SBedergi, 2022; 6(10), 84-107
DOI: 10.29228/sbe.62516

E-ISSN: 2602 – 4306 www.sbedergi.com

Geliş Tarihi (Received): 19.05.2022 Kabul Tarihi (Accepted): 29.05.2022

EXAMINING THE STEM COURSE PLAN PREPARATION SKILLS AND OPINIONS OF PRESERVICE SCIENCE TEACHERS ON STEM APPLICATIONS

Müzdelife KURT [1]
https://orcid.org/0000-0002-7049-3408

Semra BENZER [2]
https://orcid.org/0000-0002-8548-8994

Abstract

The main purpose of this study is to evaluate the findings of science teachers' STEM lesson plan preparation skills and self-assessment forms and to examine their views on STEM applications. STEM education is an effort based on the integration of science, technology, engineering, and mathematics to help individuals gain economic strength, enabling them to find solutions to real-life problems using the steps of scientific process. In the spring semester of the 2019-2020 academic year, science teaching at a public university in Ankara was carried out with 18 preservice science teachers (17 females, 1 male) who were studying in the 4th grade. Case study method was used from qualitative research methods within the scope of the study. The preservice science teachers who formed the study group primarily received basic STEM education and studied STEM studies. Preservice science teachers were asked individually to prepare STEM lesson plans that included environmental issues in the secondary school science curriculum. In the study, it is seen that most preservice teacher do not receive STEM education. Preservice teacher who are practitioners of the STEM approach can be provided with STEM education with courses to be given during the undergraduate period. In this study, when the views of teachers and preservice teacher are examined, it is understood that there should be projects and studies supporting STEM education activities in their university life.

Keywords: Science; Teacher candidate; Opinion; Self-evaluation; STEM

STEM DERS PLANI HAZIRLAMA BECERİLERİNİN VE STEM UYGULAMALARINA İLİŞKİN FEN ÖĞRETMENLERİNİN GÖRÜŞLERİ

[1] Öğretmen, Milli Eğitim Bakanlığı, Y.Lisans mezunu, mzdlfgkhnkrt@gmail.com
[2] Prof. Dr., Gazi Üniversitesi, Matematik ve Fen Bilimleri Eğitimi Bölümü, sbenzer@gazi.edu.tr

Alıntı (Cite): Kurt, M., & Benzer, S. (2022). Examining The Stem Course Plan Preparation Skills And Opinions Of Preservice Science Teachers On Stem Applications. SBedergi, 6(10), 84-107. http://dx.doi.org/10.29228/sbe.62516

Öz

Bu çalışmanın temel amacı, fen bilimleri öğretmenlerinin STEM ders planı hazırlama becerileri ve öz değerlendirme formlarına ilişkin bulgularını değerlendirmek ve STEM uygulamalarına ilişkin görüşlerini incelemektir. STEM eğitimi, bilim, teknoloji, mühendislik ve matematiğin bütünleştirilmesine dayalı, bireylerin ekonomik güç kazanmalarına yardımcı olmak, bilimsel süreç adımlarını kullanarak gerçek yaşam problemlerine çözüm bulmalarını sağlamak için yapılan bir çabadır. Çalışma; 2019-2020 Eğitim-Öğretim yılı bahar döneminde Ankara'da bir devlet üniversitesinde fen bilgisi öğretimi gören 4. sınıf 18 fen bilgisi öğretmen adayı (17 kadın, 1 erkek) ile gerçekleştirilmiştir. Araştırma kapsamında nitel araştırma yöntemlerinden durum çalışması yöntemi kullanılmıştır. Çalışma grubunu oluşturan öğretmen adayları öncelikle temel STEM eğitimi almış ve STEM çalışmaları okumuştur. Fen bilgisi öğretmen adaylarından bireysel olarak ortaokul fen bilimleri müfredatında çevre konularını içeren STEM ders planları hazırlamaları istenmiştir. Araştırmada öğretmen adaylarının çoğunun STEM eğitimi almadığı görülmektedir. STEM yaklaşımının uygulayıcısı olan öğretmen adaylarına lisans döneminde verilecek derslerle STEM eğitimi verilmelidir. Bu çalışmada öğretmen ve öğretmen adaylarının görüşleri incelendiğinde üniversite yaşamlarında STEM eğitimi faaliyetlerini destekleyen proje ve çalışmaların olması gerektiği anlaşılmaktadır.

Anahtar Kelimeler: Bilim; Öğretmen adayı; Fikir; Öz değerlendirme; STEM

INTRODUCTION

In a world where technology is constantly changing through innovation, education policies are also parallel the trend of globalization. An international approach is needed in which science and technology are more supported so that countries can find solutions to many global problems such as climate change, population density, reduced energy resources, and reduced water resources. One of these approaches is STEM which consists of the integration of Science, Technology, Engineering and Mathematics disciplines (Stohlmann, Moore, & Roehrig, 2012).

For more than 10 years, interest in STEM has increased in terms of both education and workforce. However, despite the current global interest, no universal definition has been formed (English, 2016). STEMhas been described as "students gaining knowledge and skills using different disciplines" or a "learning approach" (Honey, Pearson, & Schweingruber, 2014). STEM is also defined as an effort to combine the disciplines of science, technology, engineering, and mathematics with a single class, unit or lesson based on links between real-world problems (Moore & Smith, 2014).

STEM education is the name of an integrated effort that removes traditional barriers between disciplines, focuses instead on the process of solution complex problems using existing tools and technologies. STEM education requires programs that integrate

technology and engineering into the science and mathematics curriculum, also promotes the scientific research and engineering design process (Kelley & Knowles, 2016).

The STEM approach has two goals (Thomasian, 2011). These are to increase the number of individuals want to do careers in science, technology, engineering, and mathematics and increase the STEM knowledge of individuals. The second goal is important for students to be able to evaluate problems, use STEM concepts and find creative solutions in everyday life. The strong emphasis on the application of information underscores the philosophy of using STEM knowledge in STEM disciplines and studies in non-STEM fields (Thomasian, 2011). One of the goals of STEM education is to encourage individuals to become "STEM literate". STEM literacy, linking science, technology, engineering and maths disciplines aim to build different skills for each area. The first of these goals is scientific literacy which is the ability to use scientific methods to understand the natural world and accept the variables that affect it. The second is technology literacy which can use, manage, understand, evaluate technology, and analyze how new technologies affect our country. The third is engineering literacy which is formed by the effective use of engineering design processes and scientific and mathematical principles such as design, production, and operation of machines. The fourth is mathematical literacy which is the ability of students to come up with, formulate and solve solutions to mathematical problems in various situations, effectively analyze their ideas when interpreting, reason (APA, 2010).

STEM education and engineering practices contribute to the development of self-confidence of individuals. It provides the development of high-level skills such as logical thinking, problem solving, critical thinking. It allows the information they learn in individuals to be permanent, to associate the newly learned information with their previous knowledge, in short, to gain an interdisciplinary perspective. It allows individuals to develop their creativity in areas such as prototyping and designing which are the steps of engineering applications (Morrison, 2006).

It is reported that digital games can effectively promote and improve students' learning achievement in STEM education and improve our understanding of the application and practice of digital games in STEM education (Wang, Chen, Hwang, et al., 2022).

When studies with preservice teacher in STEM education are examined there are not many studies aimed at examining the skills of preservice science teachers to prepare STEM lesson plans (Arslanhan & İnaltekin 2020; Bannikova, Boronina, & Kemmet, 2016; Bektaş & Aslan, 2019; Bozkurt Altan & Üçüncüoğlu, 2019; Güleryüz, Dilber, & Erdogan, 2019; Kızılay, 2018; Öztürk, Yılmaz Tüzün, & Çakır Yıldırım, 2019; Schulz & Pinkwart, 2016; Timur & Belek 2020; Üçüncüoğlu & Bozkurt Altan, 2018; Yıldırım, 2017; Yıldırım & Türk, 2018; Walan & Gericke 2021; Wang et al. 2022).

The main purpose of this study is to evaluate the findings of science teachers' STEM lesson plan preparation skills and self-assessment forms and to examine their views on STEM applications. In line with the study, the following research problems were seek answered:

1. What are the opinions of preservice teacher on STEM applications at the end of the study?
2. What are the findings of the self-evaluation forms of the preservice teacher at the end of the study?
3. What are the findings of teacher candidates' STEM lesson plan preparation skills?

1. METHODOLOGY

Case study method was used from qualitative research methods within the scope of the study. Case study is a qualitative research approach that enables a thorough investigation and depiction of the formation of a limited system, situation, or case (Chmiliar, 2010). With the situation study method, studies such as determining deficiencies in the current environment, collecting data, analyzing data, and evaluating the results of analysis are carried out. In addition, it is determined what should be considered in subsequent studies (Davey, 2009).

In the study, criterion sampling method, one of the purposeful sampling methods, was used in the selection of participating distance education graduate students. This method indicates that every individual to be selected has an equal chance. In other words, individuals are not included in the study group according to a certain criterion (Büyüköztürk, Çakmak, Akgün, et al., 2016).

The data were collected by the "opinion questionnaire", which was prepared by the researchers by examining the literature and then examined by the field experts and

language experts. In the opinion survey, there are open-ended questions consisting of 19 items about STEM. Open-ended questions were shared with the participants when the informatics classes were over and the participants were asked to evaluate. In the study, the data obtained from the opinion survey were analyzed by making content analysis. With content analysis, those who gave similar answers were gathered under the same heading and interpreted and a conclusion was reached. In addition, some items were analyzed by creating "category and code" titles. Category, themes; themes consist of codes that are related to each other (Yıldırım & Şimşek 2008).

1.1. Study Group

In the spring semester of the 2019-2020 academic year, science teaching at a public university in Ankara was carried out with 18 preservice science teachers (17 females, 1 male) who were studying in the 4^{th} grade.

1.2.Implementation Stages

The implementation phase of the research was carried out by the researcher for fourteen weeks in the fall semester of the 2019-2020 academic year. The preservice teachers who formed the study group first received basic STEM education and examined STEM studies. Preservice teachers were individually asked to prepare STEM course plans within the scope of the achievements in the secondary school science course curriculum. At the end of the application, the opinions of preservice teachers about STEM applications were collected by the semi-structured interview form prepared by the researchers. In addition, preservice teachers were asked to fill out a self-assessment form at the end of the study where they could evaluate themselves. The STEM course plans of the teacher candidates, their opinions on STEM applications and the findings of the self-evaluation form were analyzed with content analysis.

1.3.Analysis of Data

In the content analysis of the data obtained from preservice science teachers, frequency values were created according to the explanations of the teacher candidates, while the percentage values were created by considering more than one explanation made by the teacher candidates.

In the research, the opinions of the participants were given in the form of P1, P2 … PN (Participants number) by coding without giving the names of the participants. Defining the characteristics of the participants, expressing the limitations, talking about the data collection process and analyzes were explained under appropriate headings, and external reliability was tried to be ensured.

2. DISCUSSION

The explanations of the preservice science teachers participating in the research about STEM education, their various answers about science-related disciplines, their views on the contributions of STEM education, and the contributions of the STEM education they received are given in Tables 1-4, respectively.

Table 1: Explanations of Preservice Teacher on STEM Education

Explanations on STEM education	Frequency (f)	Percentage (%)	Some statements
Abbreviation	9	15.0	-"STEM is a word that is an abbreviation of Science, Technology, Engineering and Mathematics. (P8)"
An integrated approach	18	30.0	-"STEM education aims to create a generation that can solve everyday life problems and create new discoveries by creating a harmonious integration between Science, Technology, Engineering, Mathematics disciplines, asking questions, exploring, producing projects based education (P5)"
Career awareness	6	10.0	
21st century skills	11	18.3	
Solution to daily life problems	9	15.0	
Creating product	7	11.7	-"STEM education approach develops students' skills such as creative thinking, critical thinking and problem solving in the field of production and invention. When they enter the business world, it is aimed that they can easily adapt to the qualities that business life wants thanks to their project skills. (P4)"

Table 2: The Opinions Of The Preservice Teacher About The Relationship Of The Science Course With Other Disciplines

Disciplines	Frequency (f)	Percentage (%)	Some statements
Mathematics	17	20.0	-"Science is associated with all disciplines. For example, cooperation is also made with music in solving a problem related to the frequency, intensity and timbre of the sound. It is particularly associated with mathematics, engineering, technology and Science. (P11)"
Engineering	15	17.6	
Technology	9	10.6	
Physics	7	8.24	
Chemistry	7	8.24	
Biology	7	8.24	
Astronomy	4	4.71	-"It is suitable for cooperation with many fields. Examples of these fields are mathematics, technology, engineering, natural sciences. (P15)"
World Science	1	1.18	
Social studies	3	3.53	
Turkish	6	7.06	-"It is mainly associated with physics, chemistry, biology, then mathematics, Turkish, engineering. (P4)"
English	1	1.18	
Visual Arts	1	1.18	
Geometry	1	1.18	
Art	1	1.18	
Music	2	2.35	
Health	1	1.18	

Psychology	1	1.18
Natural Sciences	1	1.18

Table 3: Preservice Teacher' Thoughts on The Overall Contributions of STEM Education

Thoughts on the contributions of STEM education		f	P (%)	Some statements
For students	Creative thinking skills	6	75.4	-"It enabled the students to develop their creative thinking skills, to know the problem situation and the steps to make the design / product they will create, to respect different ideas and to learn how to use different disciplines together. (P1)" -"It allows them to learn by living by doing it. (P9)" -"STEM activities contribute to students' self-esteem development. It also develops high-level skills such as critical thinking, problem solving, collaboration, which are 21st century skills. (P12)" -"It also support the qualities necessary for STEM literate individuals to catch up with. (P5)"
	Gaining the skill to design	4		
	Gaining product creation skills	3		
	Gaining the skill to respect different ideas	2		
	Gaining critical thinking skills	5		
	Gaining problem solving skills	5		
	Gaining 21st century skills	5		
	Establishing interdisciplinary relationship	3		
	Learning by doing and by living	5		
	Providing self-confidence development	2		
	Becoming STEM literate individual	3		
For teachers	Contributing to professional development	4	7.01	-"The teacher also contributes to his professional and personal development. (P5)"
For countries	Increasing the level of development	4	17.5	-"STEM education is very important in advancing our technology and reaching the level of developed countries. (P2)" -"STEM aims to develop a workforce that collaborates with group friends and is highly communicator, open to change and produce. (P9)"
	Technological progress	3		
	Increasing labor qualification	3		

Table 4: The Thoughts Of The Preservice Teacher For The Contributions Of STEM Education Received Within The Scope Of This Course

Thoughts on the contributions of STEM education to them	f	P (%)	Some statements
Gaining the ability to learn STEM implementation stages	5	10.0	"It has won the ability to think critically. I have learned solutions to solve our problems from everyday life. Teamwork has improved my skill. (P2)" -"Creating products using imagination gives the ability to produce practical solutions to problems and creative thinking skills. (P4)" -"For a period of time, we offered solutions to the problems of ourselves and our environment, which improved our analytical thinking skills and gained communication skills. (P18)" -"I have developed the ability to think and find solutions in a multifaceted way about a project and
Gaining the ability to guide students	18	36.0	
Gaining critical thinking skills	5	10.0	
Gaining the ability to solve daily life problems	5	10.0	
Gaining communication skill	2	4.00	
Gaining the ability to establish an interdisciplinary relationship	2	4.00	
Creating product	3	6.00	
Gain learning skills by doing	1	2.00	
Gaining innovative thinking skill	1	2.00	

Gaining creative thinking skill	6	12.0	about making and solving it. I'm in a position to guide the students. Through this course, I also learned what stem's content consists of and how to apply STEM to gains in science. (P15)"
Gaining analytical thinking skill	2	4.00	-"Thanks to this course, I understood how to establish a relationship with other sciences in transferring the gains in the science course to the students, and thus what the students will learn by doing and living. (P14)" -"It allows for innovative thinking. (P5)"

The preservice science teachers who participated in the study that they had not received STEM-based education until this year. The preservice teacher stated that they received this education as courses in the 3rd and 4th grades of the university and received it in the form of distance education from a different university and by participating in the TUBITAK project.

Frequency and percentage values of the views of preservice science teachers about the inclusion of STEM-based activities in science lessons (Table 5), their views on the fact that its use may have different advantages for the teacher (Table 6), and that its use may provide an advantage for students to gain creativity, critical thinking, and collaborative skills (Table 7), it can be a problem for teacher-centered time management, material supply, crowded classrooms (Table 8), individual differences in student-related practices, communication and task sharing difficulties among students (Table 9), it is more suitable for biology and physics. while some of them stated that it can be applied in all subjects (Table 10).

Table 5: Preservice Teacher 's Thoughts About its Usible Of STEM-Based Activities

Thoughts about its usible of STEM-based activities in science courses	**Codes for the use of STEM-based activities in science courses**	**f**	**P (%)**	**Some statements**
Yes, it's always usible.	Active participation	10	52.6	-“STEM activities make students more active. (P2)”
	Creativity skills	2	10.5	-“Skills such as research, inquiry, creativity, critical and analytical thinking and decision-making are some of the characteristics sought in qualified individuals. I think that the fields of science and mathematics and engineering and technology associated to these fields have an important role in acquiring these skills. (P8)”
	Critical and analytical thinking	3	15.8	
No, it can't be used all the time or in all environment.	High number of students in the classroom	1	5.26	-“Teachers should have the infrastructure for STEM. It should definitely be used in a

	Lack of infrastructure	1	5.26	small class where the appropriate conditions are met. (P1)"
	Teacher's not having enough information	1	5.26	-"It's a time taker event. The appropriate media, should also be sufficient in terms of materials. (P15)"
	Time consuming	1	5.26	

Table 6: The Advantages Of The Use Of STEM-Based Activities in Terms Of Teacher

Advantages of using STEM-based activities in terms of teacher	f	P (%)	Some statements
Self development	10	27.0	-"It contributes to us being a teacher who develops the spirit of guidance by being involved in teamwork between teachers, knows the method of how to solve daily life problems. (P4)"
Guidance to the student	4	10.8	
Vocational satisfaction	6	16.2	
Effective participation of students	4	10.8	-"It allows the teacher to explain the subject by making it concrete.(P15)"
Different perspective	3	8.10	
Embodying	5	13.5	-"Themself enhancement provides. It by increasing innovative to think, their horizon to expands. It saving different perspective. (P18)"
Creativity skills	1	2.70	
Problem solving skill	1	2.70	
Teamwork between teachers	1	2.70	-"The teacher reaches vocational satisfaction with the effective participation of students. He tells the lesson more as concretely. Strengthens communication between teacher and student. (P3)"
Student-teacher communication	2	5.40	

Table 7: The Advantages Of The Use Of STEM-Based Activities in Terms Of Student

Advantages of using STEM-based activities in terms of student	f	P (%)	Some statements
Gaining meaningful learning skill	4	4.44	-"Students' motivation increases, scientific process skills develop, psychomotor skills develop, lesson success increases. They perform meaningful learning, students' perspectives change, self confidence increases, feelings of responsibility increase. (P5)"
Gaining reflective thinking skill	1	1.11	
Gaining critical thinking skill	8	8.88	
Gaining interest and motivation against the lesson	7	7.77	
Developing collaboration skill	8	8.88	-"Of the students science, mathematics and technology literacy level increases, saves students the skill to think reflective thinking. (P11)"
Gaining 21st century skills	4	4.44	
Gaining scientific process skills	1	1.11	
Lesson success	2	2.22	-"Gives students problem solving skill, they gain 21st century skills. (P9)"
Gaining psychomotor skills	3	3.33	
Gaining different perspective	1	1.11	-"STEM-trained students take the get ahead among those who want to pursue careers in these fields with the knowledge, proficiency and skills they gain. (P8)"
Gaining self confidence	4	4.44	
Gaining creativity skill	11	12.2	
Gaining awareness of responsibility	1	1.11	-"It gives students the ability to design in the process of creating products. (P4)"
Improving science, technology and math literacy	6	6.66	-"It gives students critical thinking skill. It allows students to realize aware of daily life problems. Prevents students' from being individuals consuming, ensures that there are individual who produce. Improves students' creativity. Improves students' ability to work collaboratively. Improves students' communication skills. (P18)"
Gaining the ability to solve daily life problems	8	8.88	
Gaining problem solving skills	4	4.44	
Becoming productive individual	7	7.77	
Gaining the ability to design	1	1.11	
Gaining career development skill in STEM field	6	6.66	
Gaining communication skills	3	3.33	

Table 8: The Disadvantages Of The Use Of STEM-Based Activities For Teachers

Teacher disadvantages use of STEM-based activities	f	P (%)	Some statements
Time management shortage	14	32.5	-"The teacher may have trouble in terms of time. In addition, both teachers and students may experience difficulties economically. STEM can also be difficult to apply where there are many students in the classroom. (P5)"
Shortage of material supply	12	27.9	
Shortage of crowded classrooms	6	13.9	
Inadequacy of application information	10	23.2	-"STEM activity for every topic is very difficult to find. (P16)"
Gainings relationship	1	2.32	-"The teacher should be knowledgeable about STEM. Otherwise, it's very difficult to an application. (P9)" -"Not every STEM activity can be associated with achievements in the curriculum. (P1)"

Table 9: The Disadvantages Of The Use Of STEM-Based Activities For Students

Disadvantages of STEM-based activities for students	f	P (%)	Some statements
Difficulty in application stages	6	33.3	-"After a while, students may get tired of doing the project stages. There may be problems among students. (P8)"
Difficulty communicating between students	5	27.8	-"If students cannot be explained the STEM project steps in detail and properly, students have difficulty understanding the project subject and making projects related to the subject, and they cannot and cannot fully comprehend it. (P2)"
Task sharing distress	1	5.55	
Distress in terms of interest	2	11.1	
Individual differences between students	4	22.2	-" If the division of labor is not done well in the group study, active students are at the forefront, passive students may be bored. (P11)" - Activities may not be of interest to every student. It could be an inefficient lesson for them. (P4)"

Table 10. STEM-Based Activities' Compliance With Science Topics

Which science topics STEM-based activities are suited		f	P (%)	Some statements
Biology	Environment	3	12.0	-"I think it's more suitable on issues such as for Environment. (P4)"
	Recycling	1	4.0	
	Biology based	2	8.0	
Physics	Earth, Sun and Moon	1	4.0	-"I think it is more suitable on issues such as - 93 -ort he insulation and transmission of sound. (P13)"
	Electric	2	8.0	-"Since we also use engineering in STEM activities, I think it is suitable for all physics subjects. (P18)"
	Sound	1	4.0	
	Physics based	5	20.0	
	Simple machines	1	4.0	
	Heat and temperature	1	4.0	
	Force and movement	1	4.0	
	Work and energy	1	4.0	
All topics		6	24.0	-"I think it is suitable for all subjects of science courses, as one step of STEM covers science. (P11)"

Topics in which preservice science teachers prepare a STEM-based activity plan are given in Table 11. It has been determined that the preservice science teachers prepared the STEM-based activity plan from biology and physics. At the end of the study, the data

obtained for the self-evaluation forms of the preservice science teachers were subjected to content analysis. The data obtained because of the content analysis are presented below.

Table 11: Topics Where Prospective Teachers Prepare STEM-Based Activity Plan

STEM Based Activity Plan Prepared topics		Frequency (f)	Percentage (%)
Biology	Landless agriculture	2	11.1
	Reproduction, growth and development in living things	1	5.55
	Let's get to know the living things	2	11.1
	Environmental pollution	2	11.1
	Bioplastic making	2	11.1
	Composting	2	11.1
	Let's protect our bones	1	5.55
	Substance cycles	1	5.55
	Hygienic door	1	5.55
	Household waste and recycling	1	5.55
Physics	Gas pressure	1	5.55
	Energy transformations	1	5.55
	Sucking the light	1	5.55

The frequency and percentage values of the responses of preservice science teachers to their thoughts on the difficulties they face in preparing STEM-based activities are shown in Table 12. Preservice science teachers stated that they have difficulty in preparing STEM-based activities such as time management, material selection, prototype drawing, problem status determination. They also stated that they have difficulty in subject compliance, writing the implementation stages, attracting attention, preparing an activity plan, writing activities suitable for the student level (Table 12).

Table 12: Explanations Of The Difficulties Experienced By Preservice Teacher İn Preparing For A Lesson Plan

STEM-based activities	Frequency (f)	Percentage (%)	Some statements
Time management	3	10.3	-"I had a hard time preparing events based on the age of the class to be applied. I think I'm going to have trouble drawing prototypes, too. (P2)"
Prototype drawing	5	17.2	
Material selection	3	10.3	
Implementation stages	4	13.8	-"I had a hard time preparing activities based on the age of the class to be applied. I think I'm going to have trouble drawing prototypes, too. (P18)"
Attracting interest	2	6.89	
Student level	1	3.44	
Compliance with the subject	4	13.8	-"I think I'm going to have difficulty determining the problem situation and using the time. (P11)"
Event plan	2	6.89	-"I had a hard time preparing an event plan and how to get the students' attention. (P17)"
Determining a problem status	5	17.2	-"It's hard to find STEM activity for every topic. I had a hard time finding the right effiency for my chosen subject. I also had trouble writing the implementation stages of the event and choosing materials. (P3)"

Most preservice science teachers who participated in the study stated that teachers who will use STEM-based activities in science courses should be guiding students during

activities, create guidelines and choose appropriate activities. They also stated that time management is important (Table 13). Preservice science teachers in the study will use STEM-based activities in science classes, teachers to guide students, teachers to master STEM approach and students to choose quality activities that will improve 21st century skills such as critical thinking, creativity, prepare explanatory instructions before starting activities, provide effective time management during the event, select activities according to the student level, manage effective classrooms they have indicated that they must provide the mark (Table 13).

In order to determine the STEM lesson plan preparation skills of the preservice science teachers who participated in the study, the course plans prepared by the preservice science teachers were subjected to content analysis. "STEM lesson plan template graded document" created by BAUSTEM (2021) was used for content analysis (Appendix 1).

Table 13: Explanations For Recommendations For Teachers Who Will Use STEM Activities İn Science Classes

Classes	f	P (%)	Some statements
Creating directive	5	13.8	-"In order to make the process better, the necessary explanations should be expressed to the students in a properly clear language. Students should be given a directive. Every question students ask should be answered tirelessly and they should help when necessary. (P5)"
Guidance for students	9	25.0	
Ensuring effective class management	2	5.56	
Ensuring time management	4	11,1	
Effective activity selection	6	16.7	
Dominion to topic	6	16.7	
			-"I recommend that students answer every question they ask tirelessly, step through it in descriptive language when starting the application, and specify why such an activity is held. (P4)"
Student level eligibility	4	11.1	-"It is necessary to prepare in a preliminary way, to prepare the directive in an explanatory way. In this way, we can prevent the loss of time. (P6)"
			-"Teachers should know about STEM and choose appropriate activities for students. (P18)

The content analysis of because of the examination of STEM course plans prepared by preservice science teachers is shown in Table 14. All the preservice teacher correctly stated the "science" gains that were considered as central discipline in their STEM plans. In their STEM lesson plans, 3 preservice teachers stated their science gains by associating them with other STEM disciplines: technology, engineering, and math gains. In their STEM lesson plans, 15 preservice teachers correctly stated their social product gains. All the preservice teachers have correctly specified the materials and resources to be used in

product development in their STEM lesson plans. In addition, 6 preservice teachers correctly stated the knowledge-based life

Table 14: Information On Content Analysis Of STEM Lesson Plans

					Codes for lesson plans
Target gains	Cognitive process gains	Gain of discipline		A	X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X14, X15, X16, X17, X18.
		Gain of other STEM disciplines	Mathematics	A	X2,X6,X7,X10,X11,X12,X13,X14,X15,X16,X18.
				M	X1, X3, X4, X5, X8, X9,X17.
			Engineering	A	X4, X5, X6, X7, X10, X13, X14, X15, X16, X18.
				M	X1, X2, X3, X8, X9, X11, X12, X17.
			Technology	A	X2, X4, X5, X6, X7, X10, X11, X12, X13, X14, X15, X16, X18.
				M	X1, X3, X8, X9, X17.
			21st century skills	A	X2, X14, X16, X18.
				M	X1, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X15, X17.
	Social product gains			A	X2, X3, X4, X5, X6, X7, X8, X9, X10, X13, X14, X15, X16, X17, X18.
				M	X1, X11, X12.
Materials Used				A	X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X14, X15, X16, X17, X18.
Resources				A	X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X14, X15, X16, X17, X18.
Knowledge-Based Life Problem (BTHP)	Knowledge-Based Life Problem		Writing	A	X1, X2, X6, X7, X8, X10, X11, X12, X13, X15, X17.
				M	X3, X4, X5, X9, X14, X16, X18.
			Planning of the prototype	A	X6, X7, X8, X12, X15, X17.
				M	X1, X2, X3, X4, X5, X9, X10, X11, X13, X14, X16, X18.
	Limitations			A	X1, X2, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X14, X15, X16, X17, X18.
				M	X3.
	Professions, Duties and Responsibilities		Professional groups	A	X2, X4, X5, X6, X7, X9, X11, X12, X13, X15, X18.
				M	X1, X3, X8, X10, X14, X16, X17.
Lesson Content	Presentation of BHTP and Presentation of Limitations		Visual, story and video narration	A	X1, X6, X7, X8, X9, X12, X14, X16, X17, X18.
				M	X2, X3, X4, X5, X10, X11, X13, X15.
	Information Acquisition		Open-ended research questions	A	X1, X2, X4, X5, X6, X7, X8, X9, X11, X12, X14, X18.
				M	X3, X10, X13, X15, X16, X17.
	Idea Development		Research questions to help them come up with new ideas	A	X1, X9, X13, X15, X17, X18.
				M	X2, X3, X4, X5, X6, X7, X8, X10, X11, X12, X14, X16.
	Product Development			A	X1, X2, X3, X4, X5, X6, X7, X9, X10, X11, X12, X13, X14, X15, X16, X17, X18.
				M	X8.
	Test To		Testing process	A	X1, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X15, X17.
				M	X2, X4, X16, X18.
				A	X2, X4, X16, X18.

	Research questions to make them think at an advanced level	M	X1, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X15, X17.
Sharing and Mirroring	Presenting	A	X1, X4, X5, X6, X7, X8, X12, X13, X15.
		M	X2, X3, X9, X10, X11, X14, X16, X17, X18.
	Rubriks	A	X4, X5, X6, X7, X8, X12, X13, X15.
		M	X1, X2, X3, X9, X10, X11, X14, X16, X17, X18.

Appropriate:A; Missing:M;

problem and the planning phase of the prototype in STEM lesson plans. The 17 prospective teachers correctly stated the limitations that would determine the process of creating the prototype. The 11 preservice teachers correctly stated the professional groups in which the students will assume their duties and responsibilities throughout the course. In STEM lesson plans, 10 preservice teachers correctly stated the presentation of the knowledge-based life problem with engaging visuals, videos, and stories. In the information acquisition department, 12 preservice teachers correctly stated the open-ended questions that students can study. 6 prospective teachers correctly stated the research questions to be asked for new ideas that students will develop before drawing prototypes. 17 preservice teachers correctly stated the product development process. 8 preservice teachers correctly stated the stage of presenting the product to their friends. 8 preservice teachers correctly stated their evaluations (Table 14).

STEM education is an effort based on the integration of science, technology, engineering, and mathematics, which emerges to help individuals gain strength economically, allowing them to find solutions to real-life problems using scientific process steps (NRC 2012, U.S. Department of Education, 2015). With STEM approach, it is expected that the results such as designing, organizing, and implementing the curriculum in the period from kindergarten to 12th grade will be again converted (Myers & Berkowicz, 2015). When the literature is examined, there are many studies supporting the results of the study. In the study conducted by Timur & Inançlı (2018), preservice teachers indicated that STEM education is a combination of science, mathematics, engineering, and technology, provides learning by doing and living, performs meaningful learning by connecting science subjects with daily life, and they indicated that it produced solutions to problems encountered in daily life. In the study conducted by Ozturk et al. (2019), the perceptions

of preservice teachers towards STEM were examined. In this study, most preservice teachers indicated that STEM is an interdisciplinary approach and means experimenting and projecting. Nevertheless, some preservice teachers have stated that STEM means product extraction, creativity, imagination, innovation, self-confidence, and problem solving. The preservice teachers indicated that STEM education is an integrated approach formed by the integrating of science, mathematics, engineering, and technology fields. They stated that it is an approach that transforms knowledge into practice in a process that continues from pre-school to university, facilitates adaptation to business life, provides 21st century skills, finds solutions to daily life problems, and finally a product has emerged.

STEM education is not a separate course, but a paradigm in which the disciplines of science and mathematics are blended with technology and engineering applications (Akgündüz 2016). In the study conducted by the Kızılay (2018), preservice teacher stated that mathematics is used in the field of science, technology emerges with the combination of science, engineering and mathematics, engineering has science and mathematics in it, engineering activities reveal technology; science, technology, engineering, and mathematics they have indicated that they have completed it each other. In the study conducted by the Aslan and Bektas (2019), most preservice teacher associated science course with mathematics, engineering and technology. In addition, prospective teachers associated the science course with physics, chemistry, biology, social sciences, and natural sciences. In this research, preservice science teachers, the science course is associated with mathematics, engineering, and technology disciplines. This result shows that preservice teachers understand that science, one of STEM disciplines, is associated with other disciplines.

In the study conducted by Üçüncüoglu & Bozkurt Altan (2018), preservice teachers stated that STEM activity they do was suitable for STEM education, that they learned by having fun, associated with daily life, won interdisciplinary perspective, carried out learned by doing and living. In addition, preservice teachers stated that STEM activities provide lasting learning and won 21st century skills such as collaboration, problem solving, analytical thinking, creative thinking and critical thinking. With STEM approach, it is aimed to educate individuals who can hold the economic power that will provide an advantage in the industrialization of countries. In addition, it is one of the objectives of

STEM approach to make countries industrially and economically developed countries, to increase the number of students studying STEM fields in universities and who want to continue their business life in these fields, and to educate STEM literate individuals (Çevik & Özgünay 2018; NRC 2011). In the study, most preservice teachers stated that STEM education improves students' creative thinking, critical thinking, and problem-solving skills, provides learn by doing and living and provides 21st century skills. When the field is examined, the contributions of STEM education in terms of student, teacher and country support this result.

STEM training allows individuals to have knowledge in engineering and technology. Helps them design, develop prototypes. Develops creativity and problem-solving skills, supports self-confidence development, improves interdisciplinary perspectives (Morrison, 2006). In the study, most preservice teachers stated that they had not received STEM education until this year. The preservice teachers who received STEM education until this year stated that they received this training in the form of distance education and within the scope of TUBITAK project.

In the research, all the preservice teachers indicated that the STEM education they received within the scope of this course was very useful in terms of guiding the students. Preservice teachers have indicated that they have learned the stages of applying STEM in projects, that they can find solutions to daily life problems with this training, and that they have gained critical thinking skills. This result supports the benefits of STEM education received by prospective teachers within the scope of this course.

In the study conducted by Yildirim (2017), preservice teachers stated that STEM-based activities can be used in lessons by having project designs made to students, allowing students to use their imagination, and ensuring active participation. Some preservice teachers have stated that STEM-based activities cannot be applied in lessons due to limited hours of study, too much responsibility for the teacher, negative attitudes of teachers and lack of knowledge about STEM. In the research, most preservice teachers stated that STEM-based activities can be used in science courses and that permanence can be increased with STEM activities that can be applied in many subjects. They also stated that students can gain skills such as problem solving, critical thinking and questioning with STEM activities. Some preservice teachers stated that STEM-based

science activities cannot be always implemented in any environment and due to the large number of students in the classrooms, lack of infrastructure, lack of adequate knowledge of teachers and time consuming. In addition, preservice teachers stated that through STEM-based activities, teachers can embody science lessons, gain creativity and problem-solving skills known as 21st century skills and improve their communication with their students.

In the study conducted by Yildirim & Turk (2018), preservice teachers stated that it is important to use STEM education in elementary and preschool periods, and that individuals develop characteristics such as creativity, imagination, curiosity, self-confidence, responsibility, and empathy. They stated that with STEM-based activities, students can find solutions to daily life problems, increase their interest and motivation towards the course, perform meaningful learning, increase course achievements, collaborative work and develop 21st century skills. In addition, they stated that STEM-based activities give students different perspectives, contribute to the development of self-esteem of students, increase their desire to pursue a career in STEM, improve science, technology, and mathematics literacy, and improve psychomotor skills. In the research, most preservice teachers stated that teachers may have time problems and difficulty in supplying materials when implementing STEM-based activities. They noted that factors such as teachers lacking is missing knowledge of applying STEM and difficult to implement in crowded classrooms can be disadvantageous in implementing STEM-based activities. They also stated that it is a disadvantage that not every STEM application is associated with curriculum gains.

In the research, preservice teachers stated that the implementation stages of STEM-based activities may be difficult for some students and communication problems may occur between students during the application. In addition, preservice teachers stated that although task sharing is done, the proneness of some students may outpace other students, and STEM activities may not be of interest to every student. In the study, preservice teachers stated that STEM-based activities are suitable for all science subjects. In addition, preservice teachers stated that STEM activities are suitable for biology subjects such as environment and recycling, as well as other biology-based subjects. They stated that the earth, suitable for other physics subjects such as earth, solar and moon, electricity,

sound, simple machines, heat and temperature, force and motion, work, and energy, as well as physics-based subjects.

Akgünduz & Akpınar (2018) stated that because of STEM applications, students provide active learning in the field of science and mathematics, and their creativity, critical thinking, collaboration, and problem-solving skills have improved. In the study, most preservice teachers stated that when preparing STEM activities, they have difficulty in determining problem status, drawing prototypes, and implementing activities. They also stated that they have difficulty in determining appropriate efficacy. In the research, preservice teachers stated that the homogeneous distribution of groups will facilitate teaching, guide students throughout the activity, activities will increase students' motivations, students may have difficulty writing an activity report, and small age group may complicate the activity process. In the study conducted by Guleryuz et al. (2019), teachers stated that they should have STEM knowledge, use interdisciplinary approaches, learn about engineering design processes, and have knowledge about the field.

There are very few studies on the ability of preservice teachers to prepare STEM lesson plans. Bozkurt Altan & Üçüncüoğlu (2019) stated in their study that STEM-oriented course planning skills of preservice teachers have improved because of STEM practices. When STEM course plans are examined, it is seen that preservice teachers write appropriately about the "science" gains that are considered as central disciplines, and 3 preservice teachers associate their science gains with other STEM disciplines: technology, engineering, and mathematics gains. It is seen that 15 preservice teachers correctly wrote about social product gains, the materials, and gains of all preservice teacher to be used in product development, the knowledge-based life problem in STEM lesson plans of 6 teacher candidates, and the planning stage of the prototype. It is seen that 17 preservice teachers correctly stated the limitations that will determine the process of creating the prototype, and 11 preservice teachers correctly stated the professional groups in which the students will assume their duties and responsibilities throughout the course. In STEM lesson plans, 10 preservice teacher present the knowledge-based life problem with intriguing visuals, videos, and stories, and 12 preservice teachers correctly stated the open-ended questions that students can study in the information acquisition department. It is seen that 6 prospective teachers correctly stated the research questions to be asked for new ideas to be developed before the prototype drawing, 17 teacher

candidate product development processes, 8 teacher candidate products to present the product to their friends.

CONCLUSION AND SUGGESTIONS

It is understood that STEM education is related to life, the environment, and the whole life of the individual, and in this context, it will have future benefits. In the interviews, it was seen that the pre-service teachers approached STEM education positively. Projects to increase the STEM skills of preservice teacher studying in STEM education faculties should be developed, in-service training modules should be created, cooperation should be made with engineering, science and literature faculties, and industry and school cooperation should be given importance. Based on this study, when the opinions of teachers and preservice teacher were examined, they stated that there should be projects and studies supporting STEM education activities in their university life. As a result, it is important to develop STEM strategies that will ensure cooperation between the science, mathematics and technology-design teachers of the schools, as well as supporting students' critical and creative thinking skills. This study supports the views of pre-service teachers. Suggestions developed based on the findings reached as a result of the research are organized under two headings as suggestions for practitioners and researchers.

- In the study, preservice teachers prepared a lesson plan by focusing on the discipline of "science" from STEM disciplines. With different studies to be carried out, preservice teachers can prepare a lesson plan by centering other STEM disciplines.
- In the study, it is seen that most preservice teachers do not receive STEM education. Preservice teachers who are practitioners of the STEM approach can be provided with STEM education with courses to be given during the undergraduate period. In addition, with the cooperation of education faculties and engineering faculties, preservice teachers can be provided with applied STEM projects.
- There are few studies in the literature that examine STEM lesson plans prepared by teacher candidates. In this direction, studies can be carried out that examine the STEM lesson plans prepared by preservice teachers at different class levels and branches.
- There are few studies in which teacher candidates related to STEM approach evaluate themselves with a self-assessment form. Different studies can be carried out using STEM approach and self-evaluation forms.

REFERENCES

Akgündüz, D. (2016). A Research about the Placement of the Top Thousand Students in STEM Fields in Turkey between 2000 and 2014. *Eurasia Journal of Mathematics, Science & Technology Education*. *12*(5):1365-1377. https://doi.org/10.12973/eurasia.2016.1518a

APA (American Psychological Association) (2010). *Psychology as a Core Science, Technology, Engineering, and Mathematics (STEM) Discipline: Report of the American Psychological Association 2009 Presidential Task Force on the Future of Psychology as a STEM Discipline*.

Arslanhan, H. & İnaltekin, T. (2020). The Effects of Design-Based Learning Applications on STEM Perceptions Development of Pre-Service Science Teachers. *YYU Journal of Education Faculty*, *17*(1), 231-265. https://doi.org/10.33711/yyuefd.691585

Bannikova, L., Boronina, L. & Kemmet, E. (2016). *Gender stereotypes and STEM education.* International Multidisciplinary Scientific Conferences on Social Sciences and Arts, Albena.

BAUSTEM (2021). *Bahçeşehir University Teacher Professional Development Application and Research Center*. https://inteach.org/

Bektaş, O. & Aslan, F. (2019). Determination of Pre-service Science Teachers' Views Regarding STEM Applications. *MM-International Journal of Educational Sciences, 3*(2):17-50. https://doi.org/10.46762/mamulebd.646318

Bozkurt Altan, E. & Üçüncüoğlu, I. (2019). Examining the development of pre-service science teachers' STEM-focused lesson planning skills. *Eurasian Journal of Educational Sciences, 83*:103-124, https://doi.org/10.14689/ejer.2019.83.5

Bozkurt Altan, E. & Üçüncüoğlu, İ. (2018). STEM Focused Laboratory Practices for Pre-Service Science Teachers: Healthy Living Module. *International Journal of Humanities and Education*. *4*(9):329-347.

Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz, Ş. ve Demirel, F. (2016). Bilimsel Araştırma Yöntemleri, Pegem Akademi Yayınları, Ankara.

Çevik, M. & Özgünay, E. (2018). STEM education through the perspectives of secondary schools' teachers and school administrators in Turkey. *Asian Journal of Education and Training, 4*(2):91-101. https://doi.org/10.20448/journal.522.2018.42.91.101

Chmiliar, l. (2010). Multiple-case designs. In A. J. Mills, G. Eurepas & E. Wiebe (Eds.), *Encyclopedia of case study research* (pp 582-583). USA: SAGE Publications.

English, L. D. (2016). STEM education K-12: Perspectives on integration. *International Journal of STEM Education, 3*(3): 1-8. https://doi.org/10.1186/s40594-016-0036-1

Güleryüz, H., Dilber, R. & Erdogan, İ. (2019). Prospective teachers' Views on 3D Printer Use in Stem Applications. *Journal of Ağrı İbrahim Çeçen University Social Sciences Institute, 5*(2):1-8. https://doi.org/10.31463/aicusbed.592061

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

Kelley, T.R. & Knowles, J.G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education, 3*(11). https://doi.org/10.1186/s40594-016-0046-z

Kızılay, E. (2018). Pre-Service Science Teachers' Opinions About The Relationship of Stem Fields. *Journal of Research in Education and Society of Education and Community Research, 5*(2):174-186.

MEB. (2017). *STEM Eğitimi Öğretmen El Kitabı*. (Turkish). MEB Press

Moore, T. J. & Smith, K.A. (2014). Advancing the state of the art of STEM integration. *Journal of STEM Education, 15*(1):5–10.

Morrison, J. (2006). *TIES STEM education monograph series, attributes of STEM education*. Baltimore, MD: TIES, *2*:5-10.

Myers, A. & Berkowicz, J. (2015). *The STEM shift: A guide for school leaders.* Thousand Oaks, CA: Corwin Press

NRC (National Research Council). (1996). *National science education standards: Observe, interact, change, learn.* Washington, DC: National Academy Press.

NRC (National Research Council). (2011). *Succesful K-12 STEM education,* Washington, DC: National Academy.

Öztürk, N., Yılmaz Tüzün, Ö. & Çakır Yıldırım, B. (2019). Investigation of Preservice Teachers' Self-efficacy Beliefs and Views Regarding STEM Applications in Science Education. *Trakya Journal of Education*, *9*(4):649-665. https://doi.org/10.24315/tred.473464

P21. (2018). *Partnership for 21st century learning* 2015.

Schulz, S. & Pinkwart, N. (2016). *Physical Computing in STEM Education*. The Workshop in Primary and Secondary Computing Education Conference. https://doi.org/10.1145/2818314.2818327

Stohlmann, M., Moore, T. & Roehrig, G. (2012). Considerations for teaching integrated STEM education. *Journal of Pre-College Engineering Education Research*, *2*(1):28–34. https://doi.org/10.5703/1288284314653

Thomasian, J. (2011). *Building a science, technology, engineering, and math education agenda.* Washington, DC: National Governors Association Center for Best Practices.

Timur, B. & Belek, F. (2020). Investigation of the Effects of STEM Activities on Pre-Service Teachers' Self-Efficacy Beliefs and their STEM Intention Levels. *Pamukkale University Journal of Education*, *50*:315-332. https://doi.org/10.9779/pauefd.465824

U.S. Department of Education. (2015). *Science, technology, engineering, and math: Education for global leadership*.

Walan, S. & Gericke, N. (2021). Factors from informal learning contributing to the children's interest in STEM–experiences from the out-of-school activity called Children's University. *Research in Science & Technological Education*, *39*(2):185-205. https://doi.org/10.1080/02635143.2019.1667321

Wang, L. H., Chen, B., Hwang, G. J., Guan, J. Q., & Wang, Y. Q. (2022). Effects of digital game-based STEM education on students' learning achievement: a meta-analysis. International Journal of STEM Education, *9*(1), 1-13. https://doi.org/10.1186/s40594-022-00344-0

Yıldırım, A., & Şimşek, H. (2008). Sosyal Bilimlerde Nitel Araştırma Yöntemleri (6. Baskı). Ankara: Seçkin Yayıncılık.

Yıldırım, B. & Türk, C. (2018). Pre-Service Primary School Teachers' Views about STEM Education: An Applied Study. *Trakya University Journal of Education Faculty, 8*(2):195-213.

Yıldırım, P. (2017). A Qualitative Study On Integration Of Science, Technology, Engineering, And Mathematics (STEM). *Journal of Kazım Karabekir Education Faculty, 35*:31-55.