. Creativity Assessment Packet of Williams (1980) consists of the Thinking Different Test, the Feeling Different Test, and the Williams Scale in which parents and teachers evaluate children's creativity. The sub-dimensions of the different thinking tests are fluency, flexibility, originality, elaboration, and title. The Wallach and Kogan Test consists of verbal and non-verbal activities, and each item is scored according to fluency, elaboration, and originality (Wallach and Kogan, 1965). When the tests used in evaluating creative thinking skills are examined, it is observed that they generally measure divergent thinking (Karabey and Yürümezoğlu, 2015). A The Test for Creative Thinking - Drawing Production (TCT-DP; Jellen & Urban,

1986) was adapted into Turkish by Can-Yaşar (2009). The Khatena-Torrance Creative Perception Inventory was developed in 1998 with a sample that also evaluated gifted individuals (Aslan, 2005).

The CTTC developed in the current study is considered important for several reasons. The first of these reasons is the recommendation of the task structure instead of self-report measurements in creativity measurements (Chien and Hui, 2010). The Torrance Creativity Test, which is a measurement tool with a task structure, was developed in 1957 in American culture. It is seen that the other measurement tools mentioned above were developed in different cultures and adapted to Turkish. It is important that measurement tools are up-to-date and culture-specific (Anastasia, 1988). Self-report assessment tools have limitations such as respondents may have a tendency to show themselves better (Batson & Ventis, 1982), questions are not fully understood or alternative answers can be given (Dağ, 2005). Since creative thinking is considered as a skill, a performance-based measure was preferred. In addition to these, it is thought that developing a measurement tool suitable for group measurements and application in the school environment is economical in terms of time and labor.

Aim of Study

It is thought that the CTTC developed in this study has the advantages of including a task structure based on the individual's performance (Torrance, 1977; Wallach & Kogan, 1965; Williams, 1980) and being culture-specific (Anastasia, 1988; Cronbach, 1990). As far as we know, CTTC is the first measurement tool developed in Turkish culture to measure creative thinking skills. In this study, it is explained that the development process of CTTC includes advantages of creative thinking skills tests comprising task structure based on individual performance (Torrance, 1977; Wallach and Kogan, 1965; Williams, 1980) and culture-specific development (Anastasia, 1988; Cronbach, 1990). The aim of this study is to develop the "Creative Thinking Task for Children (CTTC), which examines the creative thinking levels of teenagers between the ages of 11-14.

Method

The present study is a descriptive study. The purpose of descriptive studies is to define individuals, events and conditions by examining them (Parkin & Bray, 2005).

Participants

A total of 668 (319 girls, 349 boys) children who attend 5th, 6th, 7th, and 8th grades (11-14 years old) in six different secondary schools in the central districts of Ankaraprovince in Turkey were participated in the study, and it was determined by convenience sampling. Class level distributions of the participants are as follows: 5th grade 215 (32.2%), 6th grade 161 (24.1%), 7th grade 118 (17.1%) and 8th grade 174 (26.0%). While determining the sample size, it was taken into consideration that there were five times the number of participants for factor analysis in the measurement tool development process (Tabachnik & Fidell, 2001).

Developed for individuals aged 11-14 years of CTTC. Considering it as a period when creative thinking skills begin to decline at the age of 11-14 (Öncü, 2003) seems important. In addition, the education programs of individuals attending secondary school at this age differ, and a period is passed from a process carried out by the classroom teacher to a period in which different branches are involved and therefore the student takes the responsibility of his own development. Educational environments have a role in developing creative thinking skills (Cowley, 2005; Katz, 2009), and for these reasons, a measurement tool has been developed for individuals aged 11-14.

Instruments

Creative Thinking Task for Children (CTTC)

The CTTC scale developed in the current study has a four-factor structure with 11 items scored between 0-3, developed with children aged 11-14. Sub-dimensions are originality, elaboration, fluency, and divergent thinking. While the Cronbach Alpha reliability coefficient of the total score of the measuring tool was found as .67, the Cronbach Alpha reliability coefficients of the sub-dimensions were; originality as .73, elaboration as .60, fluency as .61, divergent thinking as .69. Evaluation of CTTC is made according to scoring criteria. In this article, the development process of CTTC has been explained, and CCTS is omitted.

Personal Information Form. The form included questions about the participants' gender, age, grade level, school they attended, and the education level of their parents.

Process

Within the study's scope, after the sample was determined for the development of CTTC, permissions were obtained from the University Ethics Committee (19.12.2016/27/349) and the National Education Directorate. Volunteer students were reached by talking to school administrators, and the practice, which took an average of 40 minutes, was conducted in the students' classes.

Measurement Tool Development Stages. The development process of the measurement tool started with a literature review and the format of the measurement tool was decided by taking advantage of expert opinions (three assessment and evaluation, three educational psychology experts). An item pool was created by writing 18 items in the structure containing open-ended questions. While preparing the items; Care was taken to ensure that the items were simple and understandable, and that an item should not contain more than one judgment (Naresh, 2017). The prepared items were sent to 12 experts to get expert opinion. These experts; four of them work as classroom teachers in primary schools; Three experts have creative drama leadership, four experts carry out academic studies on creativity and one expert works in the field of assessment and evaluation. Experts were asked to read each item carefully, and they were asked to decide to what extent it contained the dimensions of creative thinking and to what extent that item was suitable for measuring the desired dimensions of creative thinking. Experts were asked to indicate whether the expression of each item was appropriate for the age levels within the scope of the study, if not, how it could be improved, and if there were additional item suggestions, they were asked to indicate. For the measurement tool, 3 out of 18 items were removed and the task statement in one item was changed, and the application was carried out by determining 15 items. Scope and face validity was ensured by expert evaluations (Büyüköztürk, 2018). Due to the open-ended nature of the items, expert opinions were sought to determine the evaluation criteria.

After the application, the answers for each item were determined as 0, 1, 2, 3 points and different criteria were created for each sub-dimension. All data were coded by three raters and the intraclass correlation coefficient was calculated. The responses received from the participants for the Originality sub-dimension were ranked according to the frequency, for the Elaboration sub-dimension, the responses were ranked according to the number of responses for the fluency sub-dimension, and were scored as 1,2,3 by dividing them into three groups. In all sub-dimensions, irrelevant answers were scored as zero. In the divergent thinking sub-dimension, the criteria are; single-function/limited response (1 point), multiple-functional response (2 points), and fictional response (3 points). The sample item evaluation for the rubric created for scoring is as seen in Table 1.For the full test and its final version, see Appendix 1.

Table 1.

Rubric Example and An Example of A Test Question

Item no	12	
Item content	Deniz lived far from her elderly grandmother. She loved to call her grandmother and tell her what had happened that day. Since her grandmother lived alone, she was very happy when Deniz called. However, she couldn't hear when the phone rang because her grandmother's ears were low. Deniz decided to design a phone so that her grandmother could recognize when the phone was ringing and pick it up. What kind of phone would you design for grandma? Write down the features of the phone you are designing.	
Point	0 point	No response or answers that do not contribute to the solution (Example: Do not talk on the phone).
	1 point	Single-function/limited response (Example: Auto-on when the phone rings. Setting certain hours to talk on the phone).
	2 points	Response with multiple functions (Example: Making a watch phone, connecting the phone to the house bell, attaching a vibration device to the arm, flashing light on the phone).
	3 points	Fictional/Storytelled) response (Example: Perfumed phone, vibrating clock phone, glasses vibrating when the phone rings, flashing lighted signs at home).

Data Analyses

Cronbach's Alpha analysis, Pearson correlation coefficient, and in-class correlation coefficient were calculated within the study's scope of reliability analysis. Invalidity analyses, the construct validity was examined by exploratory and

confirmatory factor analysis, and the content and face validity were examined by expert opinions. The analyses of the data wereconducted by statistical package programs (SPSS 22.0 and LISREL 8.7). Necessary assumptions were analysed before exploratory, and confirmatory factor analyses were performed.

Results

Construct Validity (Exploratory Factor Analysis)

520 data were drawn randomly from the data set of 668 people. Randomization was done by creating random sequence numbers in Excel. 520 data obtained before the Explanatory Factor Analysis (EFA) were analyzed in terms of the necessary assumptions. Kaiser-Meyer-Olkin (KMO) test was applied to test whether the sample size is suitable for factor analysis, and the KMO value was found .59. This value is seen as "bad" but sufficient (Leech, Barrett, & Morgan, 2005). The sample size was decided to be suitable for factoring taking into consideration different explanations due to the low KMO value. Comrey and Lee (1992) stated that the sample size above 500 for factor analysis was "very good," Kline (1994) explained that the sample size was 10 times of the number of items is sufficient, and the chi-square value was significant ($\chi^2_{(66)} = 1207{,}002$; $p > .01$) for factoring. After the examinations in terms of normality and other assumptions, 4 data were extracted, and the analysis continued with 516 data. The results showed that the factor design of the CTTC had 6 components with an eigenvalue above 1 for the 15 items included in the analysis. All results were evaluated together, and it was decided that the measurement tool could have four factors. The Explanatory Factor Analysis was repeated for four factors, it was observed that the factor loadings of the two items were below .30 (Floyd & Widaman, 1995) (9 and 10), and the two items were overlapped (11 and 15). These items were excluded from the analysis. With the remaining 11 items, it was determined that six factors that explains 63.3% of the total variance emerged and this six factors structure was also suitable for theoretical explanations.

Horn's parallel analysis was performed with the help of the Monte Carlo Program to verify the results of principal component analysis and scree plot (Figure 1), and according to the results, it was seen that only the principal component analysis eigenvalues of four factors were greater than the parallel analysis values, and the values of the other components were small (Watkins, 2000). With the Scree Plot, the graph needs to be examined to determine the point of separation between the principal components and the remaining components. However, in practice, it can sometimes cause subjective interpretations due to the absence of sharp decreases in the graph (Hayton, Allen, and Scarpello, 2004).

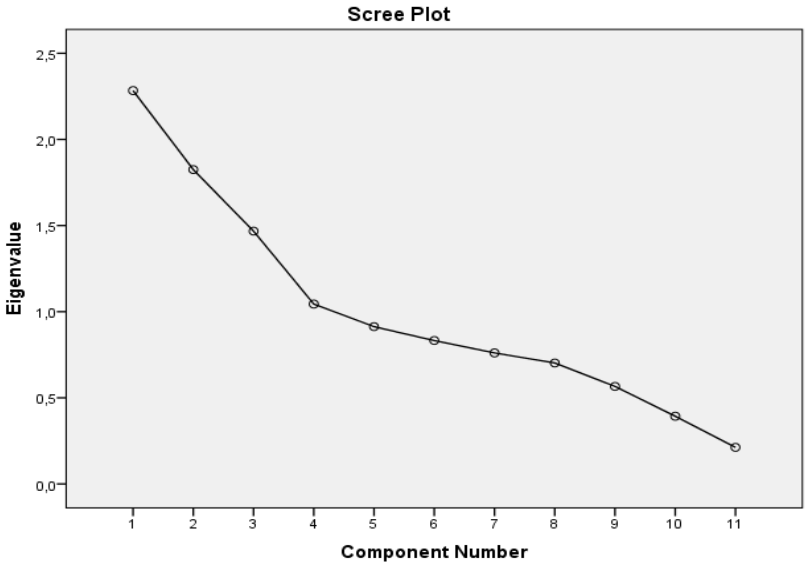

Figure 1

Scree Plot

The factor loadings and common factor variances of the items of the structure consisting of four factors, 11 items are given in Table 2.

Table 2

CTTC Factor Loadings and Common Factor Variances

Items	Originality	Fluency	Elaboration	Divergent Thinking	Common Factor Variance(h2)
1	.865				.754
2	.803				.653
3	.755				.594
6		.847			.484
7		.845			.543
4			.694		.504
5			.735		.717
6			.709		.717
12				.523	.327
13				.897	.820
14				.917	.851

The result of the analysis extracted four factors under theoretically defined items and accounted for 63.322% of the total variance. Originality sub-dimension has 21.11%, fluency sub-dimension 16.55%, elaboration sub-dimension 13.94% and divergent thinking sub-dimension has 11.70% explained variance. Loadings on the factor 1 (originality) are between .75 and .86, loadings on the factor 2 (fluency) are .84, loadings on the factor 3 (elaboration) are between .69 and .70 and loadings on the factor 4 (divergent thinking) between .52 and .91. The correlation coefficients between the total score and the sub-dimensions were between .07 and .68, while the correlation coefficients between items were between .03 and .70.

Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) was performed with 11 items obtained to confirm the structure obtained from EFA ($\chi^2_{(38)} = 38.50$, $p < .01$).CFA was carried out with 235 people randomly selected from the data set. As seen in Figure 2, according to the .01 significance level, the t values related to cases where latent variables explain observed variables are not significant, and according to these values, a perfect fit can be mentioned (Hoyle, 1995).

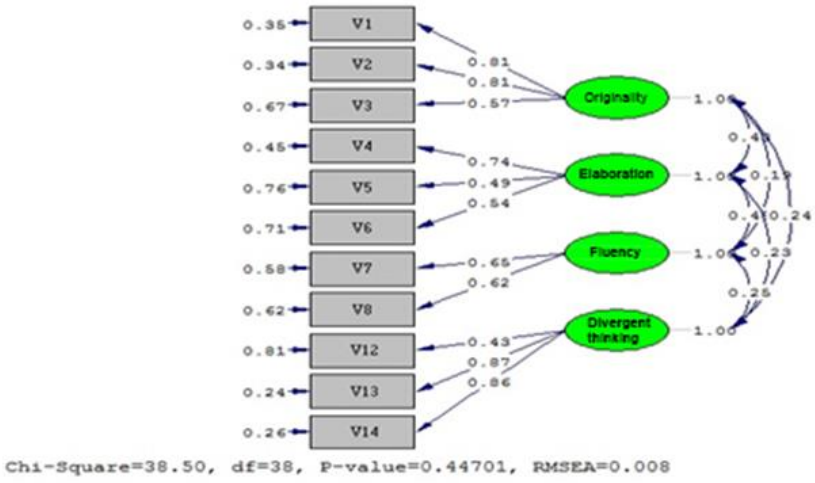

Figure 2.

CTTC 4-Dimensional Model Factor Analysis Standardized Factor Loadings

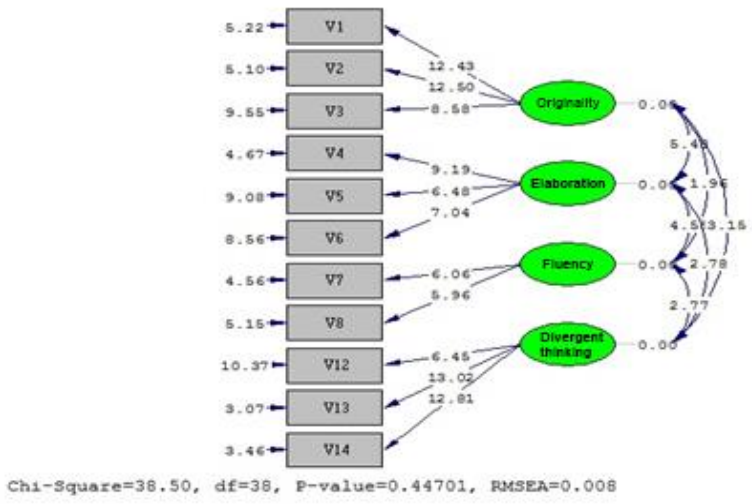

Figure 3

CTTC 4-Dimensional Model Factor Analysis t Values

When Figure 3 is examined, it is seen that no insignificant path is observed in the path diagram and the error variances of the items are below .90. General fit index results regarding the model of CTTC created the results of confirmatory factor analysis are given in Table 3.

Table 3

CTTC Values of Fit Indices

Reviewed indices of fit	Perfect fit criteria	Acceptable fit criteria	Achieved fit indexes	References	Conclusion
χ^2/sd	≤ 3	≤ 5	1.01	Tabachnick & Fidell (2013)	Perfect
RMSEA	≤ .05	≤ .08	.0075	Hu & Bentler (1999)	Perfect
SRMR	0	≤ .08	.044	Bryne (1994); Hu &Bentler (1999)	Accaptable
NFI	≥ 0.95	0.94-0.90	.95	Bryne (1994)	Perfect
NNFI	≥ .95	≥ .90	1.00	Schumacker & Lomax (1996)	Perfect
CFI	≥ .97	≥ .95	1.00	Hu & Bentler (1999)	Perfect
AGFI	≥ .90	≥ .85	.95	Marcholudis & Schumacher (2001)	Perfect

$\chi^2$38.50 Sd38 NFI

According to the CFA results, it was seen that the fit indexes of the Creative Thinking Task for Children, consisting of 11 items and four sub-dimensions, were in a structure that showed a very good fit. (Hooper, Coughlan, & Mullen, 2008; Hoyle, 2000; Tabachnick & Fidell, 2013; Thompson, 2007). In model fit, X2/sd value less than 5 is acceptable, while a value less than 3 indicates perfect fit of the model (Tabachnick & Fidell, 2013). However, for a model to fit well; The RMSEA value is expected to be less than .08, but a value less than .05 indicates a perfect fit (Hu & Bentler, 1998). In addition, NNFI and CFI values between .95 and 1.00 mean that the model fits perfectly (Hu & Bentler, 1999; Schumacker & Lomax, 1996). In line with this information, when the results in Table 2 are examined, it is seen that the fit indices are generally very good.

Reliability

The Cronbach-Alpha internal consistency coefficient for the total 11-item of CTTC is .67 Sub-dimensions are 73 for originality, .69 for divergent thinking, .60 for elaboration, and .61 for fluency ($p < .01$). A value of $0.6 \leq \alpha < 0.7$ is acceptable, and $0.7 \leq \alpha < 0.9$ is considered good (Cortina, 1993; George & Mallery, 2003). Accordingly, the findings indicated that the reliability of the scale is acceptable and good. It is stated in the literature that relatively low values may result from the small number of elements in the scale (Tavakol & Dennick, 2011). To determine the consistency between raters, it was seen that the intraclass correlation coefficient calculated on the scores obtained from three raters was .81 and this value is interpreted as high correlation (Kalaycı, 2014).

Item Statistics. In order to determine the discrimination levels of the items and to determine the predictive power of the total score, corrected item-total correlations were included (Table 4).

Table 4

Results of Item Analysis

Item no	Average	Standard deviation	Corrected item-total correlation	When the item is removed scale Alpha
1	1,72	.83	.354	.556
2	1.75	.87	.342	.558
3	1.54	.96	.333	.559
4	1.70	.73	.244	.580
5	1.75	.68	.246	.580
6	1.79	.73	.220	.585
7	1.48	.73	.142	.600
8	1.31	.85	.104	.612
12	1.23	.74	.272	.575
13	1.30	.85	.316	.564
14	1.33	.95	.317	.563

When the item-total correlations were examined, it was seen that the values of the two items (7 and 8) were below 0.20 and the values of "When the item is removed scale Alpha" were above the current Alpha coefficient. It was decided by expert opinions to keep these two items in the measurement tool. Item-total score correlations vary between 0.24 and 0.35 for other items. Items with an item-total correlation greater than 0.20 were considered discriminating or reliable (Doi & Minowa, 2003).

Conclusion and Discussion

The Creative Thinking Task for Children (CTTC), which was developed to investigate the creative thinking skills of children aged 11-14, was found to be a valid and reliable four-factor measurement tool in this study. Exploratory and confirmatory factor analysis was carried out for construct validity. Content and face validity was provided by expert opinions. The validity of a measurement tool expresses what the scale measures and how well it measures (Anastasi, 1988). It is recommended to obtain opinions from at least 5 field experts for the content and face validity, and the opinions of 12 experts were obtained in the current study (Cronbach, 1990; Lawshe, 1975).

Based on expert opinions, three items were removed, and the application was made with 15 items. Exploratory factor analysis (EFA) values were evaluated together with Horn's parallel analysis, and 11 items and a four-dimensional structure were obtained by removing two items due to factor loads below .30 and two items due to overlap. When the structure emerging in EFA was evaluated together with the significance levels and theoretical structure in the confirmatory factor analysis, 4 items were removed from the analysis, and CFA performed with 11 items (χ^2 = 38.50 (38) p> .01). According to the CFA results, there is a perfect fit in the structure (Hoyle, 1995).

In this study, a measurement tool was developed that includes tasks that participants can answer as many times as they want, draw figures, and express verbally. Since creative thinking is considered a cognitive skill, it is an accepted approach to use measurement tools with tasks instead of tools based on self-report (Chien & Hui, 2010; Torrance, 1977; Wallach & Kogan, 1965; Williams, 1980). Sub-dimensions of creative thinking skills like originality, fluency, elaboration, and divergent thinking emerged in the CTTC. In the literature, originality, fluency, and elaboration sub-dimensions are also seen in other measurement tools that evaluate creative thinking skills (Torrance, 1977; Wallach & Kogan, 1965; Williams, 1980). Divergent thinking, the other sub-dimension, refers to evaluating different alternatives (Guilford, 1967; Fautley & Savage, 2007). In this respect, it is thought to be similar to flexibility (Chien & Hui, 2010), including finding different ideas about a problem. In the evaluation of CTTC, the results are evaluated by giving each item a score from the criteria of originality, fluency, elaboration, and flexibility. When the overlapping structures of the concepts of flexibility and divergent thinking are taken into consideration together, it can be thought that divergent thinking, which is a more inclusive concept, has emerged as a sub-dimension. Therefore, in future studies, it may be recommended to develop measurement tools that include different creative thinking skills.

CTTC has been developed for individuals aged 11-14. It can be said to be important to develop a measurement tool for the individuals' age between 11-14 in line with the views that creative thinking skills can be developed (Rawlinson, 1995; Vexliard, 1966), and educational environments have an important role in developing creative thinking skills (Cowley, 2005; Katz, 2009). Thus, it will be possible to plan to evaluate and develop these skills individually or as a group in educational settings. Although there are different opinions about the results change due to age increase in creative thinking skills, the age of 11-14, which is the target group of CTTC, is considered a period when these skills begin to decline (Öncü, 2003). Therefore, it is important to pave the way for evaluating and supporting creative thinking skills through CTTC at these ages.

As a consequence, the findings obtained in this research showed that CTTC is a valid and reliable instrument comprising tasks that includes the sub-dimensions of originality, fluency, elaboration, and divergent thinking for evaluating the creative thinking skills of individuals between the ages of 11-14. It is seen that CTTC is the first measurement tool that has been developed specifically for Turkish culture and includes a task structure for 11-14 ages. It is stated that it is important to develop measurement tools specific to a culture (Anastasia, 1988; Cronbach, 1990). In future, studies can be carried out using CTTC in different samples individually and as a group. Also, studies can be planned for sub-dimensions that are thought to be developed by evaluating the results.

Limitations of Study

This study has some limitations. The criterion validity for the measurement tool was not examined. Another limitation of the study is that variables such as socio-economic status or place of residence were not evaluated. Also, Measurement Invariance by gender has not been examined. The measurement tool developed in the current study should be evaluated with these limitations.

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Appendix 1.

Creative Thinking Task for Children (CTTC)-Turkish Version

Çocuklar için Yaratıcı Düşünme Görevi (ÇYDG)

Okul: Sınıf: Tarih:

Sevgili öğrenciler,

Bu çalışma sizin yaşınızdaki bireylerin özelliklerini daha iyi anlamak için bilimsel amaçlı yapılmaktadır. İsim yazmanız gerekmemektedir. Sonuçlar yalnızca araştırma için kullanılacaktır. Katılmanız gönüllük esasına dayanmaktadır. Lütfen boş madde bırakmayın ve her madde için sizden ne istendiğini dikkatle okuyarak yapmaya çalışın.

Katıldığınız için teşekkür ederiz.

Kaçıncı sınıfa gidiyorsun?	
Kaç yaşındasın?	
Cinsiyet	Kız ☐ Erkek ☐
Siz dahil kaç kardeşsiniz?	
Kaçıncı çocuksunuz?	En büyük ☐ Ortanca ☐ En küçük ☐
Çaldığınız bir müzik aleti var mı?	
Resimle uğraşıyor musunuz?	
Bir sporla uğraşıyor musunuz?	

-A-

Herkesin yapacağından farklı bir hayvan oluşturun. Bunu yaparken aklınıza gelen bütün nesne ve varlıkları kullanabilirsiniz. Çizdiğiniz hayvanın özelliklerini mutlaka yazın.

Çizim:
Özellikleri:

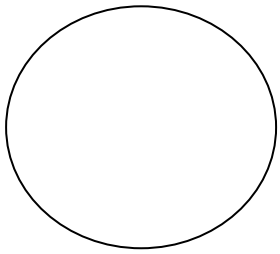
-B-

B1.	Aşağıdaki durumu okuyarak herkesin aklına gelebilecek olanlardan farklı çözümler bulmaya çalışın. Bir sınıftaki öğrenciler, teneffüs zili çaldığında sınıflarından duyulmadığı için teneffüslere hep geç çıkıyorlar. Bu sorunu çözmek için bir icat yapmaya karar veriyorlar? Ne yapsınlar?
B2	Aşağıdaki duruma uygun bir ürün ortaya çıkarmaya çalışarak özelliklerini yazın. Deniz yaşlı büyükannesinden uzakta yaşıyordu. Büyükannesine telefon edip o gün olanları anlatmayı çok seviyordu. Büyükannesi yalnız yaşadığı için Deniz'in aramasına çok seviniyordu. Ancak büyükannenin kulakları az işittiği için telefon çaldığında duyamıyordu. Deniz, büyükannesinin telefon çaldığında fark edip açabilmesi için bir telefon tasarlamaya karar verdi. Siz olsanız büyükanne için nasıl bir telefon tasarlardınız? Aşağıya özellikleri yazın. (açık olarak tüm özellikleri belirtin)

	Tasarladığınız telefonun özelliklerini buraya yazın:

-C-

C1. Aşağıdaki çembere bakın, bu çemberi kullanarak neler yapabilirsiniz, çizin. Çemberin içini ve dışını istediğiniz şekilde kullanabilirsiniz.



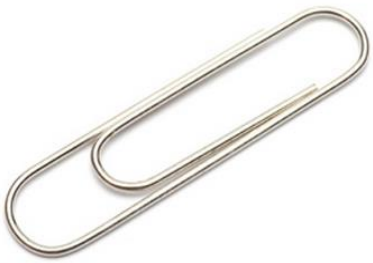
C2. Aşağıdaki üç nokta ile neler yapabilirsin? Noktalar bu şekildeyken yapabileceğin şeyleri düşün ve çiz. Noktaları tek tek ya da birlikte kullanarak birden fazla çizim yapabilirsin.

C3. Aşağıdaki şekille neler yapabilirsin? Çiz.

-D-

D1 ve D2 satırlarında, nesneleri nasıl ve ne amaçla kullanabileceğinize ilişkin seçenekler üretin. Mümkün olduğunca çok sayıda farklı kullanım yazın. Başkalarının aklına gelmeyecek kullanımlar düşünmeye çalışın. Burada önemli olan önerdiğiniz kullanımların sayısının fazla olmasıdır.

D1		Kavanozun farklı kullanımlarını listeleyin:

D2		Ataşın farklı kullanımlarını listeleyin:

Appendix 2.

Scoring Criteria for CTTC-Turkish Version

Çocuklar İçin Yaratici Düşünme Görevi (ÇYDG) Puanlama Kriterleri

MADDE NO	PUAN	PUAN KRİTERLERİ
A SORUSU: 1,2 ve 3. maddeler ÇYDG'nin "A" sorusu için verilen üç alt puandır. A sorusu orjinallik alt boyutunda puanlanmaktadır.		
1	0 puan	Belirsiz çizim ve karalamalar. Hayvan dışındaki canlı ve cansız varlıkları ana figür olarak çizme (eşya, bitki vb). Var olan bir hayvanın aynısı olan çizim ve özellikler.
	1 puan	Basit özellikler ekleme (kafası döner, konuşur, tehlikelidir, korkunçtur, sevimlidir, suyla beslenir vb.). Basit birleştirmeler yapma; zürafa fil karışımı, yarı inek yarı köpek.
	2 puan	Birden fazla canlının özellikleri birleştirme (hayvanlar, hayvana bitkinin ya da insanın özelliklerinin eklenmesi vb). Yeni bir isim koyma. Hayvanların özelliklerini birleştirme (uçan bir hayvanın kendisini korumak için dikenleri var, doğaüstü güçleri, sihri var).
	3 puan	Tamamen yeni bir canlı oluşturma. Kurgusal özellikler ekleme (tehlike anında su fışkırtma, lazer atan göz vb).
2	0 puan	Var olan herhangi bir hayvana ait çizimler (normal bir köpek vb.). Karalamalar, belirsiz şekiller.
	1 puan	Genel özellikleri belli olan bir hayvana basit özellikler ekleme (örneğin rengi, deseni, boyu farklı).
	2 puan	Farklı organ ya da uzuv ekleme (göz, boynuz, kanat vb.). Birden fazla hayvanın görüntüdeki detaylarını birleştirme.
	3 puan	Canlı ve cansız varlıkları birlikte kullanarak çizim (palet ayak vb). İnsan ve hayvan görüntüsünü birleştiren çizimler. Görüntüde tamamen yeni bir canlı oluşması.
3	0 puan	Var olan herhangi bir hayvana ait çizimler (normal bir köpek vb.). Karalamalar, belirsiz şekiller.
	1 puan	Belirli bir hayvana basit işlev ekleme (eğlendirir vb.). İnsana ait işlevler ekleme (konuşur, şarkı söyler, düşünür vb)
	2 puan	Hayvanlarda var olan işlevleri birleştirme; (at gibi hızlı koşan, deve kadar dayanıklı ancak küçük olduğu için her yerde yaşayabilen bir hayvan, köpek ama süt verir, yarasa ama bal yapar vb). Hayvanlarda var olmayan işlevler ekleme; ağzından sıvı fışkırtma, gözünden ışık çıkarma, ışınlanma, şarkı söyleme, odasını toplama, ödev yapar, ışınlanır, görünmez olabilir, renk değiştirir.
	3 puan	Sistem içeren yanıtlar ve yararlı somut işlevler ekleme; hipnotize eder, savaşı engeller, ölümsüzdür, istekleri gerçekleştirir, geri dönüşüm yapabilir, çim biçer, havayı temizler vb. 2 puan alan işlevleri sonuçlarıyla verme (görünmez olup insanları korur vb.).
B SORUSU: B'nin altında iki ayrı madde bulunmaktadır. B1; 4. Soru, B2 ise 5 ve 6. Soru olarak puanlanmaktadır. 5 ve 6. maddeler ÇYDG'nin "B2"" sorusu için verilen iki alt puandır. B sorusu ıraksak düşünme alt boyutunda puanlanmaktadır.		
4	0 puan	Teneffüse çıkmasınlar gibi çözüme yönelik olmayan yanıtlar.
	1 puan	Elle çalınan zil kullansınlar, Sessiz olsunlar, öğretmen zilin çaldığını söylesin, saate baksınlar

	2 puan	Saate bağlanan hoparlör, sınıfa ayrı zil takılması, okulla aynı anda çalan yakına yerleştirilen ayrı zil.
	3 puan	Sistem geliştiren yanıtlar; görüntülü zil, titreşimli zil, zil çalınca kapıya vuran cihaz, zil çalınca sinyal gelmesi, sınıfta ışık yanması vb.
5	0 puan	İşitme cihazı taksın, telefonu yanına alsın gibi tasarıma katkı sağlamayan yanıtlar. Gerçekçi olmayan yanıtlar (telefon çalınca gelip koluna dokunsun vb.).
	1 puan	Titreşimin artırılması, hoparlör işlevinin değiştirilmesi, farklı zil sesi kullanılması (siren sesi, dikkatini çekebilecek sesler vb.).
	2 puan	Işık işlevinin farklılaştırılması, telefon ekranındaki görüntünün dikkat çekecek hale getirilmesi.
	3 puan	Koku, hologram, eve yansıyan görüntü.
6	0 puan	Telefonla konuşmasın gibi çözüme katkı sağlamayan yanıtlar.
	1 puan	Telefon çalınca otomatik açılması. Telefonla konuşmak için belli saatler belirlenmesi.
	2 puan	Saat telefon yapılması, telefonu evin ziline bağlamak, koluna titreşim cihazı bağlamak, telefonda ışık yanıp sönmesi.
	3 puan	İşitme cihazını telefona bağlamak, parfüm çıkaran telefon, telefona bağlı bileklik (ışık saçan ya da titreşimli), titreşimli saat telefon, telefon çaldığında gözlüğünün titremesi, evde ışıklı tabelalar yanıp sönmesi.
C SORUSU: C'nin altında 7,8 ve 9.maddeler bulunmaktadır. C sorusu ayrıntılama alt boyutunda puanlanmaktadır.		
7	0 puan	Anlamsız çizgi ya da şekiller ekleme
	1 puan	Şeklin yalnızca kendisini kullandığı çizimler; Top, saat, pizza, güneş, gülen yüz, tekerlek, çiçek, pusula, dünya gibi. Süsleme, mandala vb.
	2 puan	Bir bütünün parçasını oluşturan yanıtlar (güneş sistemi, Gezegen çiçek buketi vb.). Şeklin dışına da eklemeler yaparak oluşturulan araba, hayvan, insan, kuyu, fotoğraf makinesi objektifi, kol saati eşya vb. Semboller ve amblemler; okul, araba, marka vb amblemleri, mevsim tablosu, tabela, hedef tahtası, olimpiyat halkası, kum saati, iyilik dağıtan çiçek.
	3 puan	Kurgusal, hikaye oluşturan yanıtlar; uçan balon uçuran çocuk. Var olmayan bir varlık oluşturma. Farklı işlev ekleyen yanıtlar. Soyut ve manevi kavramlar.
8	0	Anlamsız çizgi ya da şekiller ekleme, yalnızca üç noktayı birleştirme.
	1 puan	Noktaları birleştirerek yapılan şekiller; kalp, üçgen, açı, pizza, parti şapkası.
	2 puan	Noktaları merkeze alarak farklı varlıklar çizme (eve, arabaya dönüştürme, dondurma, hayvan, zarf, uçurtma, kaydırak vb.) Soyut kavramlar oluşturma; İlluminati, sevgi bahçesi vb.
	3 puan	Hikaye oluşturan yanıtlar (çocuğun hayatı, evlerin olduğu bir mahalle vb). Var olmayan bir varlık oluşturma. Farklı işlev ekleyen yanıtlar (insanlara yardım eden bir kalp vb.).
9	0 puan	Belirsiz çizim ve karalamalar.

	1 puan	Çizgiyi ana figür olarak kullanma; tırtıl, yılan, solucan, şeker, sosisli sandviç, kuyruklu yıldız, balon, uçurtma.
	2 puan	Çizgiyi bir nesnenin parçası olarak kullanma; perde, yol, kaydırak, defter, dalga, saç, yay-ok, dna sarmalı, bıçağın tutma yeri, ipe geçen iğne, saatin yelkovanı, dalgadaki gemi vb. Şekil ekleme; bir çift küpe vb. Sembol ve amblemler; Okul amblem vb.
	3 puan	Kurgusal ve hikaye oluşturan yanıtlar (yayla ok atan kişi, ödül alan kişinin sahneye gittiği yol, çocuğun oynadığı balon, kedinin iple oynaması, uçan halı, akan şelale vb.). Var olmayan bir varlık oluşturma. Farklı işlev ekleyen yanıtlar.
D SORUSU: D'nin altında 10 ve 11.maddeler bulunmaktadır. D sorusu akıcılık alt boyutunda puanlanmaktadır.		
10	0 puan	Yiyecek konur, gerçekçi olmayan yanıtlar (içinde giysilerimizi saklarız).
	1 puan	1-3 adet farklı kullanım.
	2 puan	4-5 adet farklı kullanım.
	3 puan	6 ve üzeri farklı kullanım.
11	0 puan	Defter ve kitabın kenarına takılır, gerçekçi olmayan yanıtlar (uçak yakıtı olarak vb).
	1 puan	1-2 adet farklı kullanım.
	2 puan	3-4 adet farklı kullanım.
	3 puan	5 ve üzeri farklı kullanım.

Appendix 3.

Creative Thinking Task for Children (CTTC)-English Version

Creative Thinking Task for Children (CTTC)

-A-

Create a different animal than anyone else would. While doing this, you can use all the objects and assets that come to your mind. Be sure to write down the characteristics of the animal you draw.

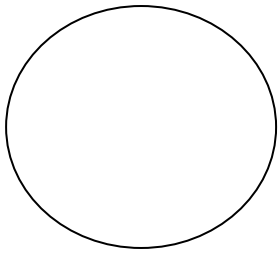
Drawing:
Properties:

-B-

B1.	Read the story below and try to come up with solutions that are different from what anyone can think of. Students in a class are always late for recess because they are not heard from their class when the bell rings. They decide to make an invention to solve this problem? What should they do?
B2	Trying to come up with a product suitable for the following event, write its characteristics. Deniz lived far from her elderly grandmother. She loved to call her grandmother and tell her what had happened that day. Since her grandmother lived alone, she was very happy when Deniz called. However, she couldn't hear when the phone rang because her grandmother's ears were low. Deniz decided to design a phone so that her grandmother could recognize when the phone was ringing and pick it up. What kind of phone would you design for grandma? Write the specifications below. (explicitly specify all features) Write the features of the phone you are designing here:

-C-

C1. Look at the circle below, draw what you can do using this circle. You can use the inside and outside of the circle as you wish.



C2. What can you do with the three dots below? Think and draw what you can do while the dots are like this. You can draw more than one by using the dots individually or together.

.

.

.

C3. What can you do with the figure below? Draw.

-D-

In rows D1 and D2, generate options for how and for what purpose you can use the objects. Write down as many different uses as possible. Try to think of uses that others may not think of. The important thing here is that the number of uses you suggest is high.

D1		List the different uses for the jar:
D2		List different uses of paper clip:

Appendix 4.

Scoring Criteria for CTTC-EnglishVersion

Item	Point	Scoring Criteria
QUESTION A: Items 1,2 and 3 are the three sub-points given for the "A" question of the CTTC. Question A is scored in the originality sub-dimension.		
1	0	Indeterminate drawings and doodles. Drawing animate and inanimate objects other than animals as main figures (items, plants, etc.). Drawing and features identical to an existing animal.
	1	Adding simple features (dizzy, talking, dangerous, scary, cute, water-fed, etc.). Making simple joins; Giraffe elephant mix, half cow half dog.
	2	Combining characteristics of more than one living thing (animals, adding plant or human characteristics to an animal, etc.). Don't give a new name. Combining the characteristics of animals (a flying animal has spines to protect itself, has supernatural powers, magic).
	3	Creating a completely new live. Adding fictional features (e.g. water squirt in danger, laser eye, etc.).
2	0	Drawings of any existing animal (a normal dog, etc.). Doodles, vague shapes.
	1	Adding simple features to an animal with certain general characteristics (for example, different color, pattern, size).
	2	Adding different organs or limbs (eyes, horns, wings, etc.). Merge details of multiple animals in the image.
	3	Drawing using living and non-living things together (pallet feet, etc.). Drawings combining the image of humans and animals. The formation of a completely new life in the image.
3	0	Drawings of any existing animal (a normal dog, etc.). Doodles, vague shapes.
	1	Adding a simple function to a particular animal (entertains, etc.). Adding human functions (speaks, sings, thinks, etc.).
	2	Combining functions existing in animals; (An animal that runs fast like a horse, is as hardy as a camel but can live anywhere because it is small, a dog gives milk but a bat makes honey, etc.). Adding functions that do not exist in animals; squirts out of his mouth, shoots out light from his eyes, teleports, sings, tidies his room, does homework, teleports, can become invisible, changes color.
	3	Adding systemic responses and useful concrete functions; hypnotizes, prevents war, is immortal, fulfills wishes, can recycle, mow grass, clean the air, etc. Giving functions that get 2 points with their results (invisible, protecting people, etc.).
QUESTION B: There are two separate items under B. B1; Question 4 is scored as question B2, and question 5 and 6. Items 5 and 6 are the two sub-points given for the "B2" question of the CTTC. Question B is scored in the divergent thinking sub-dimension.		
4	0	Non-solution-oriented answers, such as not going to recess.
	1	Let them use a manual bell, Let them be silent, Let the teacher say that the bell rings, Let them look at the clock.
	2	The loudspeaker connected to the clock, the installation of a separate bell in the classroom, the separate bell placed nearby that rings at the same time as the school.
	3	System-enhancing responses; video bell, vibrating bell, the device that knocks on the door when the bell rings, the signal comes when the bell rings, the light comes on in the classroom, etc.

5	0	Answers that do not contribute to the design, such as wear a hearing aid or take the phone with you.
	1	Unrealistic responses (come and touch your arm when the phone rings, etc.).
	2	Increasing the vibration, changing the speaker function, using different ringtones (siren sound, sounds that may attract attention, etc.).
	3	Differentiating the light function, making the image on the phone screen stand out.
6	0	Answers that do not contribute to the solution, such as not talking on the phone.
	1	Automatically turn on when the phone rings. Determining certain hours to talk on the phone.
	2	Making a watch phone, connecting the phone to the house bell, attaching a vibration device to the arm, flashing light on the phone.
	3	Connecting the hearing aid to the phone, the phone that emits perfume, the wristband (luminous or vibrating) connected to the phone, the vibrating watch phone, the vibration of the glasses when the phone rings, the flashing of the illuminated signs at home.
QUESTION C: Items 7, 8 and 9 are under C. Question C is scored in the detail sub-dimension.		
7	0	Add meaningless lines or shapes.
	1	Drawings where the shape only uses itself; Such as ball, clock, pizza, sun, smiley face, wheel, flower, compass, earth.
	2	Ornament, mandala, etc.
	3	Responses that form part of a whole (solar system, Planetary bouquet, etc.).
8	0	Don't add meaningless lines or shapes, just connect three dots.
	1	Shapes made by connecting dots; heart, triangle, angle, pizza, party hat.
	2	Drawing different assets by centering the points (conversion into house, car, ice cream, animal, envelope, kite, slide, etc.)
	3	Creating abstract concepts; Illuminati, garden of love etc.
9	0	Indeterminate drawings and doodles.
	1	Using the line as the main figure; caterpillar, snake, worm, candy, hot dog, comet, balloon, kite.
	2	Using the line as part of an object; curtain, road, slide, notebook, wave, hair, bow-arrow, dna helix, handle of the knife, needle passing through the rope, minute hand of the clock, ship in the wave etc. Adding shapes; a pair of earrings, etc.
	3	Fictional and story-forming responses (the person who shoots an arrow with a bow, the way the winner takes the stage, the balloon the child plays, the cat playing with rope, the flying carpet, the flowing waterfall, etc.). Creating an entity that does not exist. Answers adding different functionality.
QUESTION D: Items 10 and 11 are under D. Question D is scored in the fluency sub-dimension.		
10	0	Food is put, unrealistic answers (we hide our clothes in it).
	1	1-3 different uses.
	2	4-5 different uses.
	3	6 or more different uses.
11	0	Used in the margin of notebook and book, unrealistic answers (as aircraft fuel etc).
	1	1-2 different uses.
	2	3-4 different uses.
	3	5 or more different uses.

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Research Article

Development of the Opinions on the Effects of Globalization in Sports Sciences Scale

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Abstract

This study aims to develop a standard scale by making the validity and reliability of the globalization survey developed for education faculties in the sample of sports sciences. A total of 878 people, including 81 academicians, 336 physical education and sports teachers, 118 trainers, and 343 sports sciences students, who were reached by a simple random method, participated in the study. The data was collected at 3 different times, Exploratory Factor Analysis (EFA) in the first group (n = 426), Confirmatory Factor Analysis (CFA) in the second group (n = 412), and test-retest analysis in the third group (n = 40) was performed. As a result of EFA, which was conducted to determine the construct validity, a structure consisting of 17 items and 3 factors was obtained, which explains 71.588% of the total variance. These factors are; teaching-learning processes are named as management and technology. The Cronbach Alpha internal consistency coefficient of the scale was calculated as .94. According to the CFA results ($\chi 2$ / df: 2.63; RMSEA: .06; PGFI: .69; PNFI: .79; GFI: .92; AGFI: .90; IFI: .96; TLI: .95; NFI:.94; CFI: .96) the scale has acceptable fit values. In the test-retest analysis, a positive correlation was found .83. As a result, it can be said that the globalization scale can be used in sports science research and is a valid and reliable scale.

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Introduction

One of the most discussed issues of our time is the question of globalization or nationalization (regionalization). In other words, globalization comes to the fore with the effect of modernizing technology under the auspices of politics and strong capital on religion and national identity, tradition, culture, and language. The concept of globalization was used for the first time in T. Levitt's book "Globalization of Markets" published in 1983. T. Levitt used globalization solely as a market phenomenon to mean the coming together of markets owned by multinational companies. Later, K. Ome noted in his work "Unlimited World" (1990) that the process is wide, not just about the market (Hacıyev and Bayramov, 2013: 410). Especially after the collapse of the Berlin Wall in 1989, the word globalization, which we frequently

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encounter in almost every field, is used not only as an economic concept but also to describe the international system we are in.

Universities have been the most important defenders of the nation-state in the modern period. However, with globalization, the status of the nation-state has also become debatable. This situation has also made universities controversial. Educational institutions are the leading institutions that are directly affected by globalization. The main reason for this is that globalization weakens the support of the nation-state and the welfare state, which is considered to be the reason for the modern university's existence (Kwiek, 2012). It is observed that globalization, which marked the last quarter of the 20th century, significantly affects the basic elements of daily life. Putting forward the thesis that capitalism (constituting the most important variable of globalization) has no alternative in order for the phenomenon of global society to be accepted; an approach that places post-modernism on the philosophical basis of the phenomenon of globalization in a sense other than the areas where it emerged is witnessed. As a reflection of this situation, in every field of social sciences, discussions, and evaluations, globalization theories or dynamics are encountered (Newman, 2001).

One of the important areas affected by globalization is the sports and sports fields in which young people are. For this reason, sports education institutions have been the focus of our research. Sports, as a social institution, is in a structure that is growing day by day within economic and cultural organizations. This social phenomenon necessitated a re-evaluation of the world's changing economic and social conditions. We cannot evaluate the changes experienced in sports separately from the cultural and economic changes in the world, because nothing is independent of other things that exist in nature or social life (Akdağcık and Karaküçük, 2013). Sport occupies a unique place in the human psyche. Athletic struggles around the world have long been a way for individuals, institutions, cities, and countries to express themselves. Sport brings out the best and the worst in people. If we go back to the 19th century, it is seen that universities use American football to give their students a sense of identity (Leeds and Allmen, 2017, p. 3). Sports is a global phenomenon and gains prevalence depending on the socioeconomic conditions of societies (Atasoy and Öztürk Kuter, 2005). Sports are also included in the consumption phenomenon that globalization has accelerated to spread. Sports types that we have not even heard of recently and the number of people interested in these sports types as spectators or participants are rapidly increasing (Ekmekçi et al., 2013). Sports is one of the most common organizations of the society. Sport is an important element of human life and public health in both narrow and broad sense. Many factors have an effect on the emergence of the globalization process. These factors are; technological impact, ideological values, and economic factors are grouped under three main headings (Atasoy and Füsun Öztürk, 2005; Ekmekçi et al., 2013).

In the age we live in, crisis, inequality, risk, insecurity, anxiety, uncertainty, and social disintegration have become the most frequently used concepts in explaining the social consequences of the globalization process. The globalization process, which has recently gained momentum with the effect of the collapsed walls between the blocks, has brought the social results expressed with the above concepts to a global level in an unprecedented way in history. Depending on the integration process of national economies, social problems have begun to globalize to a large extent, being affected by the results of the globalization process (Mutioğlu and Gözcü, 2009).

Şentürk (2007) has developed a questionnaire to determine the expected and observed effects of globalization in educational institutions. It is important to investigate management, finance, technology, research, and teaching-learning dimensions and the observed effects of globalization in other fields. For this, validity and reliability analysis should be done in the relevant sample group. This research was carried out to develop a valid and reliable scale for sports science stakeholders to use. With the developed scale, research can be done on the observed effects of globalization in sports sciences.

In summary, the problem of the study is that the survey question pool developed for the faculty of education sample tests the validity of sports sciences stakeholders.

Method

Research Model

In this research, a scale development study has been adhered to for use in sports science.

Research Group

878 volunteer individuals who work in different regions of Turkey, including 81 academicians, 336 physical education and sports teachers, 118 coaches and 343 sports sciences students, were involved in the study. Studies on different samples increase validity (Cabrera-Nguyen, 2010). For this reason, the data were collected at 3 different times, were performed, Explanatory Factor Analysis (EFA) (n=426) with the data of the first group, Confirmer Factor Analysis (CFA) (n=412) with the data of the second group and test re-test analysis (n=40) with the data of the third group. It is sufficient to reach 300 people for EFA and CFA analyzes (Can, 2019: 319; Doğan et al., 2017; Karagöz and Bardakçı, 2020: 171; Orçan, 2018; Özdamar, 2017: 41; Tabachnick and Fidell, 2015: 657). Since it is necessary to collect data from at least 30 people every 3 weeks to perform test-retest analysis (Tavşancıl, 2018: 20), a sample of 40 people was found to be sufficient. As a result, it can be said that 878 people are sufficient for the research. The qualifications of the research group are detailed in Table 1.

Table 1

Demographic Characteristics of the Participants

		EFA group N=426		CFA group N=412		Test re-test group N=40		Total	
		N	%	N	%	N	%	N	%
Gender	**Male**	284	66,7	271	65,7	26	65,0	581	66,0
	Female	142	33,3	141	34,3	14	35,0	297	34,0
Status	**Academician**	40	9,3	38	0,9	3	7,5	81	9,2
	PE teacher	160	37,6	161	39,0	15	37,5	336	38,2
	Coach	54	12,7	60	14,5	4	10,0	118	13,4
	PE student	172	40,4	153	37,1	18	45	343	39,0
Department	**PEST**	222	52,1	220	53,3	15	37,5	457	52,0
	CTD	101	23,7	99	24,0	10	25,0	210	23,9
	SMD	103	24,2	93	22,7	15	37,5	211	24,1

Data Collection Tool

Opinions on the Effects of Globalization in Sports Sciences Scale (OEGSSS)

The measurement tool, which was developed by Şentürk (2007) in the study titled "Expected and observed effects of globalization on education faculties " questionary/survey, consisting of 66 items and 5 factors, was contacted with the author by e-mail and a research permission was obtained to use it in developing a scale. The effects of globalization continue to grow not only in the field of education but also by including many sectors such as sports. By testing these previously tested substances in sports science, a valid and reliable measurement tool will be developed. There are 5 dimensions in the measurement tool: management, finance, technology, research, and teaching-learning. The validity of the measuring tool was calculated by the item total test correlation, and the Cronbach alpha internal consistency reliability analysis was calculated as .98. Scoring ranging from 1. Totally disagree, 2. Disagree, 3. Notral, 4. Agree and 5. Totally agree is done in the 5 Likert type measurement tool.

Collection of Data

The study was started by obtaining an ethical report from the Scientific Research and Publication Ethics Committee of Niğde Ömer Halisdemir University (DECISION-2021/02-12 dated 01.02.2021 and numbered E-86837521-050.99-15440). The data was collected electronically (https://docs.google.com/forms/d/e/1FAIpQLSfiyIkw6OPO1J9sjFPbOvuM4MlJaTzcr8zhyb3CihClg6wjJA/viewform) via google forms.

Data Analysis

IBM SPSS Statistics 21 and AMOS Graphics 21 package programs were used for analysis. By examining the total test correlations of 66 items, item loadings were examined, and normality analysis (Tabachnick and Fidell, 2015) was performed. For the distinctiveness of the items, the 27% upper group and the 27% subgroup (Can, 2019: 393) were compared. In order to determine the construct validity, Varimax rotation principal component analysis (maximum likelihood) was used by using Exploratory Factor Analysis (EFA), factor loads above .55 (Tabachnick and Fidell, 2015: 654) were determined. Confirmatory Factor Analysis (CFA) was performed by collecting data from different samples in order to check the consistency of the results obtained from EFA. $X^2/df < 3$ in DFA; RMSEA < .08; PGFI > .50; PNFI > .50; GFI > .90; AGFI > .90; IFI > .90; TLI > .90 CFI > .90 criteria were taken into account (Karagöz and Bardakçı, 2020: 46; Özdamar, 2017: 229-244). The test-retest reliability of the 17-item scale, which was formed as a result of factor analysis, was analyzed with the Pearson correlation test.

Results

Table 2

Item Analyzes of the Opinions on the Effects of Globalization in Sports Sciences Scale

Dimensions	Item No.	27% Subgroup n=115		27% Upper group n=115				Item total test correlation
		x̄	sd	x̄	sd	t	p	
Teaching-learning processes	59	2,27	0,81	4,34	0,64	-21,35	,000*	,794
	57	2,49	0,86	4,46	0,63	-19,71	,000*	,753
	58	2,53	0,94	4,54	0,59	-19,30	,000*	,748
	60	2,57	0,84	4,38	0,60	-18,65	,000*	,773
	54	2,77	0,89	4,43	0,67	-15,82	,000*	,720
	63	2,51	0,77	4,30	0,69	-18,48	,000*	,768
	62	2,60	0,86	4,33	0,68	-16,79	,000*	,688
Management	4	2,16	0,93	4,03	0,90	-15,38	,000*	,644
	5	2,46	0,93	4,26	0,80	-15,64	,000*	,668
	3	2,35	1,05	4,25	0,79	-15,42	,000*	,569
	6	2,33	0,80	4,25	0,78	-18,28	,000*	,705
	8	2,21	0,89	3,86	0,90	-13,82	,000*	,598
Technology	32	2,75	1,01	4,48	0,64	-15,47	,000*	,687
	33	2,66	0,90	4,60	0,57	-19,30	,000*	,745
	37	2,96	0,85	4,47	0,70	-14,61	,000*	,641
	42	2,99	0,81	4,40	0,67	-14,41	,000*	,693
	36	2,70	0,77	4,37	0,66	-17,53	,000*	,723

In Table 2, for the significance of the difference between the item scores of the upper 27% and lower 27% groups according to the arithmetic mean, the t-test values varied between -21.35 and -13.82, and p = .00 significant difference was found for the all items. Item total test correlation scores ranged from .59 to .79.

Table 3

Exploratory Factor Analysis and Factor Loadings

Item	Teaching-learning processes	Management	Technology
M59	,863		
M57	,835		
M58	,816		
M60	,801		
M54	,747		
M63	,717		
M62	,627		
M4		,825	
M5		,789	
M3		,761	
M6		,736	
M8		,586	
M32			,917
M33			,869
M37			,634
M42			,619
M36			,556

According to Table 3, the scale consists of 17 items in total, with 7 items in the teaching-learning processes dimension, 5 items in the management dimension, and 5 items in the technology dimension. Item loads vary between .55 and 91.

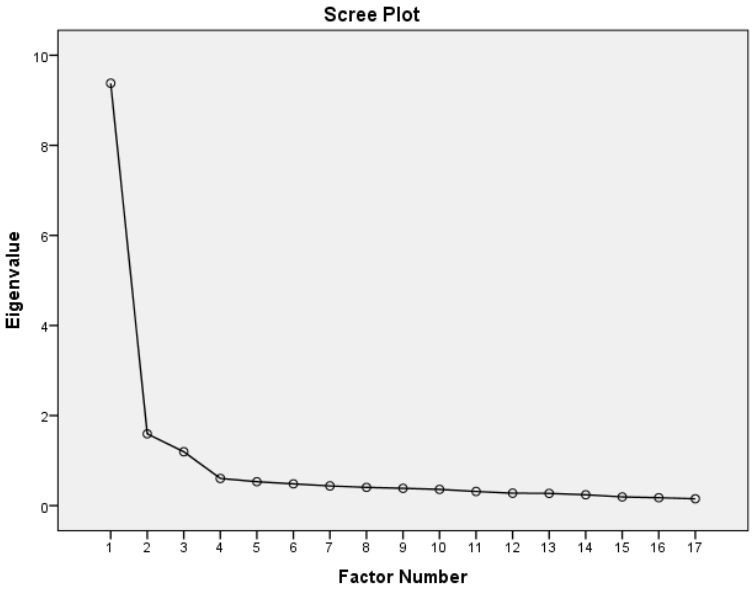

Figure 1

Scree Plot Graph of the OEGSSS

Table 4

The Explained Variance of Opinions on the Effects of Globalization in Sports Sciences Scale

Component	Total	Extraction sums of squared loadings % of the variance	Cumulative %	Cronbach's Alpha	
1	9,379	55,173	55,173	,93	
2	1,594	9,379	64,553	,88	.94
3	1,196	7,035	71,588	,90	

In Table 4, it is seen that 3 factors explain 71.588% of the total variance. Cronbach's Alpha (α) internal consistency coefficients were calculated as .93, .88, .90, and .94 for the overall scale, respectively.

Table 5

Table of Correlation Coefficients Between Factors

	Teaching-learning processes	Management	Technology
Teaching-learning processes	1	,637**	,724**
Management		1	,570**
Technology			1

According to Table 5 inter-factor correlations were found to be positively related, ranging from .57 to .72.

Table 6

Pearson Correlation Analysis for Test-Retest

	n	Correlation	p
OEGSSS	40	,838	,000**

In Table 7, it is seen that the pre and post test scores of the globalization scale are positively related (r =, 83).

Table 6

Confirmatory Factor Analysis Fit Values

Model Fit Index	Perfect Range	Acceptable Range	*Globalization
X^2/df	0<X2/df<2	2<X2/df<3	2,63
RMSEA	0.00<RMSEA<0.05	0.05<RMSEA<0.10	0,06
PGFI	0.95<PGFI<1.00	0.50<PGFI<0.95	0,69
PNFI	0.95<PNFI<1.00	0.50<PNFI<0.95	0.79
GFI	0.90<GFI<1.00	0.85<GFI<0.90	0,92
AGFI	0.90<AGFI<1.00	0.85<AGFI<0.90	0,90
IFI	0.95<IFI<1.00	0.90<IFI<0.95	0,96
TLI	0.95<TLI<1.00	0.90<TLI<0.95	0,95
NFI	0.95<NFI<1.00	0.90<NFI<0.95	0,94
CFI	0.95<CFI<1.00	0.90<CFI<0.95	0,96

Fit indices χ2/df: 2,63; RMSEA: .06; PGFI: .69; PNFI: .79; GFI: .92; AGFI: .90; IFI: .96; TLI: .95; NFI: .94; CFI: determined as .96.

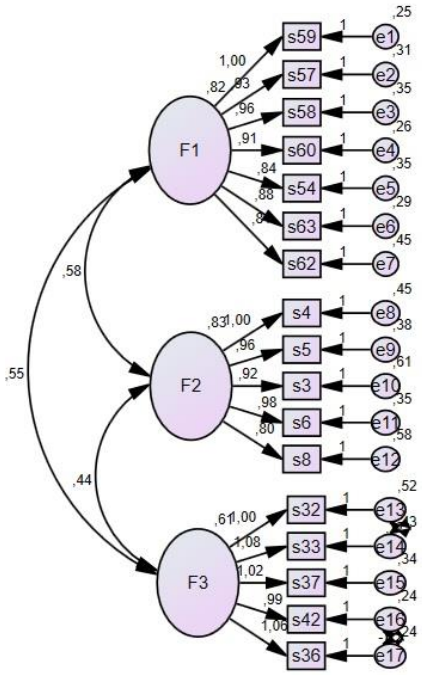

Figure 2

CFA Values

Discussion and Conclusion

In this research, it is aimed to develop the globalization scale for use in sports sciences. First of all, item analysis was performed and it was checked whether there were any items under .20 (Karagöz and Bardakçı, 2020: 109), and it was seen that 66 items had varying item correlations over .55. Then, in order to determine the distinctiveness of the items, the scores of the 27% upper group (n = 115) and the 27% lower group (n = 115) were compared and all items were found to be significantly different in favor of the upper group. The significance of the t values between the lower and upper groups indicates the distinctiveness of the item (Can, 2019: 394). Kolmogorov-Smirnov normality analysis was performed on 426 data sets and p = .055 (Can, 2019: 89) data was found to be suitable for Exploratory Factor Analysis (EFA).

The suitability of the 66-item measuring tool developed by Şentürk (2007) to Exploratory Factor Analysis (EFA) was tested with the Kaiser-Meyer-Olkin (KMO) coefficient of .94, the Bartlett test of 5491,309 and p = 0,000. If the KMO value at the sample size is over .70 (Can, 2019; Tavşancıl, 2018), it indicates that the sample is suitable for analysis. As a result of EFA, it was seen that 17 items with a factor load of .55 to .91 and a Cronbach alpha value of .94 were collected in 3 factors. These factors are; Teaching-learning processes are named as management and technology. Cronbach alpha internal consistency coefficients of the factors were determined as .93, .88, and .90, respectively. The Cronbach alpha coefficient for the sub-dimensions and the whole of the scale is highly reliable since it has a value above .80 (Karagöz and Bardakçı, 2020: 52; Özdamar, 2017: 74). The scale consisting of 17 items and 3 factors explained 71,588% of the total variance. This ratio shows that the explanation of the scale is good (Büyüköztürk, 2002; Karagöz and Bardakçı, 2020: 36; Tavşancıl, 2018: 48). Factors on the scale are positively related, ranging from .57 to .72. These values express the perfect relationship (Özdamar, 2017: 74).

In order to perform Confirmatory Factor Analysis (CFA), data was collected from different sample (n = 412) groups and the normality of the data set was tested with Kolmogorov-Smirnov analysis (p = 0,184). DFA compliance values made using the AMOS Graphics program χ^2 / df: 2.63; RMSEA: .06; PGFI: .69; PNFI: .79; GFI: .92; AGFI: .90; IFI: .96; TLI: .95; NFI: .94; CFI: .96 calculated. These values are at an acceptable level (Büyüköztürk et al., 2012; Özdamar, 2017: 183; Tabachnick and Fidell, 2015: 720-725).

In order to measure the stability of the 17-item scale, which was formed as a result of EFA and CFA analyses, data were collected from 40 people every 3 weeks. Pearson correlation test-retest analysis was performed and .83 positive correlations were found. This result explains the perfect stability (Tavşancıl, 2018: 19-25).

As a result, it can be said that the globalization scale developed for use in sports sciences is a valid and reliable measurement tool. Accordingly, the total score that can be obtained from the 5-point Likert-type scale varies between 17 and 85. When the scale scores are graded on the total score, it can be said that 17-30 points are not at all, 31-44 points are low, 45-58 points are moderate, 59-72 points are quite and 72-85 points are very observable. According to the arithmetic mean, 1.00-1.79 points never, 1.80-2.59 points low, 2.60-3.39 points medium, 3.40-4.19 points quite and 4.20 It can be said that over points has many globalization effects. High scores obtained from the scale are evaluated positively in terms of teaching-learning, management, and technology.

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Appendix 1.

Opinions on the Effects of Globalization in Sports Sciences Scale (Turkish Version)

Küreselleşmenin Spor Bilimlerinde Etkilerine Yönelik Görüşler Ölçeği

Tamamen katılmıyorum 1, Katılmıyorum 2, Kararsızım 3, Katılıyorum 4, Tamamen katılıyorum 5

	Maddeler Spor bilimlerinde;	1	2	3	4	5
1	piyasa yönelimi ve rekabet, öğretim programlarını, süreç ve yöntemlerini belirlemektedir.					
2	öğretim programları ve yöntemleri, iş gücü gereksinimine yanıt verecek şekilde düzenlenmektedir.					
3	öğrenciler bilimsel projelerde görev almaya yönlendirilmektedir.					
4	öğretim sürecinde verimlilik ve etkililik esas alınmaktadır.					
5	öğretim programları, yöntem ve tekniklerindeki değişim ve çeşitlilik artmaktadır.					
6	öğrencilerin bireysel öğrenme süreçlerini planlamaları ve yönetmeleri esas alınmaktadır.					
7	program içeriklerinde uluslararası düzeyde standartlaşma ve kredi transferi çalışmaları artmaktadır.					
8	yönetsel kararlara (demokratik karar verme süreçlerine) katılım arttırılmaktadır.					
9	uzun ve kısa dönemli gelişim planları (Stratejik Plan) yapılmakta ve uygulanmaktadır.					
10	kalite geliştirme uygulamaları artmaktadır.					
11	yönetimde etkililik ve verimliliğin temel alınmaktadır.					
12	yönetsel ve mali özerklik artmaktadır.					
13	bilgi kaynağı olarak internetten ve online veri tabanlarından yararlanma artmaktadır.					
14	teknoloji destekli öğrenme ve öğretme olanakları artmaktadır.					
15	teknoloji ve bilgi yönetimi önem kazanmaktadır.					
16	bilgisayar ve bilgi teknolojileri yardımıyla araştırma süreçleri hızlanmaktadır.					
17	personelin teknoloji kullanma bilgi ve becerileri geliştirilmektedir.					

Boyut 1. Öğrenme Öğretme Süreçleri: 1,2,3,4,5,6,7
Boyut 2. Yönetim: 8,9,10,11
Boyut 3. Teknoloji: 13,14,15,16,17

Appendix 2.

Opinions on the Effects of Globalization in Sports Sciences Scale (English Version)

Opinions on the Effects of Globalization in Sports Sciences Scale

Totally disagree 1, Disagree 2, Notral 3, Agree 4, Totally agree 5

	Items In sports sciences;	1	2	3	4	5
1	trade market trend and competition determine curriculum, processes and methods.					
2	Curriculum and methods are organized to meet the labour force needs.					
3	students are directed to take part in scientific projects.					
4	efficiency and effectiveness are based on the teaching process.					
5	change and diversity in instructional programs , methods and techniques is increasing.					
6	It is based on students' planning and management of their individual learning processes.					
7	International standardization and credit transfer studies are increasing in program content.					
8	participation in administrative decisions (democratic decision-making processes) is increased.					
9	long and short term development plans (strategic plan) are made and implemented.					
10	quality improvement practices are increasing.					
11	management is based on effectiveness and efficiency.					
12	managerial and financial autonomy is increasing.					
13	The use of the internet and online databases as a source of information is increasing.					
14	technology-supported learning and teaching opportunities are increasing.					
15	technology and knowledge management are gaining importance.					
16	Research processes are accelerating with the help of computers and information technologies.					
17	technology use knowledge and skills of the personnel are developed.					

Dimension 1. Learning Teaching Processes: 1,2,3,4,5,6,7
Dimension 2. Management: 8,9,10,11
Dimension 3. Technology: 13,14,15,16,17

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Erratum

Erratum for published article titled Social skills training in potentially gifted children

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Abstract

Esra Ömeroğlu's name erroneously was not writen in the author list of the article which was produced from doctoral thesis published in August 2017 issue of Journal for the Education of Gifted Young Scientists (Karateke, B. Social Skills Training in Potentially Gifted Children. Journal for the Education of Gifted Young Scientists, 5(3), 90-104.).

The second author (Prof. Dr. Esra Ömeroğlu) name was included in the author list of the manuscript in question and the title and the author list of the manuscript was arranged as it is listed below;

Karateke, B., and Ömeroğlu, E. (2017). Social skills training in potentially gifted children. Journal for the Education of Gifted Young Scientists, 5(3), 90-104.

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