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İlköğretim Matematik Öğretmen Adaylarının STEM Eğitimine Yönelik Tutumları ile 21. Yüzyıl Becerileri Yeterlilik Algıları Arasındaki İlişkinin İncelenmesi[1]

Investigation of the Relationship Between Elementary School Mathematics Teacher Candidates' Attitudes Towards STEM Education and Their Proficiency Perceptions of 21st Century Skills

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Özet

Bu çalışmada ilköğretim matematik öğretmen adaylarının STEM (FeTeMM) eğitimine yönelik tutumları ile 21. Yüzyıl becerileri yeterlilik algıları arasındaki ilişkinin belirlenmesi amaçlanmıştır. Nicel araştırma yöntemlerinden ilişkisel tarama modelinin kullanıldığı çalışmanın örneklemi, 71 ilköğretim matematik öğretmen adayından oluşmaktadır. Çalışmanın verileri, "STEM (Fen-Teknoloji-Mühendislik–Matematik) Eğitimi Tutum Ölçeği" ve "Öğretmen Adaylarına Yönelik 21. Yüzyıl Becerileri Yeterlilik Algıları Ölçeği" olmak üzere iki ölçme aracı ile elde edilmiştir. Çalışmada ilköğretim matematik öğretmen adaylarının STEM eğitimine yönelik tutumları ve 21. Yüzyıl becerileri yeterlilik algıları arasında sınıf düzeyi cinsiyete ve genel not ortalamalarına göre anlamlı farklılığın olup olmadığı ve STEM eğitimine yönelik tutumları ile 21. Yüzyıl becerileri yeterlilik algıları arasında anlamlı bir ilişki olup olmadığı incelenmiştir. Yapılan analizler sonucunda ilköğretim matematik öğretmen adaylarının sınıf düzeylerine göre STEM eğitimine yönelik tutumlarında anlamlı bir farklılığın olmadığı sonucuna ulaşılmıştır. 21. Yüzyıl becerileri yeterlilik algılarında ise sınıf düzeylerine göre anlamlı farklılığın olduğu belirlenmiştir. Cinsiyete göre hem STEM eğitimine yönelik tutumlarda hem de 21. Yüzyıl becerileri yeterlilik algılarında anlamlı farklılığın olmadığı ortaya konulmuştur. Öğretmen adaylarının genel not ortalamalarına göre hem STEM eğitimine yönelik tutumlarında hem de 21. Yüzyıl becerilerine yönelik yeterlilik algılarında bir farklılığın olmadığı görülmüştür. STEM eğitimine yönelik tutumları ile 21. Yüzyıl becerileri yeterlilik algıları arasında anlamlı bir ilişkinin olmadığı sonucuna ulaşılmıştır.

Anahtar Kelimeler: Tutum ölçeği, Yeterlilik algısı ölçeği, Matematik eğitimi, STEM (FeTeMM) eğitimi, 21. Yüzyıl becerileri

Abstract

This study aimed to determine the relationship between elementary mathematics teacher candidates' attitudes towards STEM education and proficiency perceptions of 21st-century skills. The relational screening model, which is used to determine the relationship between two or more variables, was used from quantitative research methods. The sample of the study consists of 71 elementary mathematics teachers. The data were collected with two measurement tools, "STEM (Science-Technology-Engineering-Mathematics) Education Attitude Scale" and "21st Century Skills and Competences Scale Directed at Teaching Candidates". In the study, it was investigated whether there is a significant difference in the attitudes of elementary school mathematics teacher candidates towards STEM education according to grade level and gender, whether there is a significant difference in 21st-century skills proficiency perceptions according to grade level and gender, and whether there is a significant relationship between their attitudes towards STEM education and 21st-century skills. As a result of the analyses conducted, it has been determined that there is a significant difference in 21st-century skills proficiency perceptions according to grade levels. It was

[1] A part of this study was presented at the "3rd International Conference on Science, Mathematics, Entrepreneurship, and Technology Education" held on 30 September-3 October 2021.

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concluded that there is no significant relationship between their attitudes towards STEM education and their perceptions of 21st-century skills competence.

Keywords: Attitude scale, Competence perception scale, Mathematics education, STEM education, 21st-century skills

1. Introduction

In today's world, the necessity of different cultures to live together, the world's getting the status of a globalized city, the development, and progress in technology, natural disasters, global warming, and wars affect the lives of individuals and make it necessary for them to adapt to these difficulties (Gürültü et al., 2020). There is a need for individuals who can think analytically and critically, collect and research data, make inquiries, and make decisions within the framework of seeking solutions to these challenges (Yamak et al., 2015). When looking at today's world from another perspective, it has become important for individuals to dig into the information they really need, analyze, and evaluate the information by making sense of it, and make inferences about the results in this context. This situation has led to the appearance of new concepts, skills, teaching methods, and approaches in the 21st century. In this context, at the beginning of the issues discussed in today's 21st century age, 21st-Century Skills (21CS) which include problem-solving, critical thinking, basic learning skills, information and technology literacy (Kozikoğlu & Altunova, 2018), Science, Technology, Engineering and Mathematics (STEM) Education, which aims to teach STEM disciplines by associating them with each other (Çorlu, 2014), Programme for International Student Assessment (PISA), which is based on the concept of literacy, and Industry 4.0 (Akgündüz, 2018) which includes basic components such as analysis of big data, system integration, simulation, and augmented reality, are coming.

STEM education can be expressed as teaching the course content associated with real-life through a holistic approach by integrating it with science, technology, engineering, and mathematics disciplines (Özcan & Koca, 2019). STEM education includes applications for 21st-century education (Akaygün & Aslan-Tutak, 2016). These four disciplines can be used together in teaching course content, or a discipline can be chosen as the main discipline and other disciplines can be used as context (Walker et al., 2018). STEM education offers a unique learning-teaching experience by focusing on students' learning and related areas (ElSayary, 2021). STEM education includes activities and educational practices that will provide students with the occasion to use their 21CS and knowledge to direct them to STEM disciplines (Baran et al., 2015).

The integrated use of STEM disciplines will enable students to gain more permanent and more meaningful learning and to have the opportunity to apply what they have learned (Wicklein & Schell, 1995). Individuals who develop themselves in line with STEM education are awaited to have 21CS including skills such as problem-solving, connection, high-level thinking, communication, self-confidence, and sociability (Bybee, 2010). In other words, within the framework of STEM education, students who focus on real-life problems develop skills such as creative thinking, critical thinking, collaboration, and design (Ceylan et al., 2018). STEM education has an important role in educating individuals in line with the skills required by the 21st century (Akaygün & Aslan-Tutak, 2016; Banks & Barlex, 2014; Koştur, 2017). In this context, developments within the STEM education framework should be followed to educate individuals with 21CS and knowledge (Radu, 2014). Supporting the development of 21CS, STEM education (Batdı et al., 2019) aims to provide students with innovative solutions to problems within the framework of 21CS by establishing interdisciplinary relationships (Yıldırım & Gelmez-Burakgazi, 2020). Therefore, STEM applications are an important driving force for individuals to acquire 21CS (Copper & Heaverlo, 2013).

Attitudes towards STEM in 21st Century education are considered extremely important (Özcan & Koca, 2018). The positive attitudes of both students and teachers towards STEM education greatly impact achieving success in the STEM field because attitudes towards STEM play a decisive role in determining the workforce potential that countries will need in the future and managing these potentials correctly (Kennedy et al., 2016). In this context, individuals' developing positive attitudes toward STEM by recognizing STEM education will increase their motivation for career planning towards these disciplines (Christensen et al., 2015; Maltese & Tai, 2011; Yerdelen et al., 2016). Teachers who practice STEM education play a big role in the positive development of individuals' attitudes toward STEM education because teachers can enhance the interest, relevance, and motivation of students towards STEM disciplines with quality STEM education practices (Hiğde et al., 2020). At the same time, considering the problems experienced in teacher quality and capacity for STEM education all over the world (Çepni, 2018), students need teachers with STEM education in order to reach high academic standards (Yıldırım, 2021). Students participating in qualified STEM education are expected to make career plans for these fields by increasing their willingness to attend classes in STEM fields (Heaverlo, 2011). In this context, teachers' attitudes towards STEM education also affect the efficiency of STEM education.

Determining the attitudes of teachers and teacher candidates towards STEM education is important both in terms of providing qualified STEM education. In the teaching profession, as in all professions, cooperation is now a necessity (Akgündüz et al., 2015). In this context, since STEM education includes the integration of disciplines (Yıldırım & Altun, 2015), it is thought that teachers for qualified STEM education should act in cooperation with their colleagues in other disciplines and demonstrate good communication in order to ensure coordination. If we consider the subject from another angle, STEM education can provide individuals with skills such as cooperation, self-confidence, and high-level thinking skills (Batdı et al., 2019). Among the 21CS, cooperation, and communication are among the learning and renewal skills (Partnership for 21st-century learning [P21], 2008). Collaboration and communication skills are among the teacher's 21CS (Orhan-Göksün, 2016). With the development of 21CS, communication and cooperation skills needed in STEM education are supported. In this context, it can be said that 21CS contributes to STEM education. In the same breath, it is thought that 21CS will enable teachers to develop positive attitudes towards STEM education.

21CS have become a key concept and maxim not only in STEM education but also in all areas of education (Greiff & Kyllonen, 2016) because 21CS are seen as necessary skills for individuals to adapt to development, progress, and change in all areas of life, including science, technology, and industry (Nacaroğlu & Kızkapan, 2017). 21CS are required in order to adapt to the development and change that occurs, to keep up with the development in technology, to use the information obtained by selecting, analysing, and synthesizing, and evaluating the information needed in the information stacks that are constantly increasing (Anagün et al., 2016). Today, individuals who take STEM courses are expected to acquire skills such as analysis, synthesis, evaluation, and problem-solving. The relevance of STEM in analysis, synthesis, and assessment (Baz, 2019) and its support for higher-order thinking skills in 21CS (P21, 2008) is another indication of the interaction between STEM education and 21CS.

When the literature is examined, there are Nacaroğlu and Kızkapan (2021) and Kan and Murat (2018) studies on the relationship between STEM education and 21CS. Nacaroğlu and Kızkapan (2021) examined the levels of gifted students with their STEM attitudes and 21CS. In the study, it was precipitated that there is no significant relationship between the STEM attitudes of gifted students and the level of having 21CS. Suggestions were made to examine the STEM attitudes of students at different education levels and their 21CS. Kan and Murat (2018), on the other hand, examined science

teacher candidates' perceptions of 21CS competence and their attitudes towards STEM education and the relationship between them. In the study, it was determined that there was no significant difference between the attitudes of science teacher candidates towards STEM in terms of gender. It has been concluded that there is a low level of relationship between attitudes towards STEM education and perceptions of 21CS proficiency. Apart from the studies of Nacaroğlu and Kızkapan (2021) and Kan and Murat (2018), it is seen that there are not enough studies aiming to reveal the relationship between STEM education and 21CS. In general, there are studies in which there are opinions that STEM and 21CS can affect each other and contribute to each other. When these studies are examined, Şahin et al. (2014) revealed that after-school activities with science, technology, mathematics, and engineering content have the potential to contribute to the improvement of 21CS. Kavak (2019) concluded that STEM activities improve 21CS such as problem-solving, cooperation, and communication in his study at the 4th grade level of primary school. Again, in the study conducted with primary school 4th-grade students, it was revealed that STEM activities have a significant effect on 21CS (Bircan, 2019). Congruently, in the meta-analysis study conducted by Batdı et al. (2019) on the STEM field, it was emphasized that the majority of the students stated that STEM applications were effective in the development of 21CS. Fajrina et al. (2020) emphasized in their studies that STEM education is an approach that develops 21CS including critical thinking, creativity, communication, and collaboration.

1.1. Importance and Purpose of the Study

There is considerable worldwide interest in 21CS and their inclusion in the education systems (OECD, 2018). When the PISA 2022 implementation framework is examined, it is seen that 21CS constitutes an important framework for mathematical literacy. It is thought that 21CS such as communication, problem-solving, cooperation, and critical thinking will provide opportunities for presenting and defending arguments for the solution of mathematical literacy problems. Considering that there is not enough work to determine the relationship between concepts such as mathematical literacy, 21CS, and STEM education, which are at the top of the agenda in the field of education today, it is thought that research on both STEM and 21CS are necessary for the field of mathematics education. The contribution of the studies to be conducted in this direction to the literature is undeniable. In addition, many studies emphasize the relationship between STEM education and 21CS (Banks & Barlex, 2014; Batdı et al., 2019; Copper & Heaverlo, 2013; Koştur, 2017; Ormancı, 2020; Radu, 2014). In this context, it was aimed to determine the relationship between elementary school mathematics teacher candidates' attitudes towards STEM education and their perceptions of 21CS proficiency.

1.2. Research Problem

Is there a significant relationship between elementary school mathematics teacher candidates' attitudes towards STEM education and their perceptions of 21CS proficiency?

1.2.1. Sub Problems

1. Is there a significant difference between the attitudes of Elementary School Mathematics Teacher Candidates towards STEM education according to grade level?
2. Is there a significant difference between the attitudes of Elementary School Mathematics Teacher Candidates towards STEM education by gender?

3. Is there a significant difference between the attitudes of Elementary School Mathematics Teacher Candidates towards STEM education according to their grade point averages?

4. Is there a significant difference between the 21CS proficiency perceptions of Elementary School Mathematics Teacher Candidates according to the grade level?

5. Is there a significant difference between the 21CS proficiency perceptions of Elementary Education Mathematics Teacher Candidates by gender?

6. Is there a significant difference between the perceptions of proficiency in 21CS according to the general grade point averages of the Elementary School Mathematics Teacher Candidates?

2. Method

In this study, the correlational survey model, which is used to specify the relationship between two or more variables, was used from quantitative research methods. In this research model, researchers focus on the relationship between variables and present comparisons between situations that occur between two or more variables (Çepni, 2007; Fraenkel & Wallen, 2009). The main reason for choosing the correlational survey model is to determine the level and direction of the relationship between attitudes towards STEM education and perceptions of 21CS proficiency.

2.1. Sample

The population of the research is the teacher candidates registered in the elementary education mathematics teaching program of the education faculties of the universities throughout Türkiye in the 2021-2022 academic year. The research was conducted with the sample selected from the population since it was not possible to reach the whole of the determined population. Thus, the sample of the study consists of 71 elementary school mathematics teacher candidates studying in the second, third, and fourth grades at a state university in the Marmara region in the 2021-2022 academic year. First-grade teacher candidates were not included in the study. The reason for this situation should be stated in the interviews conducted with first-grade elementary school mathematics teacher candidates that some of the teacher candidates do not have knowledge and experience in STEM education. Considering the easy accessibility of the sample, due to the fact that the whole world was faced with COVID-19 and was in the pandemic process when the application was carried out, the appropriate sampling method was preferred in determining the sample. In addition, the research was conducted with teacher candidates who could be reached during the pandemic and voluntarily accepted the application of measurement tools. The distribution of the sample according to grade levels and gender is presented in Table 1:

Table 1. *Demographic Characteristics of The Sample Group*

Grade Level	Female	%	Male	%	Total	%
2nd Grade	15	65.22	8	34.78	23	32.39
3rd Grade	16	84.21	3	15.79	19	26.76
4th Grade	21	72.41	8	27.59	29	40.85
Total	52	73.24	19	26.76	71	100

23 elementary school mathematics teacher candidates who participated in the research at the second-grade level constitute 32.39% of all participants. 65.22% (n=15) of the second-grade participants were female and 34.78% (n=8) were male. 19 elementary school mathematics teacher

candidates who participated in the research at the third-grade level constitute 26.76% of all participants. 84.21% (n=16) of the third-grade participants were female and 15.79% (n=3) male. At the fourth-grade level, 29 elementary school mathematics teacher candidates participated in the research and constituted 40.85% of all participants. 72.41% (n=21) of the fourth-grade participants were female and 27.59% (n=8) were male.

2.2. Data Collection Tools

The data of the study were collected with two measurement tools: "STEM (Science-Technology-Engineering-Mathematics) Education Attitude Scale" and the "21st Century Skills Proficiency Perceptions Scale".

2.2.1. STEM (Science-Technology-Engineering-Mathematics) Education Attitude Scale

The Turkish adaptation and development studies of the 20-item scale developed by Berlin and White (2010) were conducted by Derin et al. (2017) in order to measure the attitudes of adults studying science and mathematics education towards STEM education. The original scale, which is of the Osgood type, consists of two dimensions: Meaningfulness and Feasibility. The Osgood scale is a type of scale developed by Osgood et al. (1957) that is sensitive to complex perceptions and attitudes, saves time, is easy to understand, and can be scored (Berlin & White, 2010). In such scales, participants mark the part they feel closest to in the spaces between two antonyms (Derin et al., 2017). For example, "Difficult __: __: __: __: __ Easy" word group is marked according to the level felt. In this context, each item is coded from 1 to 5 according to the places marked by the participants. While 5 expresses the highest attitude and perception in coding, 1 is evaluated as the lowest attitude and perception.

In the adaptation study conducted by Derin et al. (2017), a 32-item adaptation scale was developed as a result of the validity and reliability studies conducted by adding 15 more items to the original scale consisting of 20 items. The total variance explained by the scale, which has a 2-factor structure, namely significance and feasibility, was calculated as 39.25%. While the significance sub-factor includes 18 items, the feasibility sub-dimension includes 14 items. The Cronbach's alpha value of the significance sub-factor of the adapted scale was found to be .92, and the feasibility sub-factor was found to be .84. The Cronbach alpha values calculated for the whole scale are .77. For this study, the Cronbach alpha value of the STEM education attitude scale was calculated as .72. In this study, the reason why the STEM education scale adapted by Derin et al. (2017) was used to determine the attitudes of the participants towards STEM education is that both the original scale and the adaptation scale were developed with pre-service teachers studying in the field of mathematics.

2.2.2. 21st Century Skills Proficiency Perceptions Scale

There are 42 items in the 21st-Century Skills Proficiency Perceptions Scale developed by Anagün, et al. (2016). The scale was developed based on the skills determined by P21. In this context, the scale consists of 3 sub-dimensions: learning and innovation skills, life and career skills, and information, media, and technology skills. There are 18 items for learning and innovation skills, 16 items for life and career skills, and 8 items for information, media, and technology skills. The total explained variance of the scale was calculated as 51.30%. The Cronbach alpha value of the scale developed in a 5-point Likert type is .899. In the reliability analysis performed for this study, the Cronbach alpha value of the scale was calculated as .94. Anagün, et al. (2016), the reason for using the scale is that the scale is based on the skills determined by P21 and the scale development studies were

conducted with teacher candidates, including teacher candidates studying in the field of mathematics education.

2.3. Data Collection and Analysis

Necessary explanations regarding how the scales should be marked for each item during the application phase of the scales, the importance of the application, participation in the study voluntarily, and the importance of the research in terms of reflecting real views and thoughts were explained within the framework of a detailed text. Considering the threat posed to the validity of the time the measurement tools were applied during the data collection phase (Creswell, 2013), the data were collected from the second, third, and fourth-grade elementary mathematics teacher candidates in the same week.

Considering the pandemic process, the scales to be applied to the participants were transferred online using the Google Form application to apply the scales in a healthier way. The data obtained from the scales answered by the participants online were transferred to the Statistical Package for the Social Sciences (SPSS) program by taking the Google Form application in Excel format in Microsoft Office programs. The coding of 1 to 5 for the data transferred to the SPSS program was conducted in line with the coding criteria for the scales, and the total scores of the participants for the scales were calculated. In this context, the lowest score that can be obtained from the "STEM Education Attitude Scale" is 32 and the highest score is 160. While the lowest score that can be obtained for the "21st Century Skills Proficiency Perceptions Scale" is 42, the highest score is 210. The formula "Score range (largest value – smallest value) / (number of degrees)" was used to describe attitudes towards STEM education and perceptions of 21CS proficiency as very low, low, medium, high, and very high (Tavşancıl, 2005). In this context, the values between 32-57.5 points in the STEM education attitude scale are very low, low between 57.6-83.1 points, medium between 83.2-108.7 points, high between 108.8-134.3 and It was evaluated as a very high degree of attitude in the range of 134.4-160 points. Perceptions of 21CS proficiency are very low in the range of 42-75.5, low in the range of 75.6- 109.1, moderate in the range of 109.2- 142.7, high in the range of 142.8-176.3, and it was determined as very high in the range of 176.4-210.

Before the data analysis, first of all, the normality of the data group was examined. The reason for this situation is to check whether the analysis method to be applied meets the assumptions for the distribution of the data group and to reach the result with alternative tests in order not to encounter an error in cases where the assumptions do not meet (Can, 2014). In other words, it is to decide which of the parametric or non-parametric analysis methods will be used for the analyses to be applied in determining the significant difference (Büyüköztürk, 2013; Karasar, 2008). There are multiple methods for examining the normality of data groups (Can, 2014). One of these methods is Kolmogorov-Smirnov and Shapiro Wilk tests, which are specified as normality tests (Büyüköztürk, 2013; Can, 2014; Karasar, 2008). The Shapiro-Wilk test is used when the number of people in the data groups is below 30, and the Kolmogorov-Smirnov test is used when it is more than 30 (Can, 2013). According to the results of the normality tests performed in this context, it was concluded that the data for the STEM Education Attitude Scale did not show a normal distribution in terms of grade level ($p<.05$), while the "21st Century Skills Proficiency Perceptions Scale" showed a normal distribution ($p>.05$). According to the gender variable, the data group for both the "STEM Education Attitude Scale" and the "21st-Century Skills Proficiency Perceptions Scale" showed a normal distribution ($p>.05$). According to the general grade averages, it was determined that the data group for both the "STEM Education Attitude Scale"

and the "21st-Century Skills Proficiency Perceptions Scale" showed a normal distribution. The analyses performed in line with these results are presented in the table below.

Table 2. *Summary Table of The Analyses Conducted to Determine The Significant Difference According to The Variables*

Variables	STEM Education Attitude Scale	21st-Century Skills Proficiency Perceptions Scale
Grade Level	Kruskal Wallis-H Test	ANOVA Test
Gender	Independent Samples T-Test	Independent Samples T-Test
Grade Point Average (GPA)	ANOVA Test	ANOVA Test

Analysis of variance (ANOVA) test was used to determine the significant difference in 21CS proficiency perceptions according to grade level. While performing the ANOVA analysis, the homogeneity between the variances of the groups was also examined with the Levene test (Büyüköztürk, 2013; Can, 2014). The Sidak test was used to determine the significant difference between the groups according to the results of the ANOVA test analysis conducted in line with the normality and homogeneity assumptions of 21CS proficiency perceptions according to grade level. The Sidak test is one of the most used analysis types in cases where the data group shows the normal distribution, variances are equal, and multiple comparison situations (Verbalis et al., 2010). In addition, although the fact that the groups have different sample sizes in the Sidak test does not prevent its implementation, it was developed to eliminate the type I error of LSD (Kayri, 2009).

2.4. Ethics

This study was conducted within the framework of the approval given in line with the decision of the Balıkesir University Science and Engineering Sciences Ethics Committee dated January 14, 2022 (E-19928322-302.08.01-107756).

3. Findings

3.1. Findings Related to The First Sub-Problem

The first sub-problem of the study is to determine whether there is a significant difference between the attitudes of elementary school mathematics teacher candidates towards STEM education according to grade level. The analysis result of the Kruskal Wallis-H test performed in this context is presented in the table below:

Table 3. *Kruskal Wallis-H Test Results on Comparison of Attitudes towards STEM Education by Grade*

Attitude Towards STEM Education	N	Sum of squares	df	χ^2	p
2nd Grade	23	33.59	2	.74	.69
3rd Grade	19	39.08			
4th Grade	29	35.90			

p>.05

According to the Kruskal Wallis-H test analysis results in Table 3, it was concluded that there was no significant difference between the attitudes of the participants towards STEM education according to their grade level (X^2=.74, p=.69, p>.05). When the mean ranks according to the class levels

in Table 3 are examined, it is seen that the highest average is at the 3rd-grade level and the lowest average is at the 2nd-grade level. However, it can be said that these differences are not statistically significant according to the results of the Kruskal Wallis h test analysis. It was concluded that STEM education attitudes towards grade level were high (M_2=119.48, M_3=120, M_4=119.45).

3.2. Findings Related to The Second Sub-Problem

The second sub-problem of the study is about whether there is a significant difference between the attitudes of elementary school mathematics teacher candidates towards STEM education by gender. The result of the independent samples t-test performed to determine whether there is a significant difference is given in Table 4:

Table 4. *T-Test Result on the Comparison of Attitudes Towards STEM Education by Gender*

Attitude Towards STEM Education	N	M	SD	df	t	p
Female	52	119.98	7.74	69	.56	.58
Male	19	118.58	12.98			

p>.05

When Table 4 is examined, it is seen that the significance value (p=.58) is greater than the significance level (p>.05). In line with this finding, it can be said that there is no significant difference between the attitudes of elementary school mathematics teacher candidates towards STEM education by gender (t=.56, p=.58, p>.05). Table 4 shows that the mean score of females (M_{female}=119.98) and the mean score of males (M_{male}=118.58) in the attitude scale towards STEM education are also close to each other. In addition, according to gender, it can be said that the attitudes of the participants towards STEM education are at a high level.

3.3. Findings Related to The Third Sub-Problem

The third sub-problem of the study is related to examining whether the attitudes of pre-service elementary mathematics teachers towards STEM education change according to their grade point averages. In this context, the result of the ANOVA test performed to determine the significant difference is presented in the table below:

Table 5. *ANOVA Test Analysis Results on Attitudes Towards STEM Education by GPA*

GPA	N	M	SD	Variance	Sum of Squares	df	Mean Square	F	p
2.51-3.00	10	114.10	17.35	Between Groups	453.75	2	226.88	2.73	.07
3.01-3.50	41	119.61	6.97	Withing Groups	5661.21	68	83.25		
3.51 and above	20	122.35	7.28	Total	6114.96	70			

p>.05

According to table 5, it was concluded that there was no significant difference between the elementary school mathematics teacher candidates' attitudes towards STEM education according to their GPA (F=2.73 p=.07, p>.05). In this context, it can be said that GPAs do not have a significant effect on attitudes towards STEM education. When the averages in Table 5 are examined, it can be said that

the students who have a GPA of "3.51 and above" ($M_{3.51 \text{ and above}}$=122.35) have higher attitudes towards STEM education than others. However, it was stated that this situation was not significant according to the ANOVA test analysis. It can be said that participants who have "2.51-3.00", "3.01-3.50", and "3.51 and above" grade point averages have a high level of attitude.

3.4. Findings Related to The Fourth Sub-Problem

The fourth sub-problem of the study is to examine the significant difference between the 21CS proficiency perceptions of the elementary school mathematics teacher candidates according to grade level. The analysis result of the ANOVA test performed to examine the significant difference is presented in Table 6.

Table 6. *ANOVA Test Results on Perceptions of 21st Century Skills Competence by Grade Level*

Grade Level	N	M	SD	Variance	Sum of Squares	df	Mean Square	F	p	η2	Sidak
2nd	23	157.83	16.39	Between Groups	2254.08	2	1127.04	3.91	.02*	.103	2nd -4th grade
3rd	19	167.05	17.62	Withing Groups	19608.11	68	288.35				
4th	29	170.93	17.02	Total	21862.20	70					

*p<.05

According to the ANOVA test results in table 6, it was concluded that there is a significant difference between the 21CS proficiency perceptions of elementary school mathematics teacher candidates according to their grade levels (F=3.91, p=.02, p<.05). The Sidak test was used to determine between which class levels the difference was. According to the Sidak test, it is seen that the difference between the 21CS proficiency perceptions of elementary school mathematics teacher candidates according to their grade levels are between the 2nd and 4th grades. When Table 6 is examined, it has been revealed that the average of the 4th graders is higher than that of the 2nd graders. In line with this finding, it can be said that the difference between 21CS proficiency perceptions in terms of grade levels is in favor of 4th graders. In addition, it is seen that elementary school mathematics teacher candidates have high 21CS proficiency perceptions according to their grade levels. In addition, the eta value was calculated in order to determine to what extent the 21CS proficiency perceptions affect the grade level. Eta squared effect value is interpreted as low effect size between .001-.059 or 1%- 5.9%, medium effect size between .06-.137 or 6%-13.7%, and large effect size at .138 and above or 13.8% and above values (Pallant, 2011, p. 210). In this context, it can be said that the grade level variable has a medium effect on the 21CS proficiency perceptions of teacher candidates (η2=.103).

3.5. Findings Related to The Fifth Sub-Problem

The fifth sub-problem of the research is “Is there a significant difference between the 21CS proficiency perceptions of the elementary education mathematics teacher candidates by gender?”. In this context, the analysis result of the independent samples t-test, which was conducted to answer the fifth sub-problem, is presented in Table 7:

Table 7. *T-Test Results on Perceptions of 21st Century Skills Proficiency by Gender*

21st-century skills proficiency perceptions	N	M	SD	df	t	p
Female	52	165.85	17.30	69	.15	.88
Male	19	165.10	19.12			

p>.05

When table 7 is examined, it is seen that the significance value (p=.88) is higher than the significance level (p>.05). In this context, it was concluded that there is no significant difference between the 21CS proficiency perceptions of the elementary school mathematics teacher candidates by gender (t=.15, p=.88, p>.05). When the averages of 21CS proficiency perceptions by gender in table 7 are examined, it is seen that the averages of female (M_{female}=165.85) and male (M_{male}=165.10) are almost equal. These results also support the fact that there is no significant difference between the 21CS proficiency perceptions of elementary school mathematics teacher candidates by gender. In terms of gender, it can be said that the participants' perceptions of 21CS proficiency are high.

3.6. Findings Related to The Sixth Sub-Problem

The results of the ANOVA analysis conducted for the sixth sub-problem to examine the difference between the 21CS proficiency perceptions of the elementary school mathematics teacher candidates according to their grade point averages are presented in Table 8:

Table 8. *ANOVA Test Results on Perceptions of 21st Century Skills Proficiency by GPA*

GPA	N	M	SD	Variance	Sum of Squares	df	Mean Square	F	p
2.51-3.00	10	157.40	17.35	Between Groups	842.08	2	421.04	1.36	.26
3.01-3.50	41	167.63	19.61	Withing Groups	21020.11	68	309.12		
3.51 and above	20	165.70	12.41	Total	21862.20	70			

p>.05

According to table 8, it is seen that the significance value (p=.26) is higher than the significance level (.05). In this respect, it can be said that there is no significant difference between 21CS proficiency perceptions of the elementary school mathematics teacher candidates according to their grade point averages (F=1.36, p=.26, p>.05). In terms of 21CS proficiency perceptions, the highest average ($M_{3.01\text{-}3.50}$=167.63) was found in the participants with “3.01-3.50” average, and participants with “3.51 and above” grade point average were close to the participants with “3.01 -3.50” average ($M_{3.51 \text{ and above}}$=165.70) that can be seen in table 8. In addition, it can be said that the participants' 21CS proficiency perceptions are high according to their grade point averages.

3.7. Findings Related to Examining the Relationship Between Elementary School Mathematics Teacher Candidates' Attitudes Towards STEM Education and Perceptions of 21CS Proficiency

The result of the Pearson correlation analysis conducted to examine the relationship between elementary school mathematics teacher candidates' attitudes towards STEM education and their perceptions of 21CS proficiency is presented below:

Table 9. *Results of Person Correlation Analysis*

		STEM	21CS
STEM	r	1	.11
	p		.36
	n	71	71
21CS	r	.11	1
	p	.36	
	n	71	71

p>.05

According to Table 9, it was determined that there was no significant relationship between the attitudes of elementary school mathematics teacher candidates towards STEM education and their perceptions of 21CS proficiency (r=.11, p=.36, p>.05).

4. Discussion, Conclusion and Suggestions

This study, it was aimed to determine whether there is a significant relationship between teacher candidates' attitudes towards STEM education and their perceptions of 21CS proficiency by examining whether their attitudes towards STEM education and perceptions of 21CS proficiency differ according to grade level, gender, and GPA. In this direction, it was determined that there was no significant difference according to the grade level of elementary school mathematics teacher candidates. In addition, it has been concluded that the mean scores for STEM education are close to each other according to the grade level. This finding is similar to the result of Bircan and Köksal (2020) that there is no difference in STEM education attitudes according to grade level. It was determined that teacher candidates' attitudes towards STEM education were high. Considering the worldwide problems in STEM education (Çepni, 2018), this finding is a very promising finding for the opinion that there is a need for well-educated teachers with a high level of attitude towards STEM education (Yıldırım, 2021). In this context, it can be said that the high level of attitudes of elementary school mathematics teacher candidates towards STEM education is also significant in terms of effective STEM education. It was concluded that there was no significant difference between the attitudes of elementary school mathematics teacher candidates towards STEM education in terms of grade level. The mean scores of teacher candidates for STEM education based on grade level are high with a slight difference, but they are also close to the middle level. When the elementary school mathematics teaching program is examined, it is seen that there is no course for STEM education. In this context, it is thought that there is no difference in the attitude towards STEM education in terms of grade levels, due to the absence of compulsory or elective courses for STEM education in the undergraduate education of teacher candidates. In this context, research can be conducted to determine whether the attitude towards STEM education changes according to grade levels after adding courses for STEM education to the elementary school mathematics teaching program. In addition, in the pre-study interviews with first-grade teacher candidates, it was seen that some teacher candidates did not have any knowledge about STEM education. Within this context, it is thought that courses for the students to have the necessary knowledge, skills, and equipment for STEM education at the undergraduate level should be included in the curriculum.

It was determined that there was no difference in the attitudes of elementary school mathematics teacher candidates towards STEM education in terms of gender. This situation is thought to be due to the opinion that the positive attitude towards STEM education decreases as age increases

in the study conducted by Ceylan, Ermiş, and Yıldız (2018) with secondary school students. The studies of Azgın and Şenler (2019), Sivrikaya-Özkurt (2019), and Kırıktaş and Şahin (2019) support the thinking of Ceylan, Ermiş, and Yıldız (2018). In the study where Azgın and Şenler (2019) examined STEM attitudes towards the 3rd and 4th-grade levels, there was a significant difference in favor of boys according to gender. Özkurt (2019) states that there is no significant difference in STEM attitudes of 9th and 10th-grade students in terms of gender. Similarly, Kırıktaş and Şahin (2019) revealed that there is no gender difference in the attitudes of high school students towards STEM. Considering these situations, the reason why there is no significant difference in the STEM education of elementary school mathematics teacher candidates according to gender may be due to the decrease in their attitudes towards STEM education at later ages. According to the results of Trends in International Mathematics and Science Study (TIMSS) 2019, 66% of the 4th graders participating in the research from Türkiye stated that they liked learning mathematics, while this rate decreased to 29% in the 8th grade (Mullis et al., 2020). In the same report, Türkiye's data while the rate of students who indicated that they were confident in mathematics very much in 4th grade is 34%, this rate drops to 15% in 8th grade, on the other hand, the rate of students who state that they were confident in science at the 4th grade level is 50%, this rate drops to 38% in 8 grades (Mullis et al., 2020). Within the framework of these results, it is thought that the decrease in attitudes towards STEM fields such as mathematics and science at advanced ages leads to the absence of differences in attitudes towards STEM fields in terms of gender. In addition, the conclusion that there is no significant difference in the attitudes towards STEM education according to gender is in line with the studies of Aydın et al. (2017), İçel (2019), Nacaroğlu and Kızkapan (2019). The fact that there is no difference in STEM attitudes by gender reveals that Wells et al. (2007) view that female students' interest in STEM content at the high school level decreases faster than male students is not valid at the university level.

According to the general grade point averages, it was concluded that there was no significant difference in the attitudes of elementary school mathematics teacher candidates towards STEM education. However, when the mean of attitudes towards STEM education is examined, it is seen that those with a high GPA have a higher level of attitude than others. It can be said that this situation supports the idea that students with high academic achievement will also have high STEM attitudes (Nacaroğlu & Kızkapan, 2019). Studies are showing that STEM attitudes of lower-grade students change according to their academic achievements (Bulut, 2020). In addition, STEM education will support their academic development by providing students with the opportunity to gain more permanent and more meaningful learning and to have the opportunity to apply what they have learned (Wicklein & Schell, 1995). Experiencing an increase in success in any of the STEM lessons positively affects other lessons and provides an increase in success in other STEM lessons (Acar et al., 2019). In this context, STEM education also includes the field of mathematics. Students who are academically successful in the field of mathematics are expected to have a high level of attitude towards STEM.

It has been determined that there is a significant difference in 21CS proficiency perceptions according to the grade levels of elementary school mathematics teacher candidates. This finding is that there is no significant difference according to the grade level of the teacher candidates studying in Turkish, Turkish Language and Literature, and Contemporary Turkish Dialects departments of Temiz et al. (2019), and that there is no significant difference according to the grade level of the pre-service teachers studying in the Social Studies Teaching Department of Çiftçi and Bakar (2020). There is no significant difference in 21CS proficiency perceptions according to grade level, and Gökbulut's (2020) study with teacher candidates studying at the faculty of education differs with the results that there is no difference in 21CS proficiency perceptions of pre-service teachers in terms of grade level. It is

thought that the reason for the significant difference between the perceptions of 21CS proficiency between the fourth-grade teacher candidates and the second-grade teacher candidates is the effect of the undergraduate courses taken by the teacher candidates. It can be said that the courses such as "association in mathematics teaching", "communication in mathematics classrooms", "problem-solving in mathematics" and "logical reasoning" taken by the fourth-grade teacher candidates, unlike the second-grade teacher candidates, have a positive effect on the 21CS proficiency perceptions of the pre-service teachers. Because when 21CS is analysed, it is seen that skills such as communication, association, and problem-solving constitute 21CS (P21, 2008). In this context, it is thought that there is a difference in terms of grade level with the effect of undergraduate courses.

It was determined that 21CS proficiency perceptions of elementary school mathematics teacher candidates were highly positive. This finding is in line with previous studies (Çolak, 2019; Gömleksiz et al., 2019; Gökbulut, 2020; Kozikoğlu & Altunova, 2018; Özdemir-Özden et al., 2018). The reason for the high 21CS proficiency perceptions of teacher candidates may be that the departments of education faculties are preferred by students with high scores from the point of view of university entrance, in line with the high demand for education faculties. Considering that the use of learning methods and strategies supports the emergence of 21CS (Haviz et al., 2020), it can be said that teacher candidates have high 21st century skills proficiency perceptions in their training on teaching methods and strategies.

In another case examined in the study, it was concluded that there was no significant difference in the 21CS of elementary school mathematics teacher candidates according to gender and grade point averages. These findings are the case in Gökbulut (2020), Kapaksiz et al. (2019), Kozikoğlu and Altunova (2018) and Özdemir-Özden et al. (2018) coincide with the results that there is no significant difference in terms of gender variables in 21CS, while it differs with the studies of Çiftçi and Bakar (2020) and Bozkurt and Çakır (2016). It is an important finding that the 21CS proficiency perceptions of elementary school mathematics teacher candidates do not change according to gender. Because, in line with the gender equality approach, it is an indication that the education system has the same equality in terms of females and males. In this context, the view that gender equality should be ensured in the realization of education investments (Hanushek, 2008) is supported. It has been concluded that there is no significant difference between the 21CS proficiency perceptions of elementary school mathematics teacher candidates in line with academic achievement. This finding is similar to Özdemir-Özden et al. (2018) studies. However, there are also studies showing that some sub-dimensions of 21st-century skills change according to their academic achievements. These include time management (Britton & Tesser, 1991; Durmaz et al., 2016; Tektaş & Tektaş, 2010), and communication skills (Bingöl & Demir, 2011). Furthermore, it is stated that there is a significant difference according to the academic achievements of the sub-dimensions of 21CS such as critical thinking (Akbıyık & Seferoğlu, 2006).

The relationship between attitudes towards STEM education and perceptions of 21CS competence was also examined in the study. In this context, it was concluded that there is no significant relationship between attitudes towards STEM education and 21CS. While this finding of the study supports the study of Nacaroğlu and Kızkapan (2021), it differs from the opinion of Kan and Murat (2018) that there is a low-level positive relationship between science teacher candidates' perceptions of 21CS proficiency and their attitudes towards STEM. Many studies in the literature suggest that STEM education affects 21CS (Banks & Barlex, 2014; Batdı et al., 2019; Copper & Heaverlo, 2013; Koştur, 2017; Ormancı, 2020; Radu, 2014). However, the reason why no relationship was found between 21CS proficiency perceptions and STEM education in this study may be that elementary

school mathematics teacher candidates do not have more detailed information about how STEM education should be applied rather than what it is.

In general, while teacher candidates have a positive attitude towards STEM education, their development towards the applications of STEM education should be supported (Delen & Uzun, 2018). In this context, after training on how to apply STEM education in learning environments, the relationship between attitudes towards STEM education and 21CS can be examined. First-grade teacher candidates were not included in the study because they did not have enough knowledge about STEM education. In this context, it can be suggested to add STEM education courses to teacher candidate education programs (Kan & Murat, 2018; Nadelson et al., 2012) or to implement integrated STEM education practices in some undergraduate courses. Similarly, undergraduate courses on 21CS and practices can be added to teacher training programs. In line with the views of teacher candidates on STEM education and 21CS, studies that reveal the relationship between STEM education and 21CS in a qualitative framework can be conducted. Research can be conducted in the context of teachers, secondary school, and high school students to examine the relationship between STEM education and 21CS proficiency perceptions.

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Geniş Özet

Giriş

Günümüz dünyasında farklı kültürlerin bir arada yaşama zorunluğu, dünyanın giderek küreselleşen bir şehir statüsünü alması, teknolojide yaşanan gelişim ve ilerleme, doğal afetler, küresel ısınma ve savaşlar gibi birçok problemin bireylerin yaşamlarını etkileyerek onların bu zorluklara karşı uyum sağlamalarını gerekli kılmaktadır (Gürültü vd., 2020). Bu zorluklara karşı çözüm arayışları çerçevesinde eleştirel ve analitik düşünebilen, veri toplayıp araştıran, sorgulama yapabilen ve karar verebilen bireylere ihtiyaç duyulmaktadır (Yamak vd., 2015). Günümüz dünyasına bir başka açıdan bakıldığında bilimin sürekli olarak ilerlemesiyle bilginin hızlı bir şekilde yayılmaya başlaması, bilgiye erişimin daha kolaylaşması, bilgi birikiminin durmaksızın artması bireylerin asıl ihtiyacı olan bilgiye ulaşmasını, bilgiyi anlamlandırarak analiz etmesini, değerlendirmesini ve bu bağlamda sonuçlara yönelik çıkarımlarda bulunmasını önemli hale getirmiştir. Bu durum 21. Yüzyıl çağında yeni kavramlar, beceriler, öğretim yöntem ve yaklaşımların ortaya çıkmasını sağlamıştır. Eleştirel düşünme, problem çözme, temel öğrenme becerileri bilgi ve teknoloji okuryazarlığı gibi kavramları kapsayan 21. Yüzyıl becerileri (Kozikoğlu & Altunova, 2018), fen, teknoloji, mühendislik ve matematik disiplinlerinin birbiriyle ilişkilendirilerek öğretilmesini hedefleyen STEM (FeTeMM) Eğitimi (Çorlu, 2014), okuryazarlık

kavramının temele alan PISA ve büyük verilerin analizi, sistem entegrasyonu, benzetim ve arttırılmış gerçeklik gibi temel bileşenlerin olduğu Endüstri 4.0 (Akgündüz, 2018) kavramları günümüzde sıklıkla tartışılan konuların başında geldiği görülmektedir.

Fen, teknoloji, mühendislik ve matematik disiplinlerinin entegre bir şekilde kullanılması öğrencilerin daha kalıcı ve daha anlamlı öğrenmeler kazanmalarına ve öğrendiklerini uygulama imkânı bulmalarına fırsat sağlayacaktır (Wicklein & Schell, 1995). STEM eğitimi doğrultusunda kendini geliştiren bireylerde eleştirel düşünme, problem çözme, iletişim kurma, üst düzey düşünme, iletişim, özgüven, sosyallik gibi becerileri kapsayan 21. Yüzyıl becerilerine sahip olmaları beklenmektedir (Bybee, 2010). Bir başka deyişle STEM eğitim çerçevesinde gerçek yaşam problemlerine odaklanan öğrencilerin eleştirel ve yaratıcı düşünme, iş birliği yapma, problem çözme ve tasarlama gibi becerileri gelişmektedir (Ceylan vd., 2018). 21. Yüzyılın gerektirdiği beceriler doğrultusunda bireylerin yetiştirilmesinde STEM eğitimi önemli bir paya sahiptir (Akaygün & Aslan-Tutak, 2016; Banks & Barlex, 2014; Koştur, 2017). Bu bağlamda 21. Yüzyıl bilgi ve becerilerine sahip bireylerin yetiştirilebilmesi için STEM eğitimi çerçevesinde gelişmelerin takip edilmesi gerekmektedir (Radu, 2014). 21. Yüzyıl becerilerinin gelişmesini destekleyen STEM eğitimi (Batdı vd., 2019), öğrencilerin disiplinler arası ilişkiler kurarak 21. Yüzyıl becerileri çerçevesinde problemlere yenilikçi çözümler üretmesini amaçlamaktadır (Yıldırım & Gelmez-Burakgazi, 2020). Dolayısıyla STEM uygulamaları bireylerin problem çözme, yaratıcılık ve tasarım gibi 21. Yüzyıl becerileri kazanmaları için önemli bir itici güçtür (Copper & Heaverlo, 2013).

21. Yüzyıl becerileri ve bu becerilerin eğitim sistemine dahil edilmesine yönelik yapılan çalışmalara dünya çapında dikkate değer düzeyde ilgi bulunmaktadır (OECD, 2018). PISA 2022 uygulama çerçevesi incelendiğinde 21. Yüzyıl becerilerinin matematik okuryazarlığı önemli bir çerçeve teşkil ettiği görülmektedir. Matematik okuryazarlığı problemlerin çözümüne yönelik argümanlar sunulması ve bu argümanların savunulmasında eleştirel düşünme, problem çözme ve ilişkilendirme gibi 21. Yüzyıl becerilerinin fırsatlar sağlayacağı düşünülmektedir. Günümüzde eğitim alanında en çok gündemde olan konuların başında gelen matematik okuryazarlığı, 21. Yüzyıl becerileri ve STEM Eğitimi gibi kavramların aralarındaki ilişkinin belirlenmesine yönelik yeterince çalışmanın olmadığı, matematik eğitimi alanında da hem STEM hem de 21. Yüzyıl becerilerine yönelik araştırmaların gerekli olduğu düşüncesi göz önüne alındığına bu doğrultuda gerçekleştirilecek çalışmaların literatüre sunacağı katkı yadsınamazdır. Ayrıca birçok çalışma STEM eğitimi ile 21. Yüzyıl becerileri arasındaki ilişkiye vurgu yapmaktadır (Banks & Barlex, 2014; Batdı vd., 2019; Copper & Heaverlo, 2013; Koştur, 2017; Ormancı, 2020; Radu, 2014). Bu bağlamda gerçekleştirilen araştırmada İlköğretim matematik öğretmen adaylarının STEM (FeTeMM) eğitimine yönelik tutumları ile 21. Yüzyıl becerileri yeterlilik algıları arasındaki ilişkinin belirlenmesi amaçlanmıştır.

Yöntem

Çalışmada nicel araştırma yöntemlerinden iki ya da daha çok değişken arasındaki ilişkinin belirlenmesinde kullanılan ilişkisel tarama modelinden yararlanılmıştır. Bu araştırma modelinde araştırmacılar değişkenler arasındaki ilişkiye odaklanarak iki veya daha fazla değişken arasında oluşan durumlar arasında karşılaştırmaları ortaya koymaktadırlar (Çepni, 2007; Fraenkel & Wallen, 2009). İlişkisel tarama modelinin seçilmesinin başlıca nedeni, çalışmada STEM (FeTeMM) eğitimine yönelik tutumları ile 21. Yüzyıl becerileri yeterlilik algıları arasındaki ilişkinin hangi düzeyde ve yönde olduğunun tespit edilmeye çalışılmasıdır.

Çalışmanın örneklemini 2021-2022 eğitim öğretim yılının güz döneminde Marmara bölgesindeki bir devlet üniversitesinde ikinci, üçüncü ve dördüncü sınıfta öğrenim görmekte olan 71

ilköğretim matematik öğretmen adayı oluşturmaktadır. Çalışmaya birinci sınıf ilköğretim matematik öğretmen adayları dahil edilmemiştir. Bu durumun nedeni ilköğretim matematik öğretmenliği birinci sınıf öğretmen adaylarıyla yapılan görüşmelerde öğretmen adaylarının bazılarının STEM eğitimine yönelik bilgileri ve deneyimlerinin olmadığını belirtmelidir. Uygulamanın gerçekleştirildiği zaman tüm dünya COVİD-19 görülmesi ve pandemi sürecinde olunması sebebiyle örneklemin kolay ulaşılabilirliği göz önüne alınarak örneklemin belirlenmesinde uygun örnekleme yöntemi tercih edilmiştir. Ayrıca araştırma pandemi sürecinde ulaşılabilen, ölçme araçlarının uygulanmasını gönüllü olarak kabul eden öğretmen adayları ile gerçekleştirilmiştir.

Çalışmanın verileri "STEM (Fen-Teknoloji-Mühendislik–Matematik) Eğitimi Tutum Ölçeği" ve "21. Yüzyıl Becerileri Yeterlilik Algıları Ölçeği" olmak üzere iki ölçme aracı ile toplanmıştır. "STEM Eğitimi Tutum Ölçeği", Derin vd. (2017) tarafından gerçekleştirilen uyarlama çalışmasıyla Türkçeye uyarlanmıştır. 20 maddeden oluşan asıl ölçeğe 15 madde daha eklenerek gerçekleştirilen geçerlik ve güvenirlik çalışmaları sonucunda 32 maddelik uyarlama ölçek geliştirilmiştir. "Anlamlılık" ve "Yapılabilirlik" olmak üzere 2 faktörlü yapıya sahip ölçeğin açıkladığı toplam varyans %39,25 olarak hesaplanmıştır. Gerçekleştirilen bu çalışma için STEM eğitimi tutum ölçeğinin Cronbach alfa değeri .72 olarak hesaplanmıştır. Anagün vd. (2016) tarafından geliştirilen "21. Yüzyıl Becerileri Yeterlilik Algıları Ölçeği" 42 maddeden oluşmaktadır. Ölçek P21 tarafından belirlenen beceriler temele alınarak geliştirmiştir. Bu bağlamda ölçek öğrenme ve yenilenme becerileri, yaşam ve kariyer becerileri ve bilgi, medya ve teknoloji becerileri olmak üzere 3 alt boyuttan oluşmaktadır. Ölçeğin açıklanan toplam varyansı %51,30 olarak hesaplanmıştır. Bu çalışma için gerçekleştirilen güvenirlik analizinde ölçeğin Cronbach alpha değeri .94 olarak belirlenmiştir.

Verilerin analizi sürecinde öncelikle veri grubunun normalliği incelenmiştir. Bu bağlamda gerçekleştirilen normallik testleri sonucuna göre sınıf düzeyi açısından "STEM Eğitimi Tutum Ölçeğine" yönelik verilerin normal dağılım göstermediği ($p<.05$), "21. Yüzyıl Becerileri Yeterlilik Algıları Ölçeğinin" ise normal dağılım gösterdiği sonucuna ulaşılmıştır ($p>.05$). Cinsiyet değişkenine göre hem "STEM (Fen-Teknoloji-Mühendislik–Matematik) Eğitimi Tutum Ölçeği" hem de "21. Yüzyıl Becerileri Yeterlilik Algıları Ölçeğine" yönelik veri grubunun normal dağılım gösterdiği görülmüştür ($p<.05$). Genel not ortalamalarına göre ise hem "STEM (Fen-Teknoloji-Mühendislik–Matematik) Eğitimi Tutum Ölçeği" hem de "21. Yüzyıl Becerileri Yeterlilik Algıları Ölçeğine" yönelik veri grubunun normal dağılım gösterdiği belirlenmiştir. Bu sonuçlar doğrultusunda gerçekleştirilen analizler Tablo 2'de sunulmuştur.

Bulgular

Gerçekleştirilen analizlere göre katılımcıların sınıf düzeylerine göre STEM eğitimine yönelik tutumları arasında anlamlı farklılığın olmadığı belirlenmiştir ($X^2=.74$, $p=.69$, $p>.05$). Sınıf düzeylerine göre katılımcıların sıra ortalamaları incelendiğinde en yüksek ortalamanın 3. sınıf düzeyinde olduğu en düşük ortalamanın ise 2. sınıf düzeyinde olduğu belirlenmiştir. Fakat bu farklılıkların Kruskall Wallis-H testi analizi sonucuna göre istatistiksel olarak anlamlı olmadığı söylenebilir. İlköğretim Matematik Öğretmen Adaylarının cinsiyete göre STEM eğitimine yönelik tutumları arasında anlamlı farklılığın olmadığı söylenebilir ($t=.56$, $p=.58$, $p>.05$). Ayrıca cinsiyete göre katılımcıların STEM eğitimine yönelik tutumlarının yüksek düzeyde olduğu söylenebilir. Tablo 5'e göre ilköğretim matematik öğretmen adaylarının genel not ortalamalarına göre STEM eğitimine yönelik tutumları arasında anlamlı farklılığın olmadığı sonucuna ulaşılmıştır ($F=2.73$ $p=.07$, $p>.05$). Bu bağlamda genel not ortalamalarının STEM eğitimine yönelik tutumlar için anlamlı bir etkisinin olmadığı söylenebilir.

Tablo 6'ya göre ilköğretim matematik öğretmen adaylarının sınıf düzeylerine göre 21. Yüzyıl becerileri yeterlilik algıları arasında anlamlı farklılığın olduğu sonucuna ulaşılmıştır ($F=3.91$, $p=.02$,

p<.05). Farklılığın hangi sınıf düzeyleri arasında olduğunun belirlenmesinde Sidak testinden yararlanılmıştır. Sidak testine göre ilköğretim matematik öğretmen adaylarının sınıf düzeylerine göre 21. Yüzyıl becerileri yeterlilik algıları arasındaki farklılığının 2. sınıflarla 4. sınıflar arasında olduğu görülmektedir. Tablo 6 incelendiğinde 4. sınıfların ortalaması 2. sınıflardan daha fazla olduğu ortaya konulmuştur. Bu bulgu doğrultusunda sınıf düzeyleri açısından 21. Yüzyıl becerileri yeterlilik algıları arasındaki farklılığın 4. sınıflar lehine olduğu söylenebilir. Tablo 7 incelendiğinde anlamlılık değeri (p=.88) anlamlılık düzeyinden yüksek olduğu görülmektedir (p>.05). Bu bağlamda ilköğretim matematik öğretmen adaylarının cinsiyete göre 21. Yüzyıl becerileri yeterlilik algıları arasında anlamlı farklılığın olmadığı sonucuna ulaşılmıştır. İlköğretim Matematik Öğretmen Adaylarının genel not ortalamalarına göre 21. Yüzyıl becerileri yeterlilik algıları arasında anlamlı farklılığın incelenmesi gerçekleştirmiştir. Elde edilen bulgulara göre ilköğretim matematik öğretmen adaylarının genel not ortalamalarına göre 21. Yüzyıl becerileri yeterlilik algıları arasında anlamlı farklılığın olmadığı sonucuna ulaşılmıştır (F=1.36, p=.26, p>.05). Tablo 9'a göre ilköğretim matematik öğretmen adaylarının STEM (FeTeMM) eğitimine yönelik tutumları ile 21. Yüzyıl becerileri yeterlilik algıları arasında anlamlı düzeyde bir ilişkinin olmadığı belirlenmiştir (r=.11, p=.36, p>.05).

Tartışma, Sonuç ve Öneriler

Bu çalışmada ilköğretim matematik öğretmen adaylarının STEM eğitimine yönelik tutumları ve 21. Yüzyıl becerileri yeterlilik algılarının sınıf düzeyi, cinsiyet ve genel not ortalamalarına göre farklılık gösterip göstermediğini inceleyerek öğretmen adaylarının STEM eğitimine yönelik tutumları ile 21. Yüzyıl becerileri yeterlilik algıları arasında anlamlı ilişkinin olup olmadığının belirlenmesi amaçlanmıştır. Bu doğrultuda öncelikle ilköğretim matematik öğretmen adaylarının sınıf düzeyine göre anlamlı farklılığın olmadığı belirlenmiştir. Ayrıca sınıf düzeyine göre STEM eğitimine yönelik puan ortalamalarında birbirine yakın değerde olduğu sonucuna ulaşılmıştır. Bu bulgu Bircan ve Köksal'ın (2020) STEM eğitimi tutumlarının sınıf düzeyine göre farklılığın olmadığı sonucuyla benzerlik göstermektedir. STEM eğitimine yönelik dünya çapında yaşanan sorunlar göz önüne alındığında (Çepni, 2018) STEM eğitimine yönelik yüksek düzeyde tutuma sahip ve iyi eğitim almış öğretmenlere ihtiyaç vardır (Yıldırım, 2021). Bu bağlamda ilköğretim matematik öğretmen adaylarının STEM eğitimine yönelik yüksek düzeyde tutuma sahip olmaları etkili STEM eğitimleri açısından önemli görülmektedir.

21. Yüzyıl becerileri yeterlilik algılarına yönelik gerçekleştirilen analizler doğrultusunda ilköğretim matematik öğretmen adaylarının sınıf düzeylerine göre anlamlı farklılığın olduğu belirlenmiştir. Elde edilen bu bulgu Gömleksiz vd. (2019) Türkçe, Türk Dili ve Edebiyatı ile Çağdaş Türk Lehçeleri bölümlerinde öğrenim gören öğretmen adaylarının sınıf düzeyine göre anlamlı farklılığın olmadığı, Çiftçi ve Bakar'ın (2020) sosyal bilgiler öğretmenliği bölümünde öğrenim gören öğretmen adaylarının 21. Yüzyıl yeterlilik algılarında sınıf düzeyine göre anlamlı farklılığın olmadığı, Gökbulut'un (2020) eğitim fakültesinde öğrenim gören öğretmen adayları ile gerçekleştirdiği çalışmada sınıf düzeyi açısından öğretmen adaylarının 21. Yüzyıl yeterlilik algılarında farklılığın olmadığı sonuçlarıyla farklılık göstermektedir.

Araştırmada STEM eğitimine yönelik tutum ile 21. Yüzyıl becerileri yeterlilik algıları arasındaki ilişki de incelenmiştir. Bu bağlamda STEM eğitimine yönelik tutum ile 21. Yüzyıl becerileri arasında anlamlı bir ilişkinin olmadığı sonucuna ulaşılmıştır. Araştırmanın bu bulgusu Nacaroğlu ve Kızkapan'ın (2021) çalışmasını destekler nitelikteyken Kan ve Murat'ın (2018) fen bilgisi öğretmen adaylarının 21. Yüzyıl becerileri yeterlilik algılarıyla STEM'e yönelik tutumları arasında düşük düzeyde pozitif yönde bir ilişki olduğu görüşüyle farklılık göstermektedir. Literatürde yer alan birçok çalışma STEM eğitiminin 21. Yüzyıl becerilerini etkilediği yönde görüş ortaya koymaktadır (Banks & Barlex, 2014; Batdı vd., 2021;

Copper & Heaverlo, 2013; Koştur, 2017; Ormancı, 2020; Radu, 2014). Fakat gerçekleştirilen bu çalışmada 21. Yüzyıl becerileri yeterlilik algıları ile STEM eğitimi arasında bir ilişki bulunamamasının nedeni ilköğretim matematik öğretmen adaylarının STEM eğitiminin ne olduğundan ziyade nasıl uygulanacağına yönelik daha detaylı bilgiye sahip olmamaları olabilir.

Genel olarak öğretmen adayları STEM eğitimine yönelik olumlu tutuma sahip iken STEM eğitiminin uygulamalarına yönelik gelişimlerinin desteklenmesi gerekmektedir (Delen & Uzun, 2018). Bu bağlamda STEM eğitiminin öğrenme ortamlarında nasıl uygulanacağına yönelik eğitimler gerçekleştirildikten sonra STEM eğitimine yönelik tutum ile 21. Yüzyıl becerileri arasındaki ilişki incelenebilir. Çalışmaya birinci sınıf düzeyindeki öğretmen adaylarının STEM eğitimine yönelik yeterince bilgi sahibi olmamalarından dolayı dahil edilememiştir. Bu bağlamda da hizmet öncesi öğretmen eğitimi programlarına STEM eğitimine yönelik derslerde eklenmesi (Nadelson vd., 2012; Kan & Murat, 2018) veya bazı lisans derslerinde entegre STEM eğitimine yönelik uygulamaların gerçekleştirilmesi önerilebilir.

Yayın Etiği Beyanı

Bu araştırmanın, Balıkesir Üniversitesi Fen ve Mühendislik Bilimleri Etik Komisyonu tarafından 14.01.2022 tarihinde E-19928322-302.08.01-107756 sayılı kararıyla verilen etik kurul izni bulunmaktadır. Bu araştırmanın planlanmasından, uygulanmasına, verilerin toplanmasından verilerin analizine kadar olan tüm süreçte "Yükseköğretim Kurumları Bilimsel Araştırma ve Yayın Etiği Yönergesi" kapsamında uyulması belirtilen tüm kurallara uyulmuştur. Yönergenin ikinci bölümü olan "Bilimsel Araştırma ve Yayın Etiğine Aykırı Eylemler" başlığı altında belirtilen eylemlerden hiçbiri gerçekleştirilmemiştir. Bu araştırmanın yazım sürecinde bilimsel, etik ve alıntı kurallarına uyulmuş; toplanan veriler üzerinde herhangi bir tahrifat yapılmamıştır. Bu çalışma herhangi başka bir akademik yayın ortamına değerlendirme için gönderilmemiştir

Çatışma Beyanı

Makalenin herhangi bir aşamasında maddi veya manevi çıkar sağlanmamıştır. Araştırmanın yazarı olarak herhangi bir çıkar/çatışma beyanım olmadığını ifade ederim.