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ROAD SAFETY EDUCATION IN MOROCCAN PRIMARY SCHOOLS: A SITUATIONAL ANALYSIS

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ABSTRACT

To help reduce the number of road injuries and fatalities, several road safety education activities are organized by schools. However, their effectiveness has not been researched sufficiently at the national level. The aim of this work was therefore to assess the circumstances in which these activities are organized and to determine the extent to which they contribute to the development of students' knowledge of road safety. Data collection was carried out through a questionnaire that was delivered to the directors of 105 schools in the Daraa-Tafilalet Regional Academy. The "pre-test/post-test" method was used to study the impact of a road safety education activity on students' knowledge. The results of this study reveal that schools are limited to commemorating national safe driving day. School directors ensure the participation of all students and the involvement of actors such as national security and the royal gendarmerie. As for civil society associations, their involvement remains insufficient. The training of educational actors in the conduct of road safety workshops, the involvement of parents and the adoption of interactive strategies centered on the pupil are means likely to develop pupils' knowledge and behavior.

Keywords: Education, Road safety, Morocco.

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INTRODUCTION

Today, human civilization has made great progress thanks to inventions and innovations in the various fields of life. In the transport sector, for example, several adequate means have been manufactured to facilitate easy and fast travel. However, the increase in the number of road users has led to an increase in traffic accidents, both in number and severity. In addition to the enormous material damage, road accidents killed 1.35 million people and injured tens of millions worldwide in 2016 (WHO, 2018). Since its sixty-second session, the United Nations has regarded road traffic accidents as a global crisis. Halving the number of road traffic deaths is one of the sustainable development goals set by this international organization.

According to the directorate of transport and road Safety (2017), traffic accidents cause more than 3,500 deaths and 12,000 serious injuries annually in Morocco. Statistical data show that 6.11% of deaths are children under 14 year olds. Increased efforts by all actors involved are needed to design new and effective policies to make our roads safer. It is in this spirit that the kingdom has put in place a national road safety strategy 2017-2026 to combat traffic accidents in all their forms. The objective is to reduce by half the number of deaths caused by traffic by 2026.

Measures to reduce road accidents, both their frequency and severity, have focused on three areas: modifying human behaviour, improving road infrastructure, and improving vehicle safety (Wegman, 2017). Educating primary school children about road safety is a practice recommended by several experts (Hamilton et al., 2005; Wegman, 2017).

Aware of the importance of this subject, the Moroccan Ministry of Education has adopted an educational and participatory approach based on two axes:

- Integration of road safety education concepts into curricula and carrier subjects.

- School life activities based on a participatory approach by all partners.

As part of the implementation of the 2011-2013 integrated strategic emergency plan, thematic pamphlets for students, a reference guide for educational frameworks and a guide to commemorate National Road Safety Day have been prepared.

Moroccan schools are involved in road safety education through multiple activities. However, the effectiveness of these activities is not assessed. The objective of this study is to determine the extent to which these activities contribute to improving students' knowledge of road safety.

METHOD

In order to study the road safety education activities organized by schools, we conducted a questionnaire survey among 105 school directors at the regional academy of education and training of Daraa -Tafilalet in 2017. This tool consists of 32 questions about the activities organised in each school. In order to study the impact of road safety education activities on learners' knowledge of this subject, we proceeded as follows:

- Pre-test: Prior to the intervention, a pre-test was administered to 30 sixth grade of the primary cycle to determine their prior knowledge of road safety.

- Intervention: A road safety education activity was conducted using a video for the benefit of those students (Table 1).

- Post-test: after the activity, a second test was administered to the students in order to check the evolution of their knowledge.

Statistical processing of the data was carried out using the student t-test to compare student averages at the pre-test and post-test levels.

Table 1. Description of the road safety education activity organised for the students.

Support used	Content	Beneficiaries
Awareness Video	- Consequences of road accidents ; - Meaning of signs and signals; - How to cross a road? - Road safety rules for cycling users - Safety rules for bus and coach passengers (school transport).	30 sixth-grade students

FINDINGS

Our results show that the majority of schools organise only one road safety education activity per year (Table 2). This is the commemoration of national road safety day, which coincides annually with February 18. Very few schools (2.85%) organise more than two out-of-town events. The main reason for this organization is the implementation of official instructions (82.22%) as shown in Figure 1. Rarely do schools take the initiative. The directors explain this by the time constraints and the curriculum load.

Table 2. Number of road safety education activities organized by schools during the school years 2015/2016 and 2016/2017.

Number of activities	0	1	2	3	4 or more
School year 2015/2016	17,14%	58,1%	21%	2,85%	0
School year 2016/2017	14,28%	65,714%	17,14%	2,85%	0

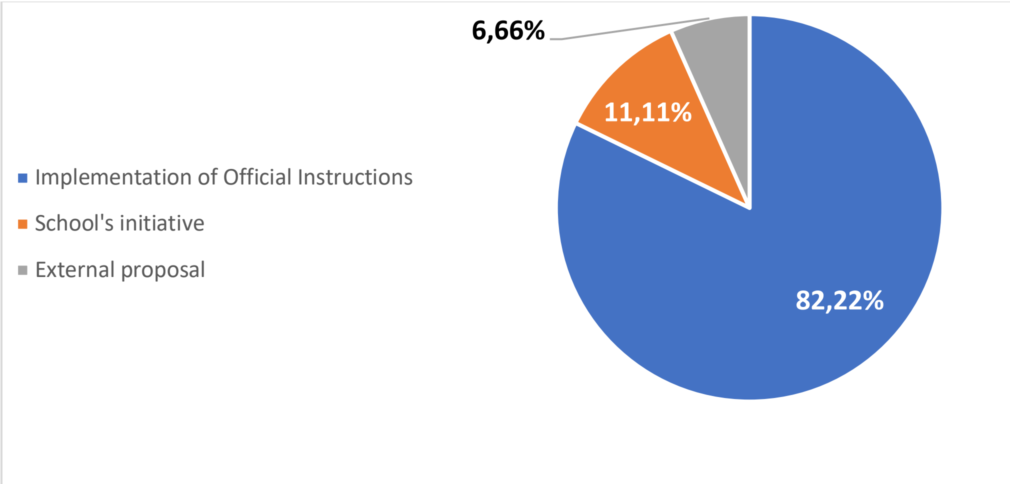

Figure 1. Reasons for the organisation of road safety education activities by schools

A single road safety education activity is not enough for children to acquire the knowledge necessary to road safely. Teachers and school directors need to be persuaded about the important role they can play in this regard. The supervisory ministry is also called upon to train teachers in this area. Elkington et al. (2000) recommend that road safety education should be delivered by teachers who have been trained. This recommendation is confirmed by Dragutinovic et al. (2006) and Elliott (2000), who cited the professional development and support of teachers as a fundamental principle of road safety education. This education is one of the most important ways for children to become more aware of road hazards and behave appropriately as pedestrians, cyclists or passengers (Ben-Bassat et al., 2016). Although increasing children's knowledge of road safety does not necessarily mean improving children's behavior in real-life situations (Zeedyk et al., 2001), it is at least necessary that they have a clear understanding of the basic rules of road safety (Eshaghabadi et al., 2016). The establishment of road safety clubs at school level is required.

Concerning the beneficiaries of road safety education activities, most schools (49.52%) ensure the participation of all students (Figure 2). However, other schools choose students from certain classrooms (32.38%) or a few students from different classrooms (12.38%). The Criteria for selecting beneficiaries are mainly the representativeness of all school levels (38.46%) and all classrooms (30.77%). To these two criteria must be added the willingness and age of the student, but with low rates (Figure 3).

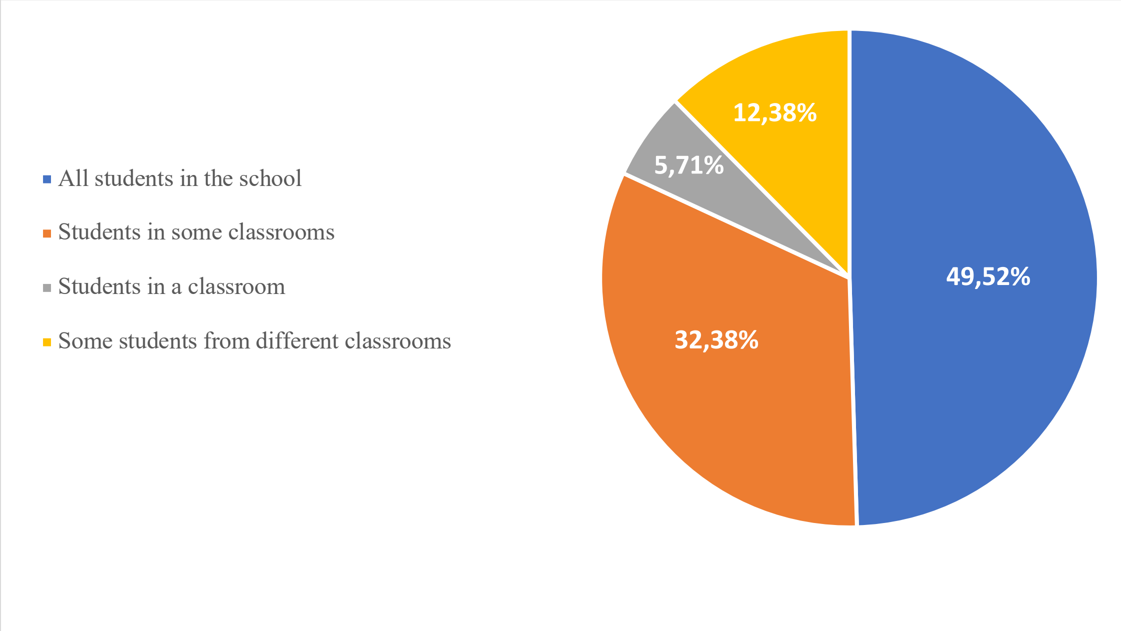

Figure 2. Beneficiaries of road safety education activities organised in 2016/2017

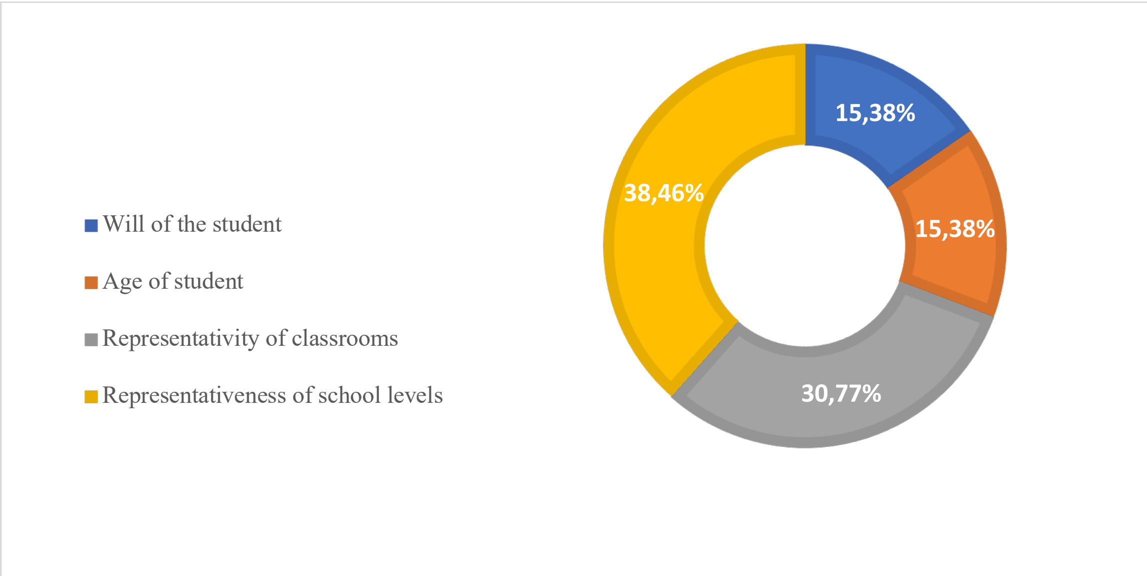

Figure 3. Criteria for selecting the beneficiaries of road safety education activities organised in schools

We find that most schools prefer the representation of different classes and levels to road safety education activities. Similarly, Dragutinovic et al. (2006) point out those children should start learning about road safety at the age of 4 or 5. Booth et al. (1997) also support curricula that should be delivered regularly throughout a child's schooling to reinforce existing concepts and introduce new skills as children develop. The Walksafe program consisted of daily half-hour sessions including classroom instruction and video (Days 1 and 3), outdoor stimulation (Days 2 and 4) and a poster contest (Day 5), during Walksafe week (Hotz et al, 2004). This program demonstrated the evolution of pedestrian safety knowledge among students in Kindergarten to Grade 5.

The schools involve their partners in road safety education activities, especially the national safety authority and the Royal Gendarmerie (Figure 4). The participation of civil protection and civil society associations in these events remains low. Schools should engage the students' families through parents' associations (Booth et al., 1997). Indeed, there is also a wealth of data on road safety that supports this point by recommending that parents should be involved in educating their children in this area (Rothengatter, 1984). Parents are in the best position to provide effective practice on the road (Thomson et al., 1998) and support learning in the classroom. A study by Stevens, Olson, Gaffney, Tosteson et al. (2002) found that educating parents at home is an effective way to increase the use of bicycle helmets by adolescents.

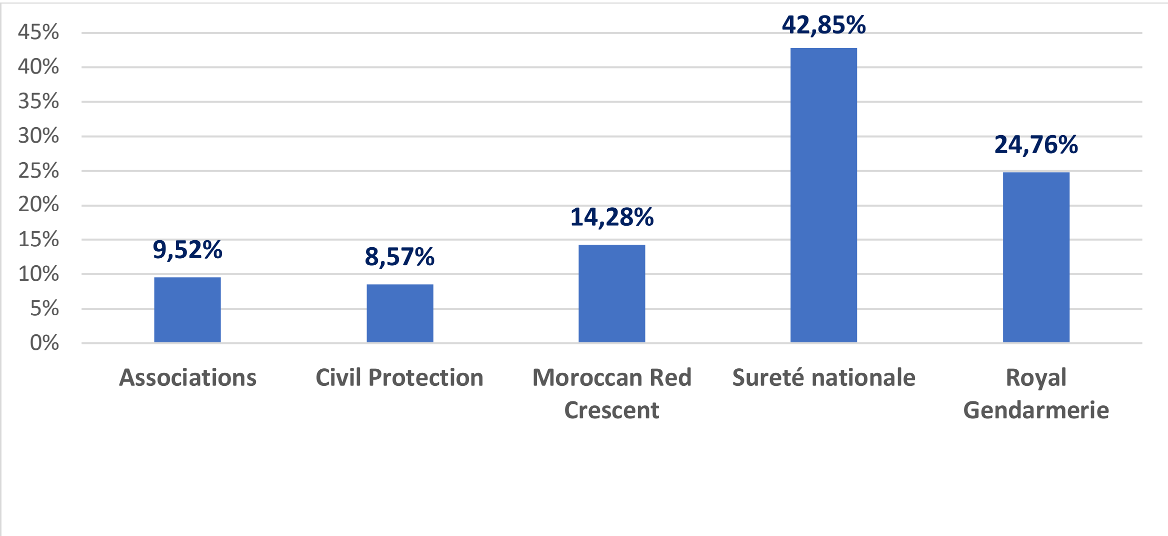

Figure 4. School partners in the organisation of road safety education activities

Comparison of student pre-test and post-test averages (Table 3) reveals that the intervention has led to changes in students' knowledge of road safety. In a similar study, Thomson et al. (1998) reported that after road safety education, five-year-olds improved their perception of the safest places to cross the road. Learning through video allows for better assimilation and understanding compared to traditional learning methods. This medium offers both the possibility of repetition and the greatest attractiveness. This finding is in accordance with the results of Bruce and McGrath (2005), who reported that interactive strategies give good results.

Similarly, Hotz et al. (2004) used interactive strategies, including videos, in their study showing an improvement in pedestrian safety knowledge among students in Kindergarten to Grade 5. Putting students in real traffic situations is important. Indeed, Elkington and Hunter (2003) recommend that skills development should be at the focus of road safety education, and that these skills should be better developed during road practice.

Table 3. Comparison of pre-test and post-test student averages.

Test	Number of students	Average	Standard deviation	t value	Significance value	Significance level
Pre-Test	30	5.3	1.25	8.21	0.000	Significant difference at 0.001
Post- test		8.26	1.74			

CONCLUSION

The results of this study reveal that the majority of schools limit themselves to only one road safety education activity per year as part of the commemoration of National Road Safety Day. Initiatives by schools in this regard remain limited. The directors are aware of the importance of these activities and ensure the participation of all students. They also ensure the involvement of other actors such as the national security forces and the Royal Gendarmerie. While the commitment of civil society associations remains insufficient. The results of this work also show that road safety education activities, using interactive tools, allow the progression of students' knowledge on this subject.

RECOMMENDATIONS

In order for schools to play a greater role in road safety education, we have made the following recommendations:

- Training of educational actors in the effective running of this activity.

- Establishment of road safety education clubs in all schools to ensure the regular organisation of activities.

- Involvement of parents' associations to support learning at school.

- Adoption of interactive and student-centred strategies to develop students' road safety knowledge and behavior.

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DETERMINING THE STUDENTS' ATTITUDES TOWARDS STEM: E-TWINNING PROJECT FROM STEM CLUB TO STEM SCHOOL

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ABSTRACT

In the research, the attitudes of the participants studying at primary school level towards STEM education approach were examined. e-Twinning project was created from "STEM club to STEM school" to integrate STEM education approach into the program. The aim of our project is to make students do STEM activities and increase their interest in STEM fields. The aim of this research is to determine the STEM attitudes of the students who are doing the e Twinning project on STEM. It was used in the screening model from quantitative research methods in the research. STEM primary school attitude Survey was used as a data collection tool in the research. The sample of the research consists of 215 students attending the 3rd and 4th grades in the project. In the research, the data were collected with STEM primary school attitude scale consisting of 37 substance sub-dimesons developed by Faber, Wiebe, Corn, Townsend and Collins (2013) and adapted to Turkish by Özyurt, Kusdemir and Başaran (2018) for primary schools. Analyzed with SPSS 21 Program. The confidence of the scores obtained from the scale was found to be 0.95. In the research, it was reached that students' attitudes regarding STEM education were high. According to the findings of the research, it was determined that the attitudes of the students who went to the science center in STEM e Twinning project were more positive than the students who did not go. It was determined that STEM attitudes were more positive for students who experimented outside the lesson than students who did not. It can be said that students who experiment outside the lesson develop a more positive attitude in science, engineering – technology and 21st century skills than students who do not conduct extra-lesson experiments. Students who used interactive boards in the lesson were found to have a more positive attitude in science and 21st century skills in their sub-dimensions than students who did not use interactive boards in the lesson. A positive correlation was found between science, technology, engineering and mathematics and STEM, which are the sub-dimensions of STEM.

Keywords: STEM, Attitude, e Twinning, Primary School.

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INTRODUCTION

New situations such as the change of expectations for schools, the new generation student profile and the reflections of technological developments on education have necessitated the development of new models in the field of education (Sağsöz, 2019). Advances in technology is pushing to change the education system in Turkey. One of the training models that meets the requirements of our time is the STEM education model (Yıldırım, 2016). STEM consists of the initials of the words Science, Technology, Engineering and Mathematics. (Gonzalez, & Kuenzi, 2012). The concept of STEM was first put forward by Judith Rahmaley in the world in 2001 (White, 2014) but is based on the early 19th century (Ostler, 2012: 55). STEM education can be considered as an approach where different disciplines are used together, allowing students to specialize in different fields, directing individuals to research and question (Akgündüz et al., 2015; Yıldırım, 2016). With STEM education, students will discover their own skills and gain an entrepreneurial and producing identity (Katz, 2010; Lindeman, Jabot & Berkley, 2014). They will have education in accordance with the 2030 sustainable development goals (Avan, Yılmaz, & Doğanay, 2019; Soylu, 2016). STEM education is an approach that can meet the human resources needed by the state economy (Kılıç & Ertekin, 2017).

STEM education can be defined as an interdisciplinary approach that includes a wide educational life from preschool to higher education (MoNE, 2016: 12). This educational model is an important element in developing interdisciplinary integration in accordance with 21st century skills (Roberts, 2012; Sarıpınarlı, 2018). Individuals who are raised in accordance with 21st century skills and countries that organized schools in accordance with 21st century skills adapt to this age by progressing in science and technology (Öztürk, 2020; Akgündüz et al., 2015).

In order to provide STEM education correctly, the learning teaching process needs to be planned correctly. There are many learning model methods and techniques used to fully transfer STEM education to students. These are mastery learning, 5E model and project-based learning (Gülen and Yaman, 2018). The most preferred STEM education model is the 5E model (Gülen & Yaman, 2018).

In STEM education, as in constructivist education, it is aimed to give students the skills of critical thinking, creativity, collaboration, and solving daily life problems, which are shown as 21st century skills. When the 5E learning model is applied in STEM education, the student concentrates the attention of the lesson, researches the information, groups it and uses what they learn in solving different situations (Bybee, 2009; Güven, Selvi, & Similar, 2018; Donkoh, Osei & Kofi-Annan 2021). The 5E learning model consists of Engage, Explore Explain, Elaborate and Evaluate stages (Güven et al., 2018; Donkoh et al., 2021).

Today, it is important for countries to use STEM to improve their economies. With the developments in science, technology, engineering and mathematics, the technologies of the countries are also developing. With these technological innovations, the economies of the countries are rising. Technically leading countries in the world are the most powerful countries in the world. Therefore, STEM education helps develop the economies and technologies of countries (Yildirim, 2016). The great promises of STEM education encouraged the spread of the idea to many other countries. One of these countries is Turkey (Soylu, 2016; Akgündüz et al., 2015).

In recent years, it has been working to integrate STEM practices into courses in private schools and public schools (Soylu, 2016). Various studies have been carried out in STEM field by the Ministry of National Education (since 2019). For example, they prepared a research called "Gain Based STEM Applications" by the General Directorate of Private Education Institutions and presented it to teachers. Many in-service trainings have been organized and tried to address the need in this field. In the reports on innovative practices in the field of education in Turkey, it is stated that we should improve STEM education. By attaching importance to STEM issues in Turkey, calls are made to develop the individuals that the business world wants (Ebony, 2020).

When the literature in the field of STEM is examined, it is understood that there are many studies for students studying in different types of schools (Abanoz, 2020; Bozdoğan & Yalçın, 2006; Damar, Durmaz & Önder, 2018; Demiral & Özacar, 2018; Güneş, Şener, Gonzalez, & Kuenzi, 2012, Topal-Germi, & Can, 2013; Katz, 2010; Keskin, Karagölge and Ceyhun, 2019; Öztürk, 2020; Lindeman et al, 2014; Şahin, Ayar and Adıgüzel 2014; Yıldırım, 2016; Yıldırım and Selvi, 2018; Yıldırım and Altun, 2015).

eTwinning project was created from "STEM club to STEM school" to integrate STEM education approach into the education program. eTwinning (partner school network) is a platform for inter-school collaboration platform supported by the European Union.

The aim of this research is to examine the primary school students' attitudes with STEM plans for STEM education in terms of various variables. These variables are going to the science center, doing experiments in the classroom, doing experiments outside of the lesson, using the laboratory in the lesson, using a tablet in the lesson, using an interactive board in the lesson, being interested in the project homework, participating in the project competition, and getting information from the STEM specialist. With this research, primary school students' attitudes with STEM will be determined and STEM activities suitable for primary school students can be planned.

METHOD

It was used in the survey model from quantitative research methods in the research. The survey model is a model that aims to describes the situation that has happened before or is still ongoing as it exists (Karasar, 2015). The aim of this research is to determine the STEM attitudes of the students who have been in the STEM e Twinning project. The students who took part in the study carried out studies in stem project one Twinning portal for 6 months. The attitudes of the students regarding STEM activities during this period were tried to be revealed with a quantitative understanding. STEM primary school attitude scale was applied to students. The collected data of the students were translated into findings and interpreted. Surveys were applied to students by classroom teachers in their classrooms.

Sample

The research group of the research consists of 215 students attending 3rd and 4th grade who participated in the Twinning project from "STEM Club to STEM School". Students participated in the STEM Club to STEM School project in September 2019-2020 academic year. Many STEM activities were carried out in the project. Participating students are students who are involved in the STEM project from different schools. The research was conducted in November of the 2019 -2020 academic year.

Data Collection Tool

Developed by Faber, Wiebe, Corn, Townsend, and Collins (2013), Primary / Secondary School Students' Attitude Towards STEM scale adapted to Turkish by Özyurt et al. (2018) was applied. The scale was applied to primary schools in Gaziantep province in the 2016-2017 academic year. The scale has been found to be applicable to primary schools. The questions in the findings section of the research (Science Center etc.) are the questions in the original of the scale. Since these 8 questions were in the questionnaire, they were asked to the students. The scale consists of 4 sub-dimensions, 5-point Likert type 37 items. It consists of STEM attitudes on scale and sub-dimensions of science, mathematics, technology-engineering and 21st century skills. The measurement tool was scored with a sequential 5-point Likert-type scale such as I do not agree (1), I strongly agree (5).

Practice Process

The project was implemented in classrooms for 6 months. Project partner teachers prepared STEM activities. STEM activities were held with students in the classroom. Since it was thought that it would be more meaningful for students to understand the questionnaire questions and answer the questionnaire themselves, it was administered to 3rd and 4th grade students. Participants filled in the questionnaires online in classrooms under the supervision of their teachers.

Data Analysis

Data analyzed with SPSS 21 Program. The reliability alpha score obtained from the scale was found to be 0.95. In this research, students' attitudes to STEM and sub-dimensions were examined. Substances of scale were examined in 5 topics: STEM, science, engineering, technology, 21st century skills and mathematics sub-dimensions. Arithmetic mean, standard deviation analyses of STEM and its sub-dimensions were carried out. T-test was performed for STEM and its sub-dimensions. For each item "Strongly Disagree (1), Disagree (2), Undecided (3), Agree (4), Strongly Agree (5). STEM attitudes of the students were accepted as the average between 1.00 - 2.33 "low", the average between 2.34 - 3.66 as "medium", and the average between 3.67 and 5.00 as "high" and interpreted accordingly. Correlation analysis was performed to determine which sub-size of STEM is the relationship with STEM.

Frequency was used to determine students' attitudes and sub-dimensions. Correlation test (Pearson moments product correlation coefficient) was used to detect the relationship between sub-dimensions. The level of meaningfulness in the research was taken as p<0.01 and p<0.05. The research findings were analyzed by sub-sections and converted into tables.

FINDINGS

STEM education and sub-dimensions of the students in primary schools were examined. STEM attitude scale is discussed in four sub-dimensions: science, mathematics, engineering, technology and 21st century skills. STEM attitudes and sub-dimensions were examined.

Table 1. Average and standard deviation values for STEM and sub-dimensions of primary schools

Dimensions	N	X	SD
Science	215	4.09	.67
Engineering - Technology	215	4.09	.69
21st Century Skills	215	4.21	.61
Mathematics	215	4.13	.69
STEM	215	4.13	.56

Primary school students had high attitudes to the science sub-dimension (X=4.09), high attitudes to the lower dimension of mathematics (X =4.09), high attitudes to 21st century skills (X=4.21), high attitudes to mathematics (X=4.13) and high attitudes to STEM (X =4.13). It can be said that primary school students have a high attitude towards STEM.

Findings of the Variable to Go to the Science Center

The results of the t-test for independent samples made in order to find out whether there is a difference in the attitudes of primary school students towards STEM and its sub-dimensions in terms of going to the science center variable are shown in Table 2.

Table 2. Findings on the variable to go to the science center

	Going to the science center	**N**	**X**	**S**	**sd**	**t**	**p**
Science	Yes	85	4,16	.73	215	1.24	.21
	No	130	4,05	.63			
Engineering - Technology	Yes	85	4,20	.74	215	1.98	.04*
	No	130	4,01	.66			
21st century. Skills	Yes	85	4,28	.62	215	1.21	.42
	No	130	4,17	.62			
Maths	Yes	85	4,19	.69	215	1.04	.12
	No	130	4,09	.71			
STEM	Yes	85	3.75	.60	215	1.66	.69
	No	130	3.73	.53			

When we looked at Table 2, it was found that there was no significant difference between students who went to the science center and those who did not go and STEM attitude [$t_{(213)}$=1.66, p>0.05]. When we looked at the sub-dimensions of STEM, there was a significant difference with the Engineering-Technology sub-field between those who went to the science center and those who did not go [$t_{(223)}$=1.98, p<0.05]. According to this finding, it can be said that students who go to the science center have a more positive attitude towards engineering, technology than students who do not go to the science center. There was no significant difference between other sub-dimensions and going to the science center.

Findings on the Variable for Experimenting in the Lesson

The results of the t-test for independent samples conducted to find out whether there is a difference in the attitudes of primary school students towards STEM and its sub-dimensions in terms of the experiment in lesson variable are shown in Table 3.

Table 3. Findings on the variable of experimentation in the lesson

	Experimenting in class	N	X	S	SD	t	p
Science	Yes	189	4,10	.66	215	.50	.62
	No	26	4,03	.81			
Engineering - Technology	Yes	189	4,13	.69	215	1.56	.12
	No	26	3,89	.71			
21st century. Skills	Yes	189	4,23	.61	215	1.02	.30
	No	26	4,20	.69			
Maths	Yes	189	4,16	.68	215	1.59	.11
	No	26	3,93	.82			
STEM	Yes	189	4,15	.55	215	1.42	.16
	No	26	3,97	.62			

When we look Table 3, there was no significant difference between students who experimented and students who did not experiment in the lesson and STEM attitude [$t_{(213)}$=1.42, p>0.05]. No significant difference was found between the sub-dimensions of STEM, science, engineering - technology, mathematics and 21st century skills, and the students who experimented in the lesson and did not. It can be said that experimenting in the lesson does not affect students' STEM attitudes.

Findings on the Variable for Experimenting Outside the Lesson

T-test results are shown in Table 4 for independent samples to find out if primary school students' attitudes toward STEM and their sub-dimensions differ in the variable of experimenting outside the lesson.

Table 4. Findings on the variable of experimentation outside the lesson

	Experimenting outside of class	N	X	S	sd	t	p
Science	Yes	143	4,18	.66	215	2.65	.01*
	No	72	3,92	.67			
Engineering - Technology	Yes	143	4,22	.69	215	3.98	.00*
	No	72	3,83	.63			
21st century. Skills	Yes	143	4,30	.64	215	2.97	.00*
	No	72	4,04	.55			
Maths	Yes	143	4,16	.69	215	.72	.48
	No	72	4,08	.72			
STEM	Yes	143	4,21	.56			
	No	72	3,97	.51	215	3.09	.00*

When we look Table 4, a significant difference was found between the STEM attitude of the students who did and did not experiment outside the lesson [t (213) = 3.09, p <0.05]. It can be said that students who do experiments outside of the classroom have a more positive attitude towards STEM than students who do not do it. When the sub-dimensions are examined, the students who do experiments outside the lesson have science [t (213) = 2.65, p <0.05], engineering - technology [t (213) = 2.98, p <0.05] and 21st century. It can be said that the skills [t (213) = 2.97, p <0.05] developed a more positive attitude than the students who did not do the experiments outside the classroom. There is no significant difference between the mathematics sub-dimension of those who do experiments outside the classroom and those who do not. It can be said that students who do experiments outside of the classroom have developed a positive attitude towards STEM and its sub-dimensions compared to students who do not do it.

Findings on the Variable for Using a Laboratory in a Lesson

T-test results for independent samples conducted to find out if the attitudes of primary school students towards STEM and its sub-dimensions differ in terms of the variable of using laboratories in the lesson are shown in Table 5.

Table 5. Findings on the variable of using laboratories in the lesson

	Using the laboratory in the classroom	N	x̄	S	sd	t	p
Science	Yes	41	4,18	,60	215	1.03	.30
	No	174	4,06	,69			
Engineering - Technology	Yes	41	4,18	,59	215	1.00	.32
	No	174	4,06	,72			
21st century. Skills	Yes	41	4,34	,50	215	1.46	.14
	No	174	4,18	,64			

Maths	Yes	41	4,09	,81	215	.37	.71
	No	174	4,14	,67			
STEM	Yes	41	4,20	,52	215	.92	.36
	No	174	4,11	,57			

When we look Table 5, there was a significant difference between the STEM attitude of the students who did not use the laboratory [$t_{(213)}$=. 92, p>0.05]. There was no significant difference between the sub-dimensions of STEM: science, engineering – technology, mathematics and 21st century skills and students who used laboratories in the lesson and students who did not. In the lesson, it can be said that students who do not use laboratories do not have the effect of developing a positive attitude to STEM.

Findings on Tablet Use Variable in the Lesson

The results of the t-test for independent samples conducted to find out if the attitudes of primary school students towards STEM and their sub-dimensions differ in terms of the variable of using tablets in the lesson are shown in Table 6.

Table 6. Findings on the variable of using tablets in the lesson

	Using tablets in class	N	X	S	SD	t	*p*
Science	Yes	99	4,08	,74	215	-.27	.79
	No	116	4,10	,61			
Engineering - Technology	Yes	99	4,08	,78	215	-.19	.85
	No	116	4,10	,63			
21st century. Skills	Yes	99	4,21	,67	215	-.02	.98
	No	116	4,21	,58			
Maths	Yes	99	4,14	,69	215	.22	.83
	No	116	4,12	,71			
STEM	Yes	99	4,13	,60	215	-.08	.94
	No	116	4,13	,52			

When we look Table 6, there was no significant difference between students who used tablets and students who did not use tablets and STEM attitude [$t_{(213)}$=-.08, p>0.05]. There was no significant difference between science, engineering – technology, mathematics and 21st century skills, which are the sub-dimensions of STEM, and students who did not use tablets in the lesson. It can be said that using and not using tablets in the lesson does not improve students' attitude towards STEM.

Findings on the Variable for Using Interactive Boards in the Lesson

T-test results were shown in Table 7 for independent samples to find out if the attitudes of primary school students towards STEM and their sub-dimensions differed in terms of the variable of using interactive boards in the lesson.

Table 7. Findings on the variable of using interactive boards in the lesson

	Using smart boards in class	N	X	S	SD	t	*p*
Science	Yes	193	4,12	,64	215	1.99	.04*
	No	22	3,82	,85			
Engineering - Technology	Yes	193	4,10	,66	215	.81	.42
	No	22	3,97	,99			
21st century. Skills	Yes	193	4,25	,54	215	2.64	.01*
	No	22	3,89	1,04			
Maths	Yes	193	4,15	,69	215	1.01	.31
	No	22	3,99	,80			
STEM	Yes	193	4,16	,51	215	.00	.06
	No	22	3,92	,85			

When we look Table 7, there was no significant difference between STEM attitude and students who used and did not use interactive boards in the lesson[$t_{(213)}=0.00$, $p>0.05$]. Students who use interactive boards in the lesson have science[$t_{(213)}=1.99$, $p<0.05$] and 21st century skills [$t_{(213)}=2.64$, $p<0.05$] was found to have a more positive attitude in the lesson than students who did not use interactive boards. There was no significant difference between engineering – technology, mathematics and 21st century skills, which are the sub-dimensions of STEM, and students who used interactive boards and did not use interactive boards in the lesson. It can be said that students develop science and 21st century skills according to students who do not use interactive boards.

Findings on the Variable of Interest in Project Homework

t-test results for independent samples conducted to find out if the attitudes of primary school students towards STEM and their sub-dimensions differ in terms of the variable of interest in project homework are shown in Table 8.

Table 8. Findings on the variable of_interest in project homework

	Be interested in project assignment	N	X	S	SD	t	p
Science	Yes	204	4,10	,66	215	.41	.68
	No	11	4,01	,98			
Engineering - Technology	Yes	204	4,10	,68	215	.92	.36
	No	11	3,90	,93			
21st century. Skills	Yes	204	4,22	,61	215	.27	.79
	No	11	4,17	,85			
Maths	Yes	204	4,14	,69	215	1.08	.28
	No	11	3,91	,80			
STEM	Yes	204	4,14	,55	215	.83	.41
	No	11	4,00	,74			

When we look Table 8, there was no significant difference between STEM attitude and students who were not interested in the project homework [$t_{(213)}$=-. 83, p>0.05]. There was no significant difference between the sub-dimensions of STEM: science, engineering – technology, mathematics and 21st century skills and students who were not interested in project homework. It can be said that interest in project homework does not affect students' attitudes to STEM.

Findings on the Variable for Participating in the Project Competition

T-test results are shown in Table 9 for independent samples to find out if the attitudes of primary school students towards STEM and their sub-dimensions differ in terms of the variable of participating in the project competition.

Table 9. Findings on the variable for participating in the project competition

	Getting information from a STEM specialist	N	X	S	SD	t	p
Science	Yes	85	4,08	,67	215	-.26	.79
	No	130	4,10	,68			
Engineering - Technology	Yes	85	4,10	,73	215	.14	.89
	No	130	4,08	,68			
21st century. Skills	Yes	85	4,25	,62	215	.78	.43
	No	130	4,19	,62			
Maths	Yes	85	4,15	,72	215	.24	.81
	No	130	4,12	,69			
STEM	Yes	85	4,14	,57	215	.26	.80
	No	130	4,12	,55			

When we look Table 9, there was no significant difference between the STEM attitude of the students and the students who participated and did not participate in the project competition

[$t_{(213)}$=1. 13, p>0.05]. There was no significant difference between the subdimensions of STEM: science, engineering-technology, mathematics and 21st century skills and students who participated in the project competition. It can be said that participating and not participating in the project competition did not affect the STEM attitudes of the students.

Findings on getting information from a STEM expert

T-test results for independent samples to find out if primary school students' attitudes toward STEM and their sub-dimensions differ in terms of the variable of receiving information from the STEM specialist are shown in Table 10.

Table 10. Findings on the variable for receiving information from a STEM expert

		Science	Engineering - Technology	21st century skills	Maths
STEM	PearsonCorrelation	,880**	,873**	,844**	,722**
	Sig. (2-tailed)	,000	,000	,000	,000
	N	215	215	215	215

**. Correlation is significant at the 0.01 level (2-tailed).

When we look Table 10, there was no significant difference between students who received information from the STEM expert and students who did not receive it, and STEM attitude [$t_{(215)}$=. 26, p>0.05]. There was no significant difference between the sub-dimensions of STEM: science, engineering – technology, mathematics and 21st century skills, as and students who received information from STEM expert and students who could not get information. It can be said that getting and not getting information in the STEM field does not affect STEM attitudes.

Relationship Between Primary School Students' Attitudes Toward STEM and Sub Dimensions

Correlation analysis and results conducted to determine the relationship between primary school students' attitudes toward STEM and their sub-dimensions are given in table 11.

Table 11. Pearson Multiplication Moments Correlation Analysis Results Between Attitudes of students toward STEM and sub-dimensions

	Science	Engineering - Technology	21st century skills	Mathematics
Pearson Correlation	,880**	,873**	,844**	,722**
Sig. (2-tailed)	,000	,000	,000	,000
N	215	215	215	215

**. Correlation is significant at the 0.01 level (2-tailed).

When the results of the correlation in Table 11 are examined, there is a significant relationship between the students' attitude, to STEM and the sub-dimensions of STEM. It is seen that there is a significant relationship between the science sub-dimension and STEM (r=0.880, p<0.01). It is seen that there is a significant relationship between the Engineering Technology sub-dimension and STEM ($r=0.873$, $p<0.01$). There is a significant relationship between 21st century skills sub-dimension and STEM ($r=0.844$, $p<0.01$). There is a significant relationship between the math sub-dimension and STEM ($r=0.722$, $p<0.01$). The area with the highest significant relationship with STEM was found to be the field of science.

CONCLUSION, DISCUSSION AND SUGGESTIONS

According to the findings of the research, the STEM attitude of the students who did the e Twinning STEM project was found to be high. In addition, their attitude to sub-dimensions such as science, engineering-technology, 21st century skills and mathematics was found to be high.

It has been determined that students who go to the science center from primary school students who do STEM e Twinning project have a more positive attitude towards engineering, technology than students who do not go. It can be said that students who experiment outside of lesson develop a more positive attitude towards STEM than students who do not experiment. When the sub-dimensions are examined, it can be said that the science, engineering – technology and 21st century skills of the students who experimented outside the lesson developed a more positive attitude than the students who did not experiment outside the lesson. It was found that students who used interactive boards in lesson had a more positive attitude than students who did not use interactive boards in science and 21st century skills alt sizes.

It was determined that primary school students who experimented with STEM eTwinning project, used laboratories in the lesson, used tablets in the lesson, were interested in project assignments, participated in project competitions and received interest in STEM subjects from a expert showed no significant difference between STEM.

Students who went to the science center were found to have a positive attitude towards STEM. It can be said that students' interest in science in science center's increases their interest in STEM. Bozdoğan and Yalçın (2006) also showed that students who went to the science center increased their interest in science. Based on this research, it is thought that those who go to the science center have a high attitude towards STEM because it is thought that their interest in science has increased. It was determined that experimenting in the lesson did not show students a positive attitude towards STEM. It can be said that the experiments students do outside of the classroom increase the STEM attitudes of the students. It can be said that extralesson studies positively increase students' attitudes to STEM. It can be said that the experiments conducted by the students after the lessons voluntarily increased the STEM attitudes of the students. In the research conducted by Şahin, Ayar and Adıgüzel (2014), it was determined that outside of school activities increased the positive attitude to STEM. The research conducted by Keskin, Karagölge and Ceyhun (2019) also found that science festivals positively affected the attitude towards science lesson. Primary school students who used interactive boards in the lesson were found to have a positive attitude to STEM. It can be said that students increase interest in technology and design with the use of interactive boards. Özyurt, Kusdemir Kayıran and

Başaran (2018) also found significant difference between interactive board and attitude to STEM in their research.

It was found that it did not significantly affect STEM attitudes of students who used laboratories in the lesson. As a result of the research conducted by Güneş Sener and Topal Germi, Can (2013), it was determined that although there are laboratories in schools, their use, experimental applications are not adequately included and science does not increase interest. In the research conducted by Demiral (2013), it was also found that using a laboratory does not positively affect the attitude towards science. It can be said that students' staying passive in the experiments did not affect their STEM attitudes just because they watched the experiments. Using tablets in the lesson was found not to affect STEM attitudes. In his research, Özacar Halvacı (2018) found that adding technology discipline to STEM activities does not change STEM attitudes. Even if interactive tablets attract students' attention, it can be said that students do not work with tablets and do not affect STEM attitudes because they do not produce anything. Interest in project assignments has been found to not meaningfully affect students' STEM attitudes. It can be said that the positive attitude does not develop because the students usually do research in their project assignments and do not do studies involving technology and engineering. There was no significant relationship between participating in project competitions and STEM attitude. It can be said that students do not fully realize the impact on STEM attitude because a small number of projects are being done in primary schools. There was no significant difference between the process and STEM attitudes that they received from a specialist in STEM subjects. It can be said that such a result emerges because STEM experts do not give verbal lectures and practices to students. A significant relationship was found between science, technology mathematics and engineering and STEM. Damar, Durmaz and Önder (2018) found that students' science, technology, engineering and mathematics practices increased students' STEM attitudes. It can be said that studies in science, technology mathematics and engineering increase students' interest in STEM and direct them to STEM. e Twinning projects can be implemented to increase students' STEM attitudes. Schools can increase students' interest in science and engineering by enabling students to participate in STEM studies. This survey can also be applied to smaller classrooms in primary schools with teachers.

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STEAM Eğitimi Araştırmaları Derneği

STEM BASIC KNOWLEDGE TEST DEVELOPMENT STUDY FOR PRE-SERVICE TEACHERS

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ABSTRACT

The purpose of this study is to develop a valid and reliable test to measure pre-service teachers' levels of STEM Basic Knowledge. Data was obtained from a total of 148 students studying in the departments of Science Education, Mathematics Teaching and Computer Education and Instructional Technology in the 2017-2018 school years. Eight characteristics were determined to be tested in this direction by examining the aims, features, benefits and the way of implementation of STEM (Science, Technology, Engineering and Mathematics) education. 40 questions related to these features were prepared. As a result of analyzes made after the application of the test to the pre-service teachers, some items were removed from the test and a test of 28 items was obtained. It was determined that the reliability coefficient of this test was 0.84, the average difficulty was 0.61, and the average discrimination was 0.49. A valid and reliable STEM Basic Knowledge Test (STEMBKT) that tests the determined gains of STEM has been obtained.

Keywords: STEM, Basic Knowledge Test, Pre-service Teachers

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INTRODUCTION

The development of countries is directly related to their progress in science and technology. A good education is the basis of this development. Considered as an innovative approach in education, STEM is based on the idea of educating students in an interdisciplinary and practiced manner in four disciplines (science, technology, engineering and mathematics) (Suprapto, 2016). Rather than addressing the four disciplines separately, STEM integrates them into a learning approach based on real-world applications (Hom, 2014).

STEM education has a great interest in recent years. It is for the desire of countries to achieve certain goals in order not to fall behind in science and technology. According to the National Research Council of America (2011), the STEM education approach has three main goals; to raise individuals who make their career in STEM fields, to spread the workforce and to increase participation in STEM fields and to raise individuals with STEM literacy

When the international literature is examined, it is seen that STEM education has started to be implemented in schools. Under the title of "Engineering and Design Skills" in the 2018 Science Curriculum, STEM education was emphasized by including the integration of science with technology, engineering and mathematics (Ministry of National Education [MEB], 2018). In addition, it is clearly seen that STEM disciplines will be integrated and included in the lessons by including the subject area of "Science and Engineering Applications" under the unit of "Applied Science" at all levels from grade 4 to 8.

It is strategically important to train human resources who are experts in the fields of Science, Technology, Engineering and Mathematics (STEM) in order to maintain Turkey's competitive power on international scale. Reforms regarding STEM education will play an important role in Turkey’s economic competitiveness (Corlu, and Capraro Capraro, 2014). Based on this importance, MEB prepared a report about STEM in June 2016. The purpose of this STEM Education Report is; to improve the dynamic education system according to the needs, to educate a generation that produces and designs (MEB, 2016). According to the report, things to do are; establishing STEM education centers, cooperation between STEM education centers and universities, training teachers in STEM fields, updating curricula regarding STEM education and preparing necessary course materials.

Akgündüz et al. (2015) have prepared STEM Turkey Report. In the report, it was stated that the lack of knowledge, skills and experience of STEM teachers, to provide education in these fields is a deficiency. In the literature, there are various scale development studies on STEM education in which teachers and pre-service teachers are determined as participants. Corlu, et al. (2015) developed a scale to investigate pre-service teachers' levels of mental readiness towards STEM education and their attitudes towards the nature and holistic teaching of mathematics and science teaching. Taş et al. (2016) adapted the Scale of Teacher Competence and Attitudes Towards STEM into Turkish. Hacıömeroğlu and Bulut (2016) adapted the integrated STEM teaching orientation scale into Turkish for pre-service teachers. Buyruk and Korkmaz (2016) developed a scale to determine the STEM basic knowledge levels of pre-service teachers studying in Computer, Mathematics and Science Teaching departments. Çevik (2017) developed a scale to determine the STEM awareness levels of science, technology, engineering and mathematics (STEM) teachers (mathematics, physics, chemistry, biology and information technologies) working in high schools. In these studies on STEM education, mostly attitude and awareness were measured. There is no study that tests the pre-service teachers' basic knowledge levels about STEM education according to the features, goals and benefits of STEM. The absence of such a test in the literature makes it necessary to develop a test for this measurement. As a matter of fact, it is important to determine whether pre-service teachers who will be implementers of STEM in the future have the basic knowledge level of STEM. From this point of view, it is thought that the valid and reliable STEM Basic Knowledge Test will make an important contribution to the field.

Purpose of the research

The aim of this study is to develop the STEM Basic Knowledge Test to determine the basic knowledge levels of pre-service teachers for STEM education. For this purpose, validity and reliability studies of the test have been performed.

METHOD

This section includes information about the participants of the study, the development of the data collection tool, and the data analysis process. The steps of the STEM Basic Knowledge Test development and the participant information are below.

Participants

Data was collected in April in the 2017-2018 school year. Participants of the research comprised of 148 senior students studying in the departments of Science Education, Mathematics Teaching and Computer Education and Instructional Technology at İnönü University Faculty of Education. Volunteerism has been taken as a basis in terms of participation.

Data Collection Tool Development Process

In this study, it was tried to develop a valid and reliable test for pre-service teachers. Test form was used as data collection tool to determine STEM basic knowledge of pre-service teachers. In the process of developing this test, national and international studies on STEM education were examined and a literature review was conducted.

The three main goals of STEM education approach are; "To educate individuals who make their careers in STEM fields, to spread the workforce in STEM fields, to increase participation in these fields and to educate individuals with STEM literacy". These goals serve the purpose of higher education (to train students according to the science policy of Turkey by their interests, skills and abilities and to train them according to the high level and manpower needs of the society at various levels).

These goals of STEM also serve the goal of National Education: "to develop the interest, competencies and abilities of all members of the Turkish nation, to prepare them for life by providing with the necessary knowledge, skills and behaviors and gaining the habit of working together and to ensure that they have a profession make them happy and contribute to the happiness of the society."

Considering the goals of STEM, eight characteristics (gains) of STEM were determined. These gains examined the aims, features, benefits and the way of implementation of STEM (Science, Technology, Engineering and Mathematics) education. According to Bloom's taxonomy, an essay form with a total of 40 items including 17 items from the knowledge level and 23 items from the understanding level was prepared. In order to develop an item pool, the literature has been reviewed (Maryland State Department of Education, 2012; Morrison, 2006; Suprapto, 2016; Hom, 2014; Bragow, Gragow and Smith, 1995; Gutherie, Wigfield and VonSecker, 2000; Hurley, 2001; Dierdorp, Bakker, van Maanen, and Eijkelhof, 2014; Sanders, 2008; Dillon, & Dillon, 1988; Fulkerson & Banilower, 2014). And the Public Personnel Selection Exam questions, which include educational sciences questions related to the aims, characteristics, benefits and implementation of STEM education were examined. A multiple choice "STEM Basic Knowledge Test (STEMBKT)" consisting of 40 items was prepared. Test items consist of 4 options, 1 of which is correct answer, 3 of which are distracting.

To ensure the content validity of the STEMBKT, a table of specifications has been prepared. In this table, it is stated which cognitive level the tested characteristics of STEM are related to. The table of specifications of the STEMBKT is given in Table 1.

Table 1. STEM basic knowledge test specifications table

Item No	Gains	Knowledge	Understanding	Percentage
1	Knows the STEM disciplines	6	-	15
2	Knows the goals of STEM education	5	-	12,5
3	Knows the benefits of STEM education	6	-	15
4	Comments student-teacher roles in STEM education	-	4	10
5	Comments methods and techniques in STEM education	-	8	20
6	Comments the relationship between STEM education and higher order thinking skills	-	3	7,5
7	Comments assessment and evaluation in STEM education	-	2	5
8	Comments the characteristics of learning environments suitable for STEM education	-	6	15
	Total	17	23	
	Percentage	42,5	57,5	

As seen in Table 1, three of the gains (42.5%) are at the knowledge level and five of them (57.5%) are at the understanding level. When Table 1 is examined in terms of the number of items related to the gains, there are 17 items related to the gains in the knowledge level. And there are 23 items in the understanding level.

At least one item to test each gain is considered. A 4-option, multiple-choice trial form consisting of 43 items was prepared. Items were examined by 3 academicians, two of which were from the Curriculum and Instruction field, one from the Measurement and Evaluation field, and 4 teachers from the Science, Mathematics, Computer and Instructional Technologies and Turkish departments. The experts find it appropriate to exclude 3 items from the test. One of these items was removed because the similarity of another item. And the other two items were removed because they did not include the tested characteristics of STEM. In addition, some items were corrected both in the root of the question and in distractors, making incomprehensible questions understandable. It was decided that the test named "STEM Awareness Test", which was presented for the opinion of experts, should be named "STEM Basic Knowledge Test".

In order to determine the clarity and understandability of the items of the prepared test, a pre-application was made with 20 undergraduate students. They were studying in Science Education, Mathematics Education and Computer Education and Instructional Technology departments. The test was rearranged by making the necessary corrections in line with the feedback from the students.

Analysis of Data

STEM Basic Knowledge Test form was administered to a total of 148 students. They were studying in the 4th grade of Science Education, Mathematics Teaching and Computer Education and Instructional Technology departments of İnönü University Faculty of Education. After the application, the difficulty and discrimination indexes of each item in the test were found by analyzing the items. The limits determined by Tekin (2003: 247-252) were taken as criteria for the comment of difficulty and discrimination. Accordingly, the item difficulty index (p) ranging from zero to +1 is considered to be moderate difficulty between 0.25 and 0.75. Tekin (2003: 249) evaluates item discrimination indexes based on the following limits:

0.40 and higher: Very good item,

0.30 - 0.39: Good item (However improvements can be made),

0.20 - 0.29: An item that needs to be corrected and improved,

0.19 or less: Very weak item (Must be excluded from the test)

FINDINGS

By analyzing the STEMBKT, numerical data for each item were obtained. The scores of the pre-service teachers were listed from the highest to the lowest. 27% upper group and 27%

subgroups were determined. The scores of 7 pre-service teachers who have the same score with the score of the 40th pre-service teacher in the upper group were also included in the group. Likewise, the score of 3 pre-service teachers in the subgroup with the same score as the 40th person was added to the subgroup.

In line with the data obtained, the discrimination and item difficulty values for each item of STEMTBT are summarized in Table 2.

Table 2. Difficulty and Discrimination Indexes of the Items in the Test

Item Number	Item difficulty index	Item discrimination index	Item Number	Item difficulty index	Item discrimination index
1	0.70	0.54	21	0.50	0.35*
2	0.21	-0.04*	22	0.47	0.29*
3	0.66	0.54	23	0.66	0.37*
4	0.63	0.48	24	0.81	0.53
5	0.44	0.27*	25	0.56	0.46
6	0.74	0.31*	26	0.82	0.38*
7	0.56	0.48	27	0.72	0.63
8	0.80	0.47	28	0.51	0.29*
9	0.64	0.41	29	0.36	0.32
10	0.60	0.55	30	0.63	0.13*
11	0.67	0.52	31	0.44	0.34
12	0.66	0.59	32	0.68	0.57
13	0.41	0.38	33	0.61	0.46
14	0.70	0.56	34	0.58	0.52
15	0.76	0.49	35	0.52	0.43
16	0.20	0.16*	36	0.62	0.26*
17	0.45	0.23*	37	0.43	0.42
18	0.72	0.50	38	0.61	0.35*
19	0.82	0.53	39	0.60	0.43
20	0.32	0.32	40	0.78	0.42

* Items excluded from the test

As seen in Table 2, 24 items with a discrimination index of 0.40 and greater have very good discrimination. These 24 items were included in the test without any changes. The discrimination of the 13 items numbered 5, 6, 16, 17, 21, 22, 23, 26, 28, 30, 36 and 38 is less than 0.40. So they were excluded from the test to increase the reliability. However, items 20, 29 and 31 with a discrimination between 0.30 and 0.39 were not excluded from the test. Because it would negatively affect the content validity. The 20th item is based on the gain of "knows the goals of STEM education". And the 29th and 31st items are based on the gain of “comments methods-techniques in STEM education. The answers given to these items were examined in detail. Distractors that were not effective in distinguishing the upper group and the lower group were strengthened. The edited items were included in the test with the consensus of the experts.

As seen in Table 2, the items have different difficulty levels. The 4 items numbered 8, 19, 24, 26 with an item difficulty of 0.80 or higher were determined to be very easy items. It was determined that 11 items numbered 1, 3, 6, 11, 12, 14, 15, 18, 23, 27, 32 were quite easy. These items are between 0.65 and 0.79 difficulty indexes. 18 items numbered 4, 5, 7, 9, 10, 13, 17, 21, 22, 25, 28, 29, 30, 31, 33, 34, 35, 37 with difficulty indexes between 0.35 and 0.64. These are medium level items. And 3 items numbered 2, 16 and 20 with difficulty indexes between 0.20 and 0.34 were determined to be quite difficult items.

The Kuder–Richardson (KR-20) formula was used to measure the reliability of the the STEMBKT. Descriptive statistics of the test are summarized in Table 3.

Table 3. Descriptive statistics for STEM basic knowledge test

Number of Items	28
KR-20 Reliability Coefficient	0.84
Item Difficulty Average	0.61
Item Discrimination Average	0.49

When Table 3 is examined, it is seen that the reliability coefficient of the test consisting of 28 items is 0.84. The average difficulty of the test is 0.61, and the average discrimination is 0.49.

According to the item analysis results, 12 items with low item difficulty and discrimination were excluded from the basic knowledge test. A valid and reliable basic knowledge test has been developed. STEMBKT consists of 28 items that tests the determined gains of STEM

CONCLUSION AND RECOMMENDATIONS

In this study, it was aimed to develop STEM Basic Knowledge Test for pre-service teachers. And for this, validity and reliability studies were performed. This test, consisting of 28 items, measures eight STEM gains. The reliability coefficient of the test was calculated as 0.84. This result indicates that the test is reliable. The average difficulty of the test was determined as 0.61, and the average discrimination was determined as 0.485. These results show that the test is moderately difficult and discriminatory.

In order for STEM to reach the desired goal in our education system, it is necessary for teachers to have the necessary equipment. Dong et al., (2020) stated that teachers with STEM education knowledge will have less difficulties in STEM teaching. As a result of their studies, the difficulties teachers will have in STEM education practices were predicted by looking at their STEM knowledge and beliefs. Kennedy et al. (2008) stated that it is important for teachers to have strong content and pedagogical knowledge about STEM education. Therefore, it is inevitable that pre-service teachers who are on the way to become teachers should have this information. The developed STEMBKT measures the gains in the knowledge and understanding dimensions of the cognitive domain level. It will make an important contribution in measuring the basic knowledge level of pre-service teachers about STEM education. Yıldırım and Türk (2018) stated in their study that teachers feel inadequate about engineering, application and science and technology knowledge. The present study has revealed a test that determines the basic knowledge level of teachers about STEM education. And it can lead to future studies. In this direction, STEM teacher training can be directed. In addition, the scales developed in studies conducted with teachers and pre-service teachers on STEM education in the literature are mostly aimed at measuring attitude and awareness (Çorlu, et al., 2015; Taş et al., 2016; Hacıömeroğlu & Bulut, 2016; Buyruk & Korkmaz, 2016; Çevik, 2017.). There are no studies testing pre-service teachers' basic knowledge levels, characteristics, goals, benefits and so on about STEM education. With this study, this deficiency in the literature will be eliminated.

It can be said that the study has some limitations. STEM Basic Knowledge Test measures only the gains of knowledge and understanding. STEM is an approach to implement high-level thinking skills. For this reason, it may be suggested to develop different tests that examine high level gains in future studies. In addition, this study was limited to eight STEM gains (tested traits) determined by the researchers. Similar studies can be done by increasing the number of gains.

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EXAMINATION OF STUDIES FOR AUTISTIC CHILDREN IN TURKEY

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ABSTRACT

The purpose of the study is to examine studies done for children with autism in Turkey and examine the trend of the studies. For this purpose, a total of 49 studies were examined in the National Thesis Center, Google Scholar, Ulakbilim and Dergi Park databases. A form was developed under qualitative research approaches by using the categorical analysis technique, one of the descriptive analysis methods, to examine the publications. The developed form categorizes the publication years of the studies, authors, sample distributions and numbers, subject areas, research methods, data collection tools and training methods. As a result of the descriptive analysis of the studies, it has been determined that the applied behavior analysis method is frequently used among education methods. It is seen that the studies increased between 2016-2021. As the sample size, generally 1-5 people, pre-school and primary education levels were chosen equally as the sample distribution. Studies focus on social interaction as a subject area in education. As a research method, among single subject research models, cross-subject research method and multiple research models were frequently preferred. In addition, the most preferred data analysis method is graphical analysis.

Keywords: Autism, Autism Spectrum Disorder, Autistic Education, Special Education Methods.

Durdu, E. & Demirbilek, M. (2021). Examination of studies for autistic children in Turkey, *Journal of STEAM Education, 4(*2), 128-139.

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INTRODUCTION

Autism Spectrum Disorder (ASD) is a lifelong neurodevelopmental disorder that usually occurs at the age of 2 years or later (American Psychiatric Association, 2013). It causes the individual to adhere to routine, to be overly sensitive or insensitive to sensory stimuli, to be insufficient in social communication areas, to exhibit repetitive behaviors, and to have limited areas of interest (Kırcaali-İftar, 2007). However, symptoms can be reduced by improving them throughout life.

Although ASD has no known cause or definitive treatment, studies show that individuals with autism can live an independent and productive life with early intervention and training. In particular, early-stage education is considered to be the most appropriate solution to the ASD problem, as it can improve reasoning skills (Konstantinidis, Luneski, Nikolaidou, Hitoglou-Antoniadou, & Bamidis, 2009).

Individuals with ASD must go through certain teaching processes in order to survive as an individual and to adapt to community life. Autism, which is a spectrum with the word meaning that progresses differently in each individual, causes individuals to show different development or disability. For this reason, the education process of individuals with ASD is focused on the area with insufficiency (Tekin-İftar, 2012). Inadequate areas are collected in 3 areas:

- Social interaction problems,
- Communication problems,
- Limited / recurring interests and behaviors.

Since a child with ASD can develop very differently from any child with ASD, the diagnosis and intervention process may also change according to these differences (Dunn & Kientz, 1997). For this reason, it is important that individuals with ASD find individual learning ways and provide more effective and useful trainings.

Training Methods

Education methods are developing day by day and there are new training methods. But as the most widely known scientifically based methods; applied behavior analysis, teacch, relationship-based methods, social stories, and facilitated communication methods are used (Tohum Autism, 2021).

Applied Behavior Analysis

It is defined as the process of developing new behaviors and changing inappropriate behaviors with appropriate behaviors by objectively analyzing individual behaviors and environmental characteristics, and it is a discipline that proves this process with experimental studies (Birkan, 2013). Appropriate behaviors are increased by using reward mechanisms, and inappropriate behaviors are reduced / eliminated by using deterrent mechanisms. Teaching methods under applied behavior analysis:

- Teaching with Discrete Trials,
- Early Intensive Behavioral Training,
- Teaching with Activity Schedules,
- Teaching with Fading Lines,
- Being a Model with Video,
- Opportunity Teaching,
- Functional Evaluation and Analysis,
- Picture Exchange Communication System (PECS),
- It consists of Verbal Behavior method.

Treatment and Education of Autistic and Related Communication Handicapped (TEACCH)

It is defined as the method in which the physical environment is structured based on the skills, interests and needs of the child with ASD and the activities are prepared in a way that the child will follow (Tohum Autism, 2021). In the TEACCH approach, in order for the child to adapt, the environment is arranged and the skills are provided from simple to complex, in an individualized manner. It is known to be effective in increasing skills and reducing behavioral problems (Mesibov, Shea & Schopler, 2005).

Relation-Based Methods

It aims to ensure that children with ASD enjoy their social interaction skills by prioritizing their emotional development (Tohum Autism, 2021). Since the movements are thought to have deep meanings, the child's movements are only watched without obstructing, and it is tried to interact with the movements similar to the child's movements.

Social Stories

It is a narrative method written specifically for children with ASD on issues that they have difficulty understanding (Tohum Autism, 2021). They are known as stories that contain pictures or drawings that can be read in a short time. It provides information transfer by using the 5W1H (who, what, where, how and when) method in order to explain the determined social situation (Sani-Bozkurt & Vuran, 2014).

Facilitated Methods of Communication

In the alternative communication method created for children with ASD who cannot communicate verbally, it is defined as a method that helps an assistant to write on the keyboard with the physical support (Tohum Autism, 2021). However, studies have suggested that the method is ineffective, considering that the messages have an auxiliary effect.

The Purpose and Importance of the Research

In the education process, it is important to determine the learning paths and environments of individuals with ASD and to use appropriate teaching techniques (Korkmaz, 2003). It is known that the education process prepared correctly has a positive effect on the education of individuals with ASD. In this context, it is important to examine studies on the education of autistic individuals and to reveal their similarities and differences as they may guide future studies. In this context, the following questions were sought by examining publication years, authors, sample distributions and numbers, subject areas, research methods, data collection tools, data analysis methods and training methods:

- How is the distribution of the studies over the years?
- How is the thesis and article distribution of the studies?
- What is the distribution of thesis studies according to universities?
- How is the subject distribution of the studies in the context of disability in children with autism?
- What are the training methods used in the studies?
- What are the research methods used in studies?
- What are the data collection tools used in the studies?
- How is the sample distribution of the studies?
- What are the sample sizes used in the studies?

METHOD

Research Design

In this study, the categorical analysis technique was used. Yıldırım and Şimşek (2011), the stages of descriptive analysis as framing, processing data, describing and interpreting. Categorical analysis technique is the division of a message into units and grouping it into categories according to the criteria determined beforehand or created during the analysis (Tavşancıl & Aslan, 2001).

Study Group

The study group of the research consists of theses and articles published in the databases of the National Thesis Center, Google Scholar, Ulakbilim and Dergi Park. The study includes studies for the education of autistic children in Turkey until 2021. In this context; "Autism", "education", "video model", "TEACCH", "social stories", "PECS", "facilitated communication methods", "applied behavior analysis" in the National Thesis Center, Google Scholar, Ulakbilim and Dergi Park databases. "Relationship-based methods", "activity charts" and "Autism", 21 theses and 18 articles were reached. In the articles produced from theses, they were not included in the study group because the basic research was theses.

Data Collection Tools

According to the scope of the research, the Autism Research Study Form for the Education of Children of Made in Turkey was prepared in order to collect data from 2003 to 2021. In this form, there are boxes containing studies, publication years, authors, sample distributions and numbers, subject areas, research methods, data collection tools and training methods. During the examination of the studies, additional boxes were created according to the needs and the form was finalized.

Data Collection Process

Some criteria have been determined for the inclusion of the studies in the research:

- To be included in the databases of the National Thesis Center, Google Scholar, Ulakbilim and Dergi Park,
- Working Group of Turkey and the Turkish language is limited,
- Articles published in a peer-reviewed journal,
- The keywords, title and summary information are suitable for the specified keywords,
- Among the aims or sub-goals of the studies, it aims to provide specially developed education for children with autism.

Data Analysis

The research took place in the study in line with the keywords and criteria. Due to the fact that the databases are more than one, repetitive publications and articles produced from theses were removed from the data set. At the end of the research, analyzes were made by transferring the data to the analysis program. The results of the study are presented in graphics.

FINDINGS

Research conducted for the examination of the studies for autistic children's education in Turkey was published as a result of descriptive analysis, the subject was handled, training methods used, research design, data collection methods, sample type, sample size and data analysis methods are presented below under the heading. Findings were analyzed based on research questions.

How is the distribution of the studies over the years?

When the distribution of the studies by years is examined, the studies increase, as can be seen in Figure 1. The issue's gaining importance in recent years can be interpreted as a result of the increase in the number of studies.

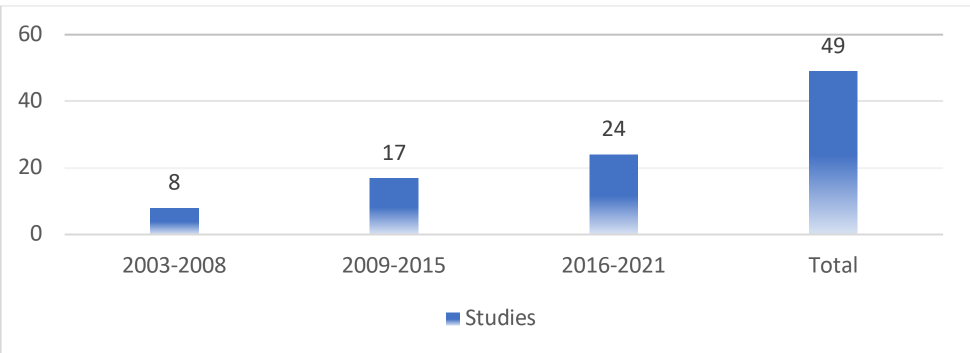

Figure 1. Distribution of studies by years

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What is the sample distribution and size of the studies?

The sample distribution of the studies is shown in Figure 2. when Figure 2 is examined, it is seen that the sample distribution of studies conducted for autistic children is mostly carried out for pre-school and primary education levels. However, it is noteworthy that the studies for secondary education level are less compared to other levels. Considering that early stage education is seen as more useful and effective, it can be interpreted as a result of the sample distribution being less at secondary education level and higher at pre-school and primary education levels.

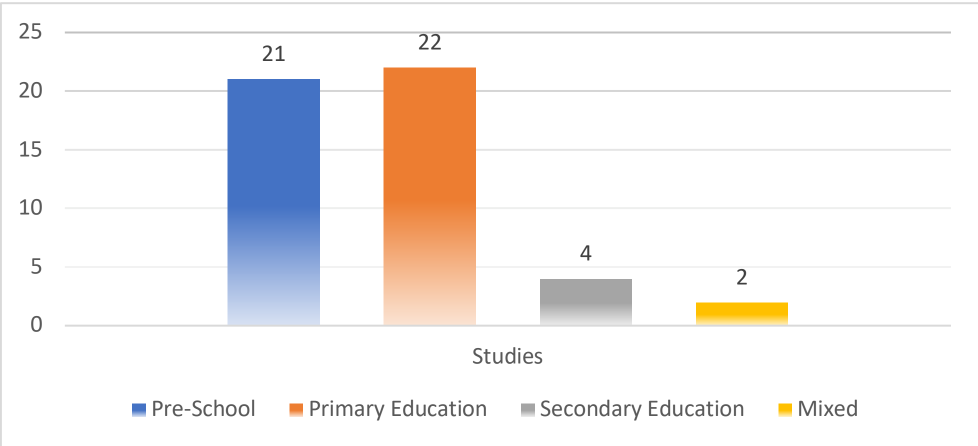

Figure 2. Sample distribution

The sample size of the study is shown in Figure 3. It is seen that the sample size is by far more in studies conducted with 1-5 people. The reason for this can be considered as the fact that it is difficult to reach students who require special education / autistic students, and the studies conducted do not comply with the criteria of the target audience due to the fact that autism is the spectrum.

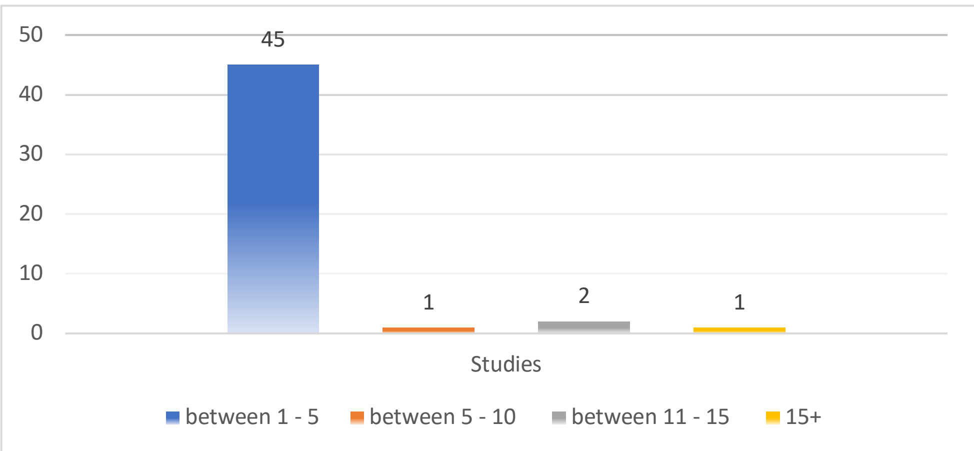

Figure 3. Sample size

How is the subject distribution of the studies in the context of the subject with disabilities in children with autism?

It is divided into 3 subject areas according to the scope of the study and the area it aims to teach. Some of the studies represent more than one subject area. For this reason, priority subject area is included in the chart. When Figure 4 is examined, it is seen that most of the studies are conducted on social interaction problems. Since it is known that autistic children show inadequacies in social interaction, it can be interpreted as the studies are primarily aimed at eliminating these inadequacies.

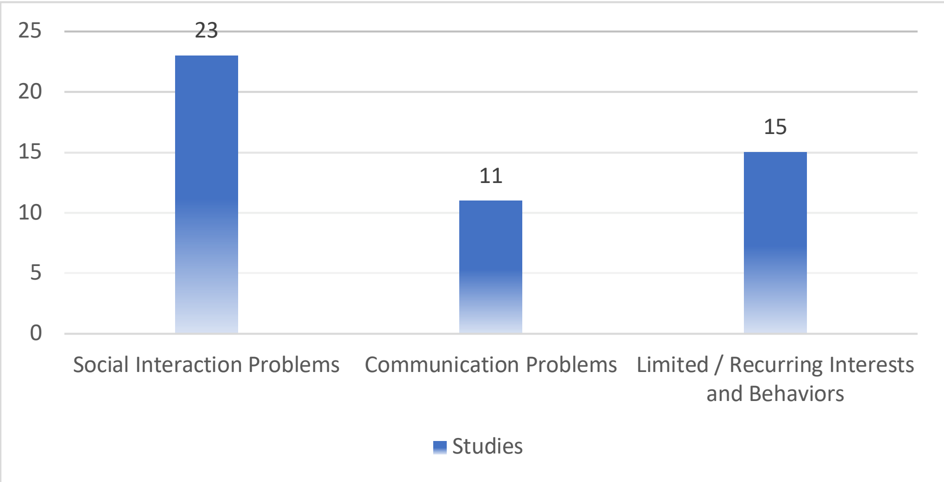

Figure 4. Subject area distribution

What are the training methods of the studies?

When Figure 5 is examined, it is seen that Applied Behavior Analysis method is mostly used as training methods. Within the scope of the study, 15 articles, 22 master theses and 5 doctoral dissertations using applied behavioral analysis methods were reached. When the studies using the applied behavior analysis method are examined, it consists of 15 studies with teaching with discrete trials, 6 with teaching with activity charts, 4 with replicating teaching, 11 with video modeling, 3 with opportunity teaching, and 3 with PECS.

There are 5 doctorate and 1 master thesis using the social stories method.

There is only 1 article using TEACCH.

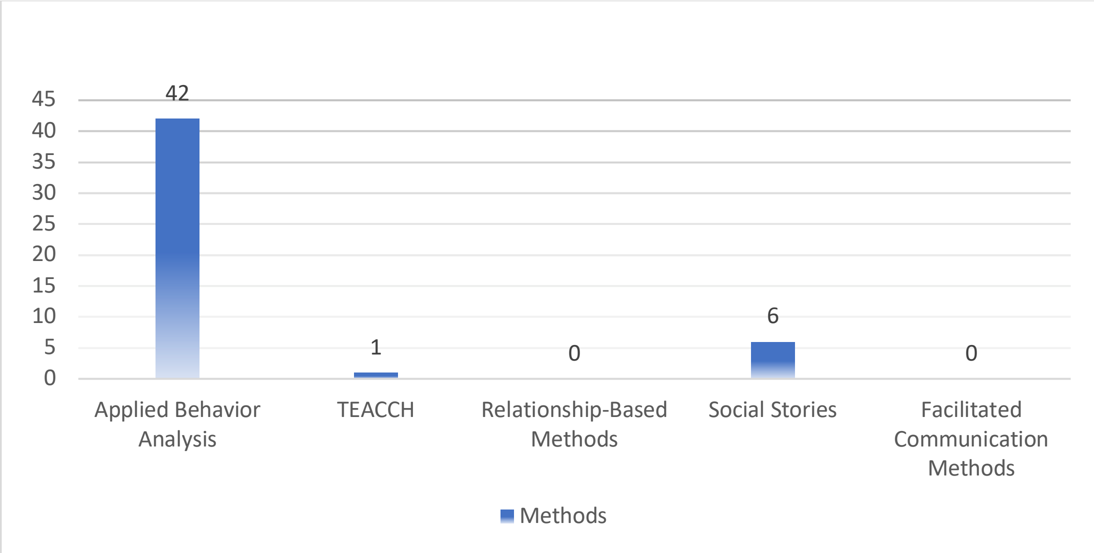

Figure 5. Distribution of training methods

What is the data collection tools of the studies?

The distribution of data collection tools used in the studies is shown in Figure 6. Since some of the studies used more than one type of data collection tool, the data were included in the chart. It is seen that observation / interview forms are mostly used to collect data in studies. Considering the target audience of the studies, it can be interpreted as an evaluation based on the desired behavior.

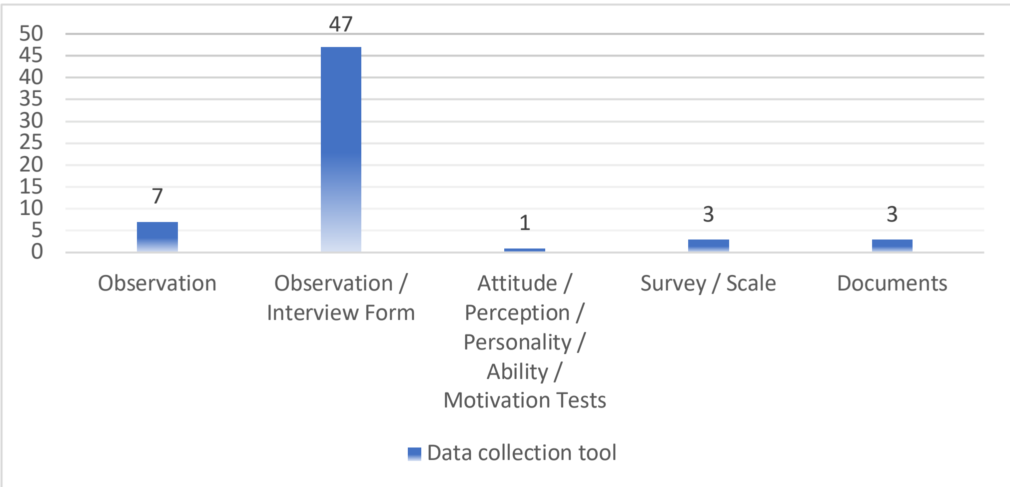

Figure 6. Distribution of data collection tools

How is the thesis and article distribution of the studies?

When the thesis-article distribution of the research is examined, as can be seen in Figure 7, within the scope of the research, a total of 49 studies, including 16 articles, 23 master's and 10 doctoral dissertations, were discussed.

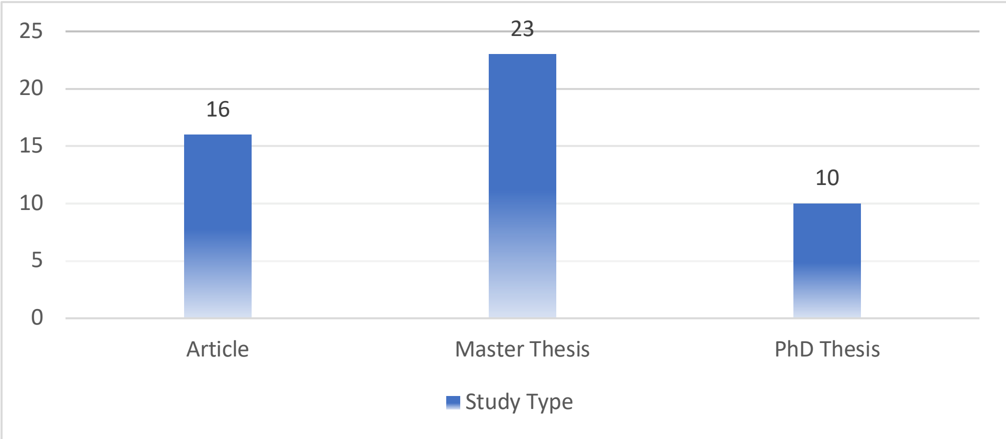

Figure 7. Distribution of study type

What are the research methods of the studies?

The research methods distribution of the studies is shown in Figure 8. Within the scope of the study, among the single-subject research models, the inter-subject multiple probe model method with probing trials 25, the adaptive rotational applications model method 13 among the single-subject research methods, the parallel applications model method 2 from the single-subject research models, the phenomenology research method 1, the case / case study method 3. Experimental model method with pre-test post-test control group was used 5 times. The low number of subjects in special education can be shown as the reason why single-subject research designs are used more frequently than other designs.

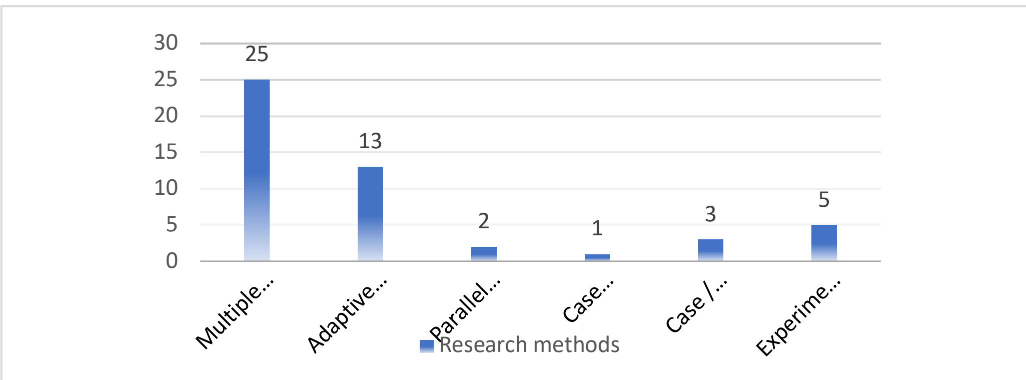

Figure 8. Research methods distribution

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What are the data analysis methods of the studies?

The distribution of data analysis methods of the studies is shown in Figure 9. Considering that single-subject research methods are intense within the scope of the study, it is seen that the graphical analysis method, which is quite frequently used in the analysis of single-subject research methods.

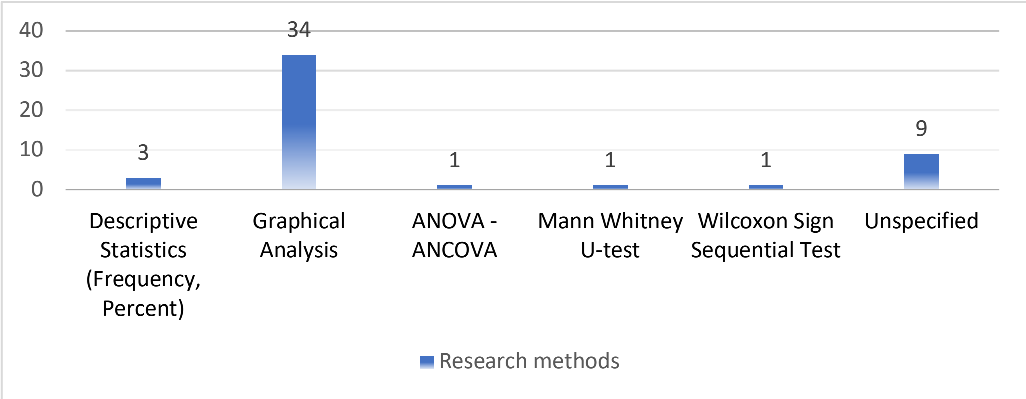

Figure 9. Data analysis methods distribution

DISCUSSION AND CONCLUSION

When the results of the research are examined, it is seen that the studies on the education of children with autism gained momentum between the years 2016-2021. It is thought that the development of autism awareness over time is a result of this acceleration. The positive feedback of the education given to children with autism gave importance to the studies. For this reason, it is normal for literature studies to increase.

It is seen that 24 of the 49 studies examined are on social skills teaching. This intensity is evaluated by the fact that the most common symptom of ASD is difficulties in social relations. Since social relations in ASD are a lifelong problem, it is thought that the studies are in this direction.

In the researches, it is seen that the study groups were selected as 21 primary education levels, 22 pre-school levels, 4 secondary education levels and 2 mixed study groups. Early education in special education is considered very necessary. For this reason, it is thought that primary and pre-school levels are frequently preferred in studies.

40 of the examined studies carried out their research with single-subject research methods, which are frequently preferred in areas where the number of subjects is limited. Accordingly, the concentration of the sample size on groups of 1-5 strengthens the interpretation. In 47 studies, observation/interview forms were used as data collection tools.

According to these findings, it is seen that the studies are generally carried out with a similar subject area, similar education method and similar research method. In the sense of progressing the literature on a wider range:

Studies can also be conducted on different educational topics.

Less used training methods can be used more in studies. In this way, you can have more clear information about training methods.

The effectiveness of the trainings can be measured more clearly by using the secondary education study group in the studies.

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The Effect of STEM Education on 21st Century Skills: Preservice Science Teachers' Evaluations

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ABSTRACT

The aim of this study is to examine the opinions of the teachers, who participated in STEM education, about the contribution of this education to the development of their 21st century skills. Purposeful sampling was used in this qualitative study, which was conducted as a phenomenology study. In this study, 24 pre-service science teachers for 14 weeks trained STEM activities. The data of the research was collected with a questionnaire with open-ended questions and by conducting semi-structured interviews with a preservice science teacher from each group and analyzed contently and descriptively in terms of 21st century learning environments. Preservice science teachers declared that STEM education developed their learning and innovation skills. Finally, it was ascertained that the STEM education provided to the development of the 21st century skills of preservice science teachers.

Keywords: 21st century skills, STEM education, preservice science teachers

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INTRODUCTION

Rapidly scientific and technological developments in the global world and the technologies that replace manpower are the most important indicators of different professional groups. Hence, countries are necessary to train personnel for a profession that doesn't exist for the time being as well as to make significant arrangements as soon as possible to be able to adapt easily to the changes (Tarhan, 2019). It has now become to produce the information for creating the information society rather than accessing the information (Levy & Mundane, 2006). In other words, it is inevitable to transform the industrial society into an information society (Anderson, 2008; Voogt, 2008). To achieve this, the competencies that individuals need to possess significantly changed, and now, the individuals are expected to master critical thinking, communication as they are expected to be creative, innovative, flexible, compliant, self-confident, and very competent in teamwork (Robinson, 2011). Moreover, these qualities and competencies are often referred to as 21st century skills (Anderson, 2008). These skills constitute the knowledge, skills, and tendencies that citizens need to be able to contribute to the information society (Voogt & Roblin, 2010).

Since it is necessary to fulfill the economic and social demands of the globalized world, there have been many developments in education as well. The role of schools in society has been significantly altered and the need for constant improvement of the quality of education has led to focus on 21st century skills and the actions to take so that the individuals acquire these skills (Bryan, et al. 2015; Brophy, et al., 2008; Morado, Melo & Jarman, 2021; National Research Council [NRC], 2012; Voogt & Robin, 2010; Yang & Baldwin, 2020). This transformation influences many factors including the technological infrastructure and the skills of the teachers. Consequently, it is concluded that 21st century skills should be included in the curriculum of schools (Anderson, 2008). In addition, students and teachers, who are the real stakeholders of the education system, have to be a part of this transformation as well. It is impossible to ignore the competencies, practices of the teachers as well as their beliefs on the education for the realization of this transformation (Trier, 2002). Hence, teachers are expected to have the targeted 21st century skills together with the pedagogical competencies to achieve the goals determined in education (Gordon, et al., 2009; Author, 2017). Thus, it was essential to redefine the qualities and skills of the teachers and students. The effects of the transformation in the global world on education weren't limited to the definition of the 21st century skills in education. If we examine the literature of recent years, we witness the development of pedagogical approaches for training individuals on 21st century skills so that the information society emerges. One of these approaches has been STEM education, which is based on the integration of the disciplines, which have been considerably emphasized and implemented in recent years (Alberta Education, 2007; Beane, 1991; Bybee, 2013; Harrel, 2010; Martín-Páez et al., 2019). Thus, STEM education has become the main focus of 21st century education programs (National Academy of Engineering [NAE] & NRC, 2009; NRC, 2012). Many research indicate that STEM education develops the 21st century skills (Author et al. 2021; Bybee, 2010; Han, Kelley & Knowles, 2021; Idin, 2020, Perignat & Katz-Buonincontro, 2019; Sahin, 2015; Sthele & Burton, 2019; Tytler, 2020). The purposes of STEM education are not exclusively for students but they are also valid for teachers and STEM education aims to increase the knowledge of teachers on the content and pedagogical matter knowledge. It is essential for teachers to learn how to teach the skills that will be acquired through STEM education and what can be done for teaching (Crane, et al., 2003). Accordingly, it is believed that it would be beneficial pedagogically if the teachers, who will provide STEM teaching, experience this education before providing the actual education. Certainly, teachers frequently use their own educational experiences in designing teaching processes (Burns & Sinfield, 2004; Minton, 2005; Tennant, McMullen & Kaczynski, 2009). Hence, it is crucial for teachers to experience this education as a student (Penuel, et al., 2007). Accordingly, hands-on STEM education for the teachers should be prepared for teachers. When all of these factors are considered together, it is crucial to provide pedagogical educations both to teachers so that the teachers acquire the 21st century skills with in-service and preservice education and to the students so that they acquire the 21st century skills. Hence, it is crucial to create an interdisciplinary STEM education framework that analyzes the nature and scope of STEM education integration and the factors related to its scope, purpose, implementation and consequences, and to examine the impact of this education on 21st century skills.

In accordance with this importance, STEM education was conducted to teachers before they began to work in this study and the evaluations of the teachers on the contribution of STEM education on the development of 21st century skills were examined. Consequently, this study aims to examine the evaluations of the teachers, who participated in STEM education, about the contribution of this education on the development of their 21st century skills. In line with the aims of this study, it will be useful to explain the importance of STEM education in the development of 21st century learning skills and learning environment, teachers' skills and 21st century skills:

21st century Learning Skills and Learning Environment

21st century skills in the literature are often called individual qualities, thinking skills, life skills, survival skills, key competencies, necessary skills, employability skills, deep learning skills they are classified in many categories by many different institutions, organizations, and researchers (e.g., Ananiadou & Claro, 2009; Assessment and Teaching of 21 Century Skills [ATCS] Project, 2010; The Partnership for 21st century Learning [p21], 2015;). If we examine the classifications, it is possible to observe that the following skills are the most repeated; creativity, critical thinking, problem-solving, Collaboration, Communication, Information and Communication Technology (ICT) literacy productivity and Social and cultural skills/ citizenship. However, critical thinking and problem-solving skills are included in several different classifications (Ekici, et al, 2017; Voogt & Roblin, 2010). However, they have exclusively included core subjects in some classifications for education and learning purposes. In this study, 21st century skills are studied for educational purposes, since it is necessary to develop some thoughts and insights for assigning the 21st century skills. Hence, the 21st century learning skills are reviewed. It has been emphasized in almost all classification thoughts that the acquisition of skills in 21st century learning environments should be realized around the core and interdisciplinary subjects. Therefore, these issues can be considered a necessity for 21st century learning environments.

In this study, the framework presented in Figure 1 is reviewed, based on the classification created by p21 for learning environments, as emphasized (Ministry of Education of Turkey, 2018), both in many other classifications and the science education program in Turkey.

Figure 1. 21st century learning environment

p21 asserts that the factors mentioned in the framework should be supported by standards, assessments, curriculum and instruction, professional development and learning environments. The fundamental skills that students need to possess to solve complex problems in the global world and to be able to adapt to the change are classified as learning and innovations skills (4C). These skills essentially are as follows; critical thinking and problem solving, creativity and innovation, communication and collaboration. In addition to these skills, it is expected that the individuals possess the following skills as well; decision-making, analytical thinking, entrepreneurship, global world awareness, career awareness, flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, leadership and responsibility skills (p21, 2015; Ananiadou & Claro, 2009). It attracts attention that these skills are also included in the classifications in the literature.

- Creativity and innovation skills require that the individual produces new, diverse, and unique ideas based on analytical and scientific knowledge; evaluates the ideas of other people during the production so that the individual contributes to a specific field (Chien & Hui, 2010).

- Critical thinking involves logical thinking and reasoning so that the individual can decide on what to do and what to believe (Evancho, 2000). The problem-solving skill involves applying the solution innovatively by obtaining information for the solution and developing a different perspective (Ulupınar, 1997).

- Communication skill is expressing thoughts orally and in writing for informing other situations, motivating, persuading, etc., listening to others for comprehending the opinions or the situation and doing it effectively (p21, 2015). Collaboration occurs when a person works tolerantly and respectfully with other teams to accomplish a common goal (Kay & Greenhill, 2011; p21, 2015).

- Scientific process skills constitute a set of skills that are adopted for many science disciplines and regarded as a reflection of the accurate behavior of scientists (AAAS, 1990).

- Decision-making is described as a process that requires choosing from alternatives to achieve a specific goal or to achieve the goal (Forman & Selly, 2001).

-Analytical thinking is defined as breaking down complex problems into single and manageable components. If a person is analytical, the person solves the problem with all its dimensions (Panprueksa, 2012).

-Entrepreneurship is defined as launching a new product to the market and the entrepreneur, similarly to the engineering design process, observes the environments, discovers the needs, expresses clearly the ideas, chooses among the ideas, creates a product, tests the products, adapts the product to the environment and manages the marketing process (Deveci & Çepni, 2014).

-Motivation constitutes a force that initiates the behaviors needed for fulfilling a certain need (Walterman, 2005). Individuals are expected to maintain their motivation to continue a job.

When designing 21st century learning environments, activities should be presented to the students so that they can express and experience their ideas and they can produce. There must be people and physical support in place in the environments (p21, 2015, Kay & Greenhill, 2011). Hence, it is possible to allow the students to confront real-life problems so that they find creative solutions after evaluating the ideas of other people. To develop collaboration, and teamwork skills in the process, instructions should encourage teamwork as well.

In the 21st century, it is expected individuals who can think critically, solve problems, communicate effectively and work in collaboration, master the core subjects described as the interdisciplinary themes by the nature of the issues/themes in terms of academic subject knowledge. Each individual must be literate in terms of finance, economics, globalization, profession, entrepreneurship, civil, health, environment, which are the indicators of the development of countries and which master today's world in addition to the subject's literature, foreign language and subjects of science, history, geography, and citizenship, which can be described as the fundamental disciplines (Bransford, Brown & Cocking, 2000; Kay & Greenhill, 2011; p21, 2015). When designing learning environments, building a daily-life context about 21st century subjects and themes can help to explain these subjects.

Hence, in the 21st century's knowledge society, individuals are living in close connection with the information, technology, and media (Bransford et al., 2000; Kay & Greenhill, 2011; p21, 2015, So, it is a necessity for these individuals to be literate of information, media, and technology. Information, media, and technology literate individuals are defined as individuals, who can access information through the media and technology and can analyze and evaluate the information/data they obtain and use the knowledge to solve the problems (Kay & Greenhill, 2011; p21, 2015). To train individuals so that they acquire these skills, technology and media tools should be included in the learning environments and students should be provided the opportunity to use and evaluate these tools and even to create technology and media products.

In today's conditions, knowledge and skills are not exclusively sufficient to maintain life, and it is necessary to have the life and career skills mentioned as "flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, leadership and responsible".

While modernizing the learning environments of the 21st century, teachers, as the persons with whom the students interact most after their family and friends (Palfrey & Gasser, 2008), should have the knowledge and skills to successfully manage this learning environment. Thus, the success of various projects related to the establishment of the 21st century learning environment was defined with the fundamental criteria of the adaptation of the pedagogical skills of the learners and teachers (National Center Education Statistics [NCES], 2002). The 21st century learning environment can reach its goal only with the teachers, who know the skills of the students and can guide the teaching process in accordance with these skills (Harris, Mishra & Koehler, 2009; Mazman & Koçak Usluel, 2011). Thus, it is inevitable to need the 21st century teachers, who know the students very well (Melvin, 2011), can create a 21st learning environment for them and guide the students in terms of teaching-learning processes. The 21st century teachers must also be able to adapt to the 21st century conditions, and the teachers should certainly learn the 21st century skills, as the teachers are also the students.

STEM Education and 21st Century Skills

The countries need to train individuals, who can think critically, creatively, and analytically in the 21st century, have high communication skills, can develop solutions to the problems they encounter in daily life, make decisions, conduct studies, interrogate and make conscious decisions in the future career choices (Cantrell & Ewing-Taylor, 2009; Holmes et al., 2018; Kızılay, Yamak & Kavak, 2020; Kier et al., 2014; NAE &NRC, 2009; Tuijl & Molen, 2016). Together with the transformation observed in the world and the structure of the problems, the qualifications required from individuals have changed as the educational policies, approaches, and strategies have been altered as well. In addition, the curricula and teaching, professional development, strategies, and conditions for implementation should be taken into consideration for the implementation of the 21st century skills. This requires an interdisciplinary vision (Vooght & Roblin, 2010). STEM education, which is based on the integration of disciplines particularly for solving the complex problems we encounter in everyday life and for help individuals to acquire the 21st century skills, is specifically recommended for the integration of 21st century skills into teaching, and in recent years, many countries implement this system as one of the most effective educational approaches in the education system (Myers & Berkowicki, 2015; Slavin, 2014).

STEM education signifies a teaching approach based on the integration of the disciplines of science, technology, engineering, and mathematics, aiming to train individuals for 21st century skills so that they can provide solutions to challenges from an interdisciplinary perspective (Bybee, 2000). As it is clear by its definition, STEM aims to develop skills such as scientific process skills, interrogation, critical thinking, and problem-solving skills rather than providing exclusively knowledge (Bender, 2015; Bryan et al. 2015). Comprehending the ways and processes of achieving the integration of the STEM disciplines will, therefore, make it simpler to recognize the role of STEM in helping individuals to acquire these skills.

STEM education process requires the implementation of the scientific method through integrated engineering design to be able to solve authentic, realistic problems, that require the use of science and mathematics, in a meaningful, rich, and social context through integrated engineering design (Bryan & Guzey 2020; Hmelo, Holton & Kolodner, 2000; Lewis, 2006; Mehalik, Doppelt & Schunn, 2008; Myers & Berkowickz, 2015; Roth, 2001). The daily life problems are presented to the students and it is beneficial for the students to search for a solution to these problems so that the students can acquire problem-solving skills and develop other analytical skills. In addition, their interest and understanding of disciplinary concepts of STEM are increased (Gallant, 2011; Yang & Baldwin, 2020). In STEM education, since there is more than one solution to the problems, the students are expected to present more than one solution, coherent with the scientific knowledge and the solution should be different and should have the potential to be developed. The students are also required to evaluate all the solution proposals communicated by everybody (Bozkurt Altan & Hacıoğlu, 2018). Hence, this greatly contributes to the development of the creative thinking and critical thinking skills of the students (Hacıoğlu, 2017; Hacioglu & Gulhan., 2021; Bozkurt Altan & Tan, 2020; Wan, So & Hui 2021,).

Although there are many methods to integrate STEM disciplines (Bybee, 2000), design-based engineering or technology applications are recommended (Leonard, 2004; Wendell, 2008; Mehalik, et al., 2008). In design-based education or STEM education, engineering or technology design process is required to be realized and there is a need to create a product (Bender, 2015; Felix, 2016; Fortus, 2003; Fortus, et al., 2004; Fortus, et al, 2005; Wendell, 2008).

While this process improves the knowledge of students on science, it also helps to develop the design skills of the students (Kolodner, 2002; Leonard, 2004; Yang & Baldwin, 2020). This process is highly based on teamwork and collaboration (Myers & Berkowickz, 2015). As this is closely related to the modern working environment, (Bender, 2015), it is highly influential in the increased level of self-confidence of 21st century individuals and the developed communication skills (Smith & Karr-Kidwell, 2000; Kolodner, et al., 1998). In addition, during the process, it is expected that the decision-making skills of the students will be improved since they will be evaluating the suggestions on the problem and creating the products (Bozkurt, 2014). Furthermore, the integration of technology and mathematics disciplines aims to develop technology literacy, algorithmic thinking, and thinking skills based on calculations (Çorlu, 2017).

To obtain information particularly about the science discipline, it is essential to include the interrogation together with the design processes for the process of solving problems (Wendell, 2008; NRC, 2012). This greatly contributes to the development of the science process skills of the teachers (Bozkurt, 2014).

METHOD

This research, which investigates the effect of STEM education on preservice science teachers' 21st century skills as their evaluations, is a qualitative phenomenology study. It is discussed in phenomenology studies that the participants feel about their experiences, their perceptions, and thoughts and how they structured them and what kind of a state of consciousness they created in themselves (Van Manen, 2007). This research includes the opinions of preservice science teachers, taking STEM-based science teaching laboratory courses, about the contribution of STEM education in the acquisition of the 21st century skills.

Participants

In this study, the non-probabilistic (purposeful) sampling technique was used because the STEM education experiences of preservice science teachers were important. The study group consists of 24 preservice science teachers (19 female and 5 male teacher candidates) that they are a student in third-grade in an education faculty of a state university in 2017-2018. The study group voluntarily participated in the study. In this study, the participants were mentioned by coding as PST1 (preservice science teacher 1), PST2, …., PST24.

STEM Education Experiences and 21st century skills' knowledge of Preservice Science Teachers

The preservice science teachers who participated in this study did not have sufficient knowledge and experience in STEM education, while they had previously taken courses about 21st century skills and have knowledge about them. To evaluate STEM education in terms of 21st century skills, it is important that they had experience about STEM education. For this reason, it was ensured that they experience via STEM activities. These activities were previously developed, applied and validated by the author for another study (Hacıoğlu, 2017) in accordance with engineering design-based science education that manages the engineering design process. In this study, the activities were applied for 4 hours each week for 14 weeks during the Science Education and Laboratory Implementations II course (September 2017- February 2018) with the participants different from participants in the study of Hacıoğlu (2017). In the preparation of the learning environment and during the process, the points emphasized in the theoretical framework for the development of the 21st century skills were taken into consideration. In this study, preservice science teachers carried out three STEM units include three grand design challenges ***(designing a straightener for clothes, designing an environment friendly vehicle, designing a sanitizer).*** Each of the grand design challenges consists of mini designs and mini research that will enable the preservice science teachers to acquire the knowledge and skills needed to achieve a considerably great design and complete these great design challenges. In this research, preservice science teachers carried out 8 mini research and 7 mini design challenges regarding 3 grand design challenges. In the whole process, the engineering design process and the research inquiry process were carried out together and repeatedly. For each STEM units, first, the problem statement was given for each grand design challenge and it is explained. After determining the criteria and limitations of the design challenge, searched the needs of problems and mini designs and mini research were carried out, where they will gain the necessary knowledge and skills to develop possible solutions. The engineering design process for each mini design, the inquiry process for each mini research were carried out and over again. Thanks to the knowledge and skills obtained as a result of mini research and mini designs, the participants suggested solutions for the grand design challenge, evaluated the solutions in the context of criteria and limitations, selected the best solution, designed a prototype, tested, revised and presented the best solution. Eventually, they completed their grand design challenge. It took a minimum of two weeks and a maximum of 4 weeks to complete each major design task. Detailed information about this activity can be found in the study of Hacıoğlu (2017).

Research Instruments and Procedures

The data of the research was collected with a questionnaire with open-ended questions and by conducting semi-structured interviews with a student from each group. In the questionnaire with open-ended questions, preservice science teachers were asked to share their opinions about STEM education's impact on the development of 21st century skills as *"Do you think STEM education has an impact on the development of your/learners' 21st century skills? If you think that STEM education effects learners' 21st century skill development, please indicate which skill it has. Explain your opinion in detail with its reasons. "* . To support the data obtained from open-ended questions, semi-structured interviews were conducted with a total of five preservice science teachers (PST1, PST2, PST3, PST4, and PST5).

Data Analysis

In this study, the steps of qualitative data analysis were followed; content and descriptive analyses were conducted. First, the data obtained from open-ended questions were coded for content analyses and their frequencies are determined. Then, in the process of creating themes by categorizing the generated codes, it was seen that the pre-service teachers did not only evaluate the process in terms of skill development but also in terms of the 21st century learning environment. So, the codes about the same subject were categorized in terms of 21st century learning environments in Figure1. To support the data obtained from open-ended questions and ensure reliability, the data obtained from the semi-structured interviews were analyzed descriptively in terms of 21st century learning environments. For the validity and reliability of data analysis, the researcher analyzed and compared the same data at different times. In this study, quotes of the opinions shared by the participants are given to assure the validity of the results.

The findings obtained from open-ended questions are given by using separate radar diagrams for each theme to be more detailed and descriptive, rather than tabulated. The explanations of the teacher candidates (the quotes) in the relevant category and the findings obtained from semi-structured interviews were interpreted under the relevant diagram. The quotes from interviews were given frequently because they are more detailed from the open-ended questions.

FINDINGS

The findings obtained from the answers of the preservice science teachers to the open-ended question related were categorized according to the dimensions of the 21st century learning framework.

The codes and frequencies for the theme of "Learning and innovations skills" are presented in Figure 2 in a radar diagram.

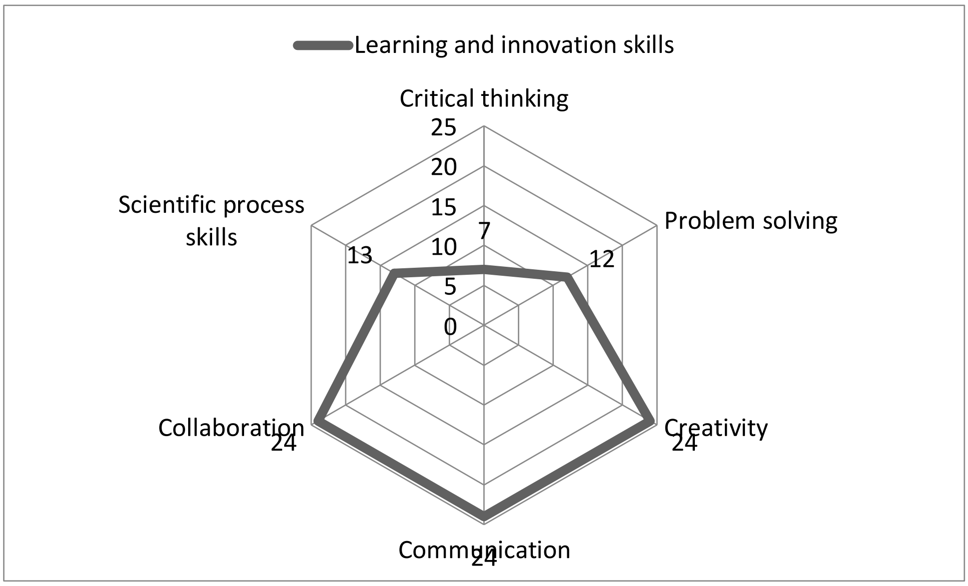

Figure 2. Findings in the theme of "Learning and innovations skills"

Examining answers of prospective science teachers related to themes of "Learning and innovations skills" (Figure 2), it is seen that they declared that STEM education contributed to the development of learning and innovation skills. However, all preservice science teachers stated that exclusively STEM education developed their skills of creativity, communication, and collaboration among the learning and innovation skills. When the explanations of the preservice science teacher are considered; they have explained the development of their creativity by the fact that they have offered many solutions for solving a problem encountered in daily life. They have also mentioned that their ability to work a team and collaboration has been increased and since they conducted some mini research and they needed the scientific information for solving the problems, this education program contributed to the development of their problem solving, critical thinking and scientific process skills.

PST1 explained that STEM education provides the development of creative thinking skills: *"... We had to use our creativity to create a solution and we have realized that we couldn't use the same material for everything and we have realized that we need to produce. We used and developed our creativity while testing our solution proposal and redesigning the design we have previously created…*

and added that STEM education needed to use collaboration and communications skills, so it provides the development of these skills:

"…Hence, communication was the most valuable skill. In the end, we were working as a group, we need to discuss, communicate and work together to make decisions and optimize our solution. As we were working as a group, I think that our collaboration skills have improved…"

Like PST1, PST5 stated also that STEM education provides the development of collaboration and communications skills. And also, he/she emphasized that it provides the development of critical thinking skills:

"In some groups, even people who don't have a friendly relationship learned to work as a team for the sake of common purpose. Therefore, we have learned how to express ourselves, to listen to each other, to comprehend what we mean... ".

On the other hand, PST4 explained the development of science process skills by the fact they have used the inquiry skills when conducting a study:

"…We have obtained necessary information by conducting experiments for solving the problem. I think this STEM education program contributed to my development in terms of number-space relationship, observation, the establishment of a number-space relationship, deduction, and comparison. Because we have used them in the process and we have realized our designs with the skills we have obtained…".

PST 13 explained the development of problem-solving skills by the fact the design process run to challenge of real-world problem:

"...In all units, the process started with a real-life problem and we designed to solve this problem. The more solutions we offer, the more successful we have been. That's why the process improved our problem-solving skills as creativity…".

The codes and frequencies for the theme of “Life and career skills” are presented in Figure 3 in a radar diagram.

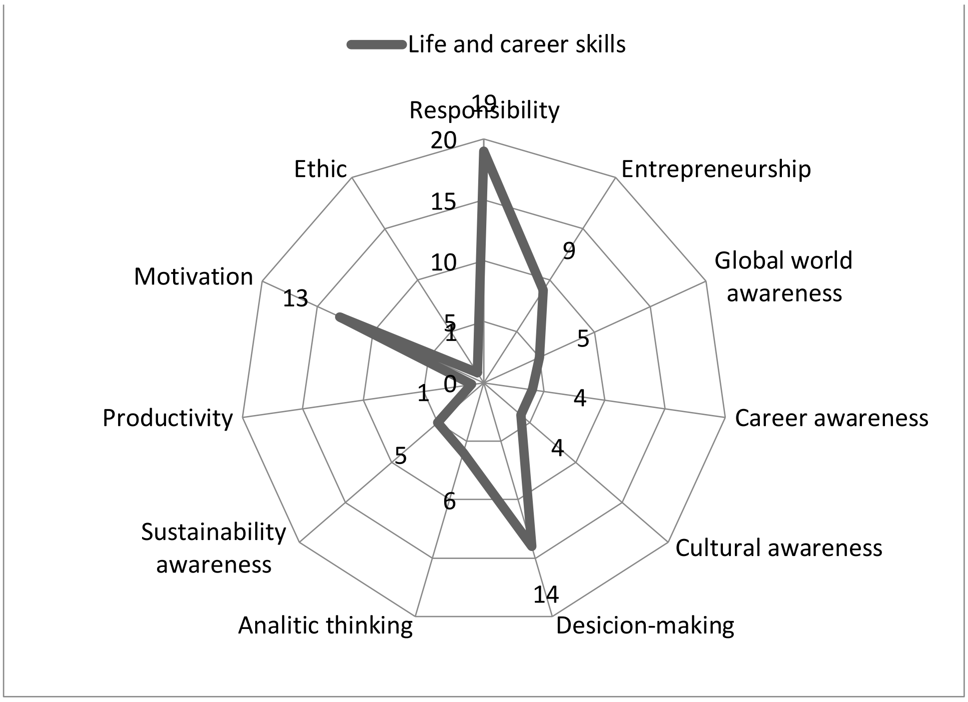

Figure 3. Findings in the theme of "Life and career skills"

Examining answers of prospective science teachers related to themes of "Life and career skills" (Figure 3), it is seen that they stated frequently that STEM education provides responsibility, decision making, motivation, and entrepreneurship skills. They have explained this by the fact that they have strived seriously to find a solution to the problem or to complete a design challenge or choose the best solution among the solutions or options.

PST16 stated their opinion about the effect of STEM education on responsibility:

".... The process begins with a problem-solving task. Therefore, students need to be active while solving problems, designing experiments, generating solutions, and designing the prototype. Each of these requires him to take responsibility and fulfill his task within the group. Therefore, a sense of responsibility develops also... "

Preservice science teachers stated their opinion about the effect of STEM education on decision-making skills by associating with the process. PST1 stated:

"...We had to use our decision-making skills when deciding on the best solution.... " and PST7 stated:

"... To be successful in solving the problem, it is important to choose one of the solutions and to decide how and what material we will use in the realization of the prototype. For this, both critical thinking skills and decision-making skills are developed by taking into account the opinions of others... "

PST5 stated during the interviews about motivation:

"... We have designed during the process, and completing a design has considerably increased our motivation. Maybe we were bored, sometimes because we were impatient, but we were satisfied with the designs that we have created, and we were happy and motivated, and we wanted to see the designs our friends created. At first, we wondered what we could do, whether we could truly create a successful design. Now we are investigating everything, outside of the course as well. ... "

and added her/his opinion related to the effect of STEM education on career awareness, unlike most other prospective science teachers who address career awareness unlike most prospective science teachers:

"... I can say our general interest in life has been improved. In fact, I can say that my career awareness has also increased. I apprehended the relationship between professions and disciplines. It also contributed to my career since I was going to use them as a teacher..."

Like some preservice science teachers, PST 22 stated that STEM education provides the development of entrepreneurship of learners:

"... It also improves entrepreneurship skills. For example; When I am a teacher, I can make different designs for my students and patents them..."

Preservice science teachers mentioned that STEM education affects sustainability awareness. PST18 stated explained:

"... In fact, we paid attention to choosing materials that are both environmentally friendly and can be used for a long time, with low cost in all design tasks. This improves the awareness on sustainability. For example, the problem with the task of designing air and water-powered vehicles served this as well ..."

Some preservice teachers stated that STEM education develops also analytical thinking skills for example PST21 explained:

"... We determined research questions to solve all problems - grand design challenges. We gradually obtained the necessary information to solve the problem thanks to mini design and mini research, and discussed how each would help solve the problem. So we tried to solve the problem piece by piece. This improves analytical thinking skills in my opinion... "

Only PST19 emphasized the ethical dimension of the process and explained it by associating it with its effect on cultural awareness:

"... While we were solving the problems, we realized that the ethical dimension is also a criterion or even a limitation. For example, in the disinfectant design process, we had to make an ethical decision, taking into account the usefulness and the harmful feature. We also took care to use substances that are compatible with religious views of societies.... " Only PST6 mentioned the effect of STEM education on productivity:

"... I realized that the more solutions we offer for each design, the more successful we will be in solving the problem. This improves our productivity with creativity. If STEM education is carried out, we get used to productive thinking.... ".

The codes and frequencies for the theme "Core subjects for science course" are presented in Figure 4 in a radar diagram.

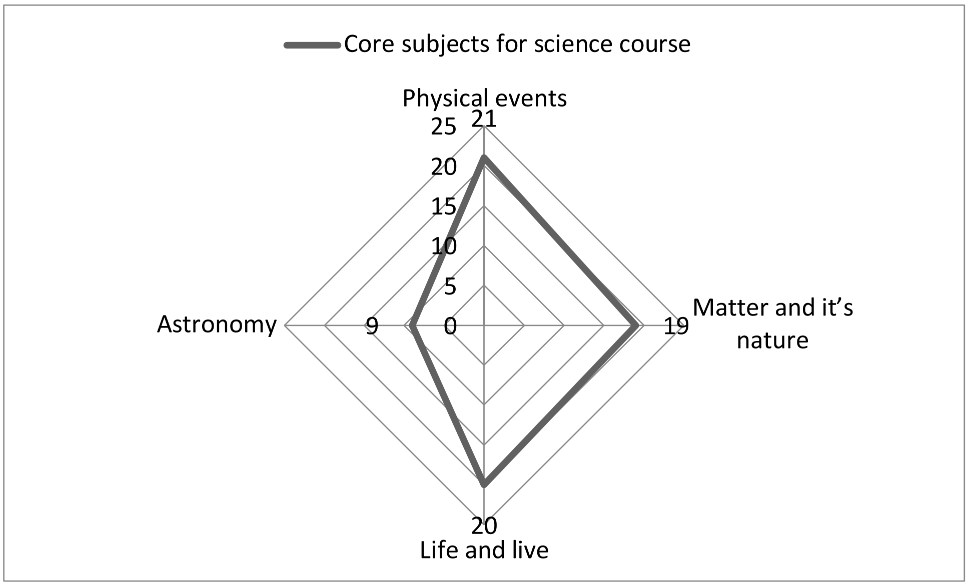

Figure 4. Findings in the theme of "Core subjects for science course"

Examining answers of prospective science teachers related to "Core subjects for science course" (Figure 4), it is seen that all preservice science teachers declared that STEM education provides the teaching of science subjects related to 'physical events', 'life and live', 'matter and its' nature' and/or 'astronomy' thanks to STEM education. They explained this situation related to their STEM education experiences. They frequently stated that they learned the science concept and subjects thanks to the implemented activities. For example, PST16 stated that STEM education affects positively learning of knowledge about physical events: *"...I think that STEM activities are effective in understanding physical phenomena since they are mostly related to physics subjects. For example, we learned about heat, heat, heat and electricity transmission and insulation while designing irons. If we had designed a vacuum cleaner, we could learn about electricity, pressure, and sound transmission, and we could develop an understanding of these concepts. But I think it will improve knowledge in all science subjects. The research problems we use in our designs are aimed at improving the information stage…".*

PST2 explained their opinions by giving example related to core subjects of 'matters and its nature':

"…We have realized that we need to use science subjects for solving daily life problems and hence, our awareness about these issues has been significantly increased. For instance, I have realized that we had to take into account the characteristics of a substance when using the substance in a design or a product. We have developed our knowledge, particularly when

combining materials having different properties. This is valid for all science subjects according to the discipline knowledge required to solve the problem we encounter…".

PST 12 explained also their opinions by giving example related to core subjects of 'life and live':

"…For example, in the disinfectant design unit, we investigated the classification of living things, which creatures are microbes and cause diseases, and how their structure, living conditions are reproductive, growth and development. Then, we designed our disinfectant by thinking about how to eliminate these conditions…".

However, it is noteworthy that they least mentioned the contribution of STEM education to the development of knowledge about astronomy that isn't context or content in the implemented activities. PST 24 explained about it:

"We did not organize activities in STEM activities in the field of world and universe learning, but I think STEM can increase knowledge and skills in all learning areas. For example, if we or students are given a problem or a design challenge in the context of world and space, we need to obtain space information to solve it…".

The codes and frequencies for the theme "Interdisciplinary themes" are presented in Figure 5 in a radar diagram.

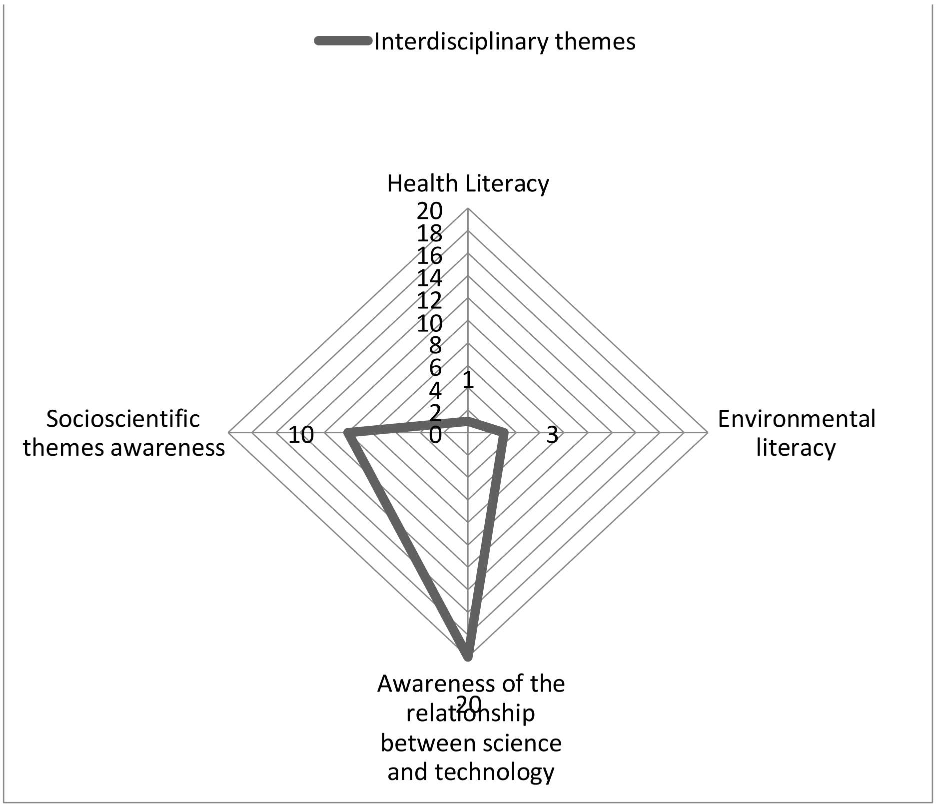

Figure 5. Findings in the theme of "Interdisciplinary themes"

Examining answers of prospective science teachers related to themes of "Interdisciplinary themes" (Figure 5), it is seen that some preservice science teachers declared frequently that they solve problems with interdisciplinary themes knowledge, so they needed and learned to knowledge related to disciplinary themes thanks to STEM education. Most of them stated that it provides awareness of socio-scientific themes -and especially- awareness of the relationship between science and technology. For example, PST3 shared her/his opinion during the interview as well and stated:

"Students can learn about professions with such practices. I raised awareness of the environment and sustainable development in terms of product design. I have said so many times. While we were learning science, we are using the information but we are not producing anything. From this perspective, we have learned to use the relationship between science and technology. The problem used in STEM education is generally a problem that we encounter every day in life. These problems are both scientific issues and social issues. This education allows finding a solution to socio-scientific issues or at least having the knowledge. Even if you talk about these issues, your awareness is raised."

Some preservice teachers explain the process related to the context of the problem situations like PST22 and mentioned that STEM education develops environmental literacy. For example, PST17 stated:

"...The disinfectant we will use also had a criterion of not harming the environment. The purpose of the vehicle design that works with air and water was to design a vehicle that does not harm the environment. I think that the information and process -we obtained while solving these design tasks- affected positively our attitude and behavior towards the environment. Thanks to STEM activities to be carried out in the context of similar environmental problems, students' environmental behaviors can also change positively....".

Only PST22 mentioned that STEM education affected his/her health literacy related to the context of design problems situation as PST:

"...We can say that our awareness about health has increased and even our literacy has increased. We designed a disinfectant to find a solution to a health problem. But we did not only use scientific knowledge to solve this problem. We felt the need to read articles about health. We read and used the knowledge in our disinfectant design...".

RESULTS AND DISCUSSION

Preservice science teachers stated that STEM education considerably contributed to the development of 21st century knowledge and skills. In fact, STEM education involves combining at least two of the STEM fields, together with the use of knowledge, skills, and beliefs of the individual in these fields (Çorlu, Capraro & Capraro, 2014).

Preservice science teachers mentioned that STEM education helped them to develop their scientific knowledge that is needed for solving the problem given in the process and they have also stated that their awareness on interdisciplinary themes has been increased. Acknowledging that it will be complicated to realize designs without science content knowledge (NRC, 2012).

This is an expected result since the participants have conducted mini research preservice science teachers also expressed that STEM education does not only increase disciplinary learning but also improves their awareness of socio-scientific issues as well (Abdullah, Halim & Zakaria, 2014; Crismond, 2001, Cotabish, et al., 2013; Martín-Páez et al. 2019; Struyf et al. 2019). We assume that it is related to the fact that the daily life problems used in the process involve much interdisciplinary information and socio-scientific issues such as cancer, climate change, and energy need (Çorlu, 2017). Consistent with this assumption, prospective science teachers think that STEM education will increase their awareness of the relationship between science and technology and socio-scientific issues. Although not the majority, they think that it will raise awareness about health and the environment in the context of the problem issue. They stated that core concepts have also developed while finding solutions to these interdisciplinary issues. As the developing core concept, 'physical events', 'life and live', 'matter and its nature' and 'astronomy' respectively. When the activities related to STEM were examined, it was seen that there were many physical events and activities. However, contrary to the opinions of the teacher candidates, it was stated that the activities in life science and astronomy were limited (Hacıoğlu, 2017; Roehrig, et al., 2021). It can be suggested to increase the STEM activities and applications related to these core concepts to support these opinions of teacher candidates.

Preservice science teachers stated that STEM education helped them to develop creativity, communication, collaboration, critical thinking, and problem-solving skills, which are mentioned as fundamental skills. In addition, they have mentioned that the process contributed to the development of responsibility, decision-making, entrepreneurship, analytical thinking, global world awareness, sustainability awareness, career awareness, cultural awareness, and productivity skills among the life and career skills. Preservice science teachers have also expressed their ideas as they have supported the related literature.

Preservice science teachers have regularly stated that STEM education develops the scientific process skills among the 21st century skills required for science learning as Meyrick (2011), Park et al. (2011) and Parno, et al. (2018, 2020). They declared that the development of these skills was ensured by the small research and research/experiments they have realized for solving the problem. As the experience of teachers or preservice teachers in terms of STEMoriented implementation increases, the skills develop, as many researchers stated (Bozkurt, 2014). Many researchers, by relating the results to the nature of the engineering design process, have stated that STEM education supported the development of critical thinking and creativity (Hacıoğlu, 2017; Kim & Choi, 2012; Kim, Ko, Han & Hong, 2014; Kwon, Nam & Lee, 2012), scientific process skills and decision-making skills (Bozkurt, 2014;). In design-based STEM education, participants strive to solve a problem while trying to complete a design challenge (Fortus, et al., 2004; Lin et al., 2021; Parno et al., 2019). To achieve this, individuals need to offer more than one solution (Silk & Schunn, 2008), so that, as the preservice science teachers indicate, it is expected to use and develop problem-solving and creative thinking skills (Hagay & Baram-Tsabari, 2015; Mentzer, 2011). Although in this study preservice science teachers don't emphasize the effect of STEM education on productive thinking skills, detailed studies in the literature that STEM education improves creativity skills reveal that STEM education also improves students' imagination and productive thinking skills as they design (Aranda et al., 2020; Lin et al, 2021; Guzey & Jung, 2021). When preservice science teachers emphasized their critical thinking, collaboration, and communication skills have been improved when they are elaborating the opinions of other people and work in a group, this opinion supports the views of Kolodner, et al. (1998). Furthermore, their research proved that interdisciplinary STEM education has developed the scientific process (Sullivan, 2008), decision-making skills (Bozkurt, 2014), as well as critical thinking and problem-solving skills (Bybee, 2010). Some research (Baran et al. 2019; Lin et el., 2021; Guzey et al., 2016; Guzey & Jung, 2021) stated that STEM teachers believe that students who attend STEM education might become more interested in STEM fields.

Preservice science teachers stated that they were striving to perform their design challenges and their efforts to find a solution to the problem, and hence their skills of being responsible and motivated have been increased during STEM education. Supporting these views of teachers, Moore (2004) states that finding solutions to authentic engineering problems in the Stem education process increases students' motivation to solve real-life problems. Preservice teachers explained also that STEM education provides entrepreneurship skills. Since complex interdisciplinary problems are solved in STEM education, entrepreneurship skill is also important and can develop (Flanagan 2020). In addition, the fact that they are aware of the fact that they can produce since they can create a design also indicates that STEM education contributes to the skills expected from an individual living in the 21st century (Robinson, 2003). Certainly, one of the common aims of STEM education is to increase the interest in STEM fields, but also to develop the skills that individuals should possess in daily life and career processes (NRC, 2012; Lin et al., 2018; Lin et al., 2021).

Since preservice science teachers have conducted research and implemented practices in interdisciplinary fields during the process, they have mentioned that their knowledge about other professions, activities, the career fields has been increased. Undoubtedly, one of the aims of STEM education is to increase the interest in STEM areas and to increase the awareness of individuals in these fields by creating a career awareness (NRC, 2012; Accelerating Strategies for Practical Innovation and Research in Economic Strengthening [ASPIRES], 2013; Park & Lee, 2014). In fact, studies have revealed that STEM education increases the perception and awareness of the individual's career (Baran, et al., 2016; Bishop, 2015; Guzey, Harwell, Moore, 2014; Heaverlo, 2011; Kutch, 2011; Holmes et al., 2018; Wang, Ye & Degol, 2017; Wayne Long, 2012). Thinking that the students do not know enough about the engineering profession (Gibbons, Hirsch, Kimmel, Rockland & Bloom, 2004; Hirsch, Capinelli, Kimmel, Rockland & Bloom, 2007; Spencer, 2011), it is hopeful to think the awareness of the teachers that will teach these issues to the students has been increased.

Remarkably, the preservice science teachers did not express their opinions on the development of information, media and technology skills among the 21st century skills. It can be considered that this is related that STEM education was based on engineering design. As the preservice science teachers focused on the integration of engineering discipline, they may ignore the literacy about other disciplines. Although this result constitutes a limitation of the research, it is limited to the practices implemented and the opinions of the participants. Finally, it was ascertained that the STEM education provided to the development of the 21st century skills of preservice science teachers.

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