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Awareness and Views of Teachers Who Received In- Service STEM Training About STEM

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Abstract

This study aimed to investigate the awareness and views of teachers from different disciplines who received in-service STEM training about STEM education. To this end, the study employed a mixed methods research design in which both quantitative and qualitative research approaches are used. For the quantitative phase of the study, the sample was composed of 64 teachers from the different branches. The teachers were sampled using convenience sampling. For the qualitative phase of the study, the teachers were chosen using criterion sampling. The sample was drawn of 16 teachers who had a high, moderate or low level of awareness. The quantitative data were collected using the "STEM Awareness Scale" and the qualitative data were collected using a semi-structured interview form. The analysis results showed that teachers' awareness of STEM increased after the in-service training. The teachers held the view that using the STEM approach in their classes is beneficial to, themselves, students, and the country and the effective implementation of STEM education depends on the elimination of shortcomings such as the lack of time, materials, and workshops.

Keywords: STEM Education, Teacher Views, Awareness, STEM Training

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INTRODUCTION

With the advances in science and technology, most developed and developing countries have recently been undertaking reforms in their education systems. Interdisciplinary teaching is the most important of these reforms. Disciplinarity has today been replaced by interdisciplinarity. Along with integrating multiple disciplines, interdisciplinarity is also of importance in associating these disciplines with everyday life. It is thus aimed to prepare individuals to have content knowledge, problem-solving skills, critical and creative thinking skills, and collaborative skills. The Science, Technology, Engineering, and Mathematics (STEM) that emerged in the United States in the early 2000s to achieve this aim has been highlighted in curricula both abroad and in Turkey. Therefore, awareness and views of teachers as the practitioners of curriculum about STEM education are of major importance.

STEM includes educational activities that focus mostly on science and mathematics but also incorporate technology and engineering and are practised at all grade levels from preschool to postgraduate (Bybee, 2010; Gonzalez&Kuenzi, 2012). Because it is difficult to fully emphasize all four disciplines within STEM due to the structure of curricula and schools, engineering and technology are often integrated into the content of science and mathematics (Bybee, 2010). One of the main goals of STEM education is to develop 21st-century skills such as problem-solving, critical thinking, creativity, and collaboration. Skills are acquired at a young age and improved at later ages. Because it is incumbent on teachers who implement STEM education to develop these skills, it is of key importance for teachers to have the knowledge of the four disciplines. Therefore, there is a need to identify teachers' awareness and views about STEM education.

A body of previous research has explored teachers' and preservice teachers' views about STEM education (Nadelson, Callahan, Pyke, Hay, Dance&Pfiester, 2013; Özçakır-Sümen&Çalışıcı, 2016; Tarkın-Çelikkıran&Aydın-Günbatar, 2017; Thomas, 2014; Uğraş, 2017; Yıldırım&Türk, 2018). Most research into teacher views about STEM education has investigated the views of science and mathematics teachers (Bakırcı&Kutlu, 2018; Eroğlu&Bektaş, 2016; Patrick, 2016; Özbilen, 2018; Wang, 2012). Teachers generally have positive views on STEM education, are willing to receive in-service STEM training and believe that STEM education increases students' interest and motivation and develops different skills while they emphasize that there is a lack of materials, time, and cooperation for more effective applications (Özbilen, 2018; Thomas, 2014; Uğraş, 2017; Wang, 2012, Yıldırım&Türk, 2018).

STEM is an interdisciplinary approach and thus requires teachers from different disciplines to cooperate in the implementation process. Teachers who have the required training and competence in STEM disciplines play a key role in the dissemination of STEM (Wang, 2012). Awareness and views not only of science and mathematics teachers but also of teachers from all disciplines including preschool are of critical importance for the effective implementation of STEM education. Thus, identifying views of preschool, primary, secondary, and high school teachers about STEM will make a major contribution to the effective implementation of STEM education in Turkey. Against this background, in this study, public school teachers from different disciplines were first given in-service STEM training and their awareness and views about STEM education were then explored. To this end, answers were sought to the following questions:

As for the teachers who received in-service STEM training;

1. Is there any significant difference in their pre-training and post-training STEM awareness?
2. What methods and approaches do they use in their lessons?
3. What are their reasons for participating in STEM training?

4. What are their views on the characteristics that STEM courses must have?
5. What are their views on how to implement STEM education in their classes?
6. What are their views on the contribution of the implementation of STEM education to
    - their lessons
    - teachers themselves, and
    - the country?
7. What are their views on the challenges that they may face during the implementation of STEM education?
8. What are their views on what can be done to implement STEM education?
9. What are their views on the opportunities that STEM education will provide?

METHOD

Research Design

The study employed a mixed methods research design in which both quantitative and qualitative research approaches are used. This design serves to find answers to research questions of different types. The mixed methods design enables researchers to use different types of data to describe the other, answer different questions with the results from one database, and cross-check the validity and reliability of different types of data (Creswell, Clark, Gutmann&Hanson, 2003). Patton (2005) illustrated the combination of inductive and deductive methods with machines that were originally created for separate functions like printing, faxing, scanning, and copying but are now combined into a single integrated technological device.

This study was conducted using the exploratory sequential mixed methods design. The exploratory sequential mixed methods design involves an initial qualitative phase of data collection and analysis and following phase of quantitative data collection and analysis. The final phase involves interpretation. Qualitative data explain quantitative data. Quantitative data play a more dominant role than qualitative data in exploratory studies (Creswell&Clark, 2017).

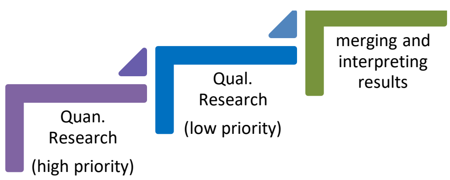

Figure 1. Exploratory sequential mixed methods design (Fraenkel, Wallen&Hyun, 2012)

The quantitative data were collected using a one-group pretest-posttest design. In one-group pretest-posttest designs, the experimental treatment or intervention is used and tested in a single group of research participants (Büyüköztürk, KılıçÇakmak, Akgün, Karadeniz&Demirel, 2010). Accordingly, the awareness of teachers participating in the in-service STEM training about STEM education was measured before and after the training.

The qualitative data were collected using a case study approach. Case studies investigate factors related to a situation using a holistic approach and focus on how these factors affect the situation and are affected by the situation in return (Yıldırım&Şimşek, 2013).

Study Group

The research participants were from the same population; however, two separate samples were recruited for the qualitative and quantitative phases of the study.

Quantitative Phase: In the quantitative phase of the study, the sample consisted of 64 teachers who were working in urban and rural schools in the city centre of Niğde and participated in the STEM training. There were six preschool, ten classroom, seven science, six mathematics, eighteen technology and design, thirteen information technology, two physics, one chemistry and one biology teachers. The sample was chosen using convenience sampling, which is a non-probability sampling technique. Convenience sampling is a technique that aims to prevent waste of time, labour, and money (Büyüköztürk et al., 2010).

*Qualitative Phase:*In the qualitative phase of the study, the sample was chosen using criterion sampling, which is a purposive sampling technique. Criterion sampling involves sampling cases that meet a set of predetermined criteria of importance (Büyüköztürk et al., 2010). Accordingly, among 64 teachers who participated in the in-service STEM training, 16 teachers who had a high, moderate or low level of awareness based on their score on the STEM Awareness Scale were sampled in the qualitative phase of the study.

Implementation Process

In this study, in-service STEM training was given to teachers who were working in urban and rural schools affiliated with Niğde Provincial Directorate for National Education. The training programme is shown in Table 1.

Table 1. STEM training programme (Basic Level)

Duration	Subjects	Scope
Day	What is STEM?	A need or a necessity? Why STEM education? What are the main objectives of STEM education? Engineering design processes 21st-century skills
Day Implementation Process I	How is STEM education implemented in the world and in Turkey?	STEM in the United States STEM in China STEM in India STEM in South Korea STEM in the EU STEM in Turkey
	What materials can I use in STEM education?	STEM using easy-to-find materials Robotics STEM education
	Science Process Skills	Science Process Skills

Day Implementation Process II	How can I implement STEM education?	Out-of-school learning environments for extracurricular activities (science centres, museums, historic sites, schoolyard, zoo, etc.) Classroom activities Methods and techniques STEM Students on the Stage (SOS)™ Model 5E Model Problem-based learning Project-based learning Collaborative learning
Day Implementation Process III	What are the processes for evaluating student learning?	Alternative approaches to evaluation in STEM education
Day Implementation Process IV	How can I integrate STEM education into lessons?	Design and implementation of lesson plans by teachers

The planned training took a total of 30 hours, including theoretical and practical training. The training programme addresses an overview of STEM and its objectives, STEM education and practices in the world and Turkey, materials that can be used in STEM education, scientific process skills,methods and examples of implementing STEM education, evaluation and assessment in STEM education, and the integration of STEM into lessons.

Data Collection Instruments

The study used two types of data collection instruments, one qualitative and the other quantitative.

Quantitative Data Collection Instrument: The STEM Awareness Scale developed by Çevik (2017) to measure teachers' awareness of STEM education was administered as the pretest and posttest after permission was obtained. The scale is a 5-point Likert-type scale. The positively worded items are rated from "strongly disagree (1) to "strongly agree (5)". The negatively worded items are rated from "strongly agree (1) to "strongly disagree (5)". The negatively worded items (I8, I9, and I10) were reverse-keyed. The scale consists of 15 items and three subscales: Effect on Students, Effect on Lessons, and Effect on Teachers. The Cronbach's alpha coefficient of the scale was found to be .84 (Çevik, 2017).

Qualitative Data Collection Instrument: A semi-structured interview form was designed by the researchers to identify teachers' views on STEM education. First, a draft form was prepared after a search of the literature. In the process of designing the form, opinions were taken from three experts: STEM education expert, science education expert, and classroom education expert. The reliability formula proposed by Miles and Huberman (1994) was used to measure the reliability of the draft form which was revised based on expert opinions. The reliability of the interview form was found to be 94%. The form consisted of 10 questions.

Focus group interviews were held with 16 teachers who had a high, medium and low level of STEM awareness. In focus group interviews, 16 teachers were divided into three groups as follows: two groups of five teachers and one group of six teachers. Focus group interview refers to a series of planned discussions to explore perceptions of a predetermined subject in a hospitable setting (Yıldırım&Şimşek, 2013). Prior to the interviews, permission was obtained from the teachers to record the interview and the teachers were assured that the records would only be used as data in an academic study.

Data Analysis

The study used two types of data analysis, one qualitative and the other quantitative.

Analysis of the Quantitative Data: The quantitative data derived from the STEM Awareness Scale were analysed using SPSS 22.0. The data were first tested for normality. The analysis results showed that the data were normally distributed.

Table 2. Findings on the normal distribution of the data

			Median	Mode	Skewness	Kurtosis
Pretest	Statistics	62.20	63.00	68.00	-.32	-.52
	Standard Error	.67			.29	.59
Posttest	Statistics	64.60	65.00	63.00	-.46	-.03
	Standard Error	.69			.29	.59

As seen in Table 2, the mean, mode, and median values of pretest and posttest scores had on the STEM Awareness Scale are close. Because the normal distribution is a symmetric distribution, the arithmetic mean, mode, and median are equal (Kalaycı, 2016). The similar mean, mode and median values in Table 2 show that the data were normally distributed. The pretest and posttest skewness values were -.32 and -.46, while the kurtosis values were -.52 and -.03. Skewness and kurtosis values ranging from +1.5 and -1.5 are sufficient for the normal distribution of data (Tabachnick&Fidell, 2013).

In line with these results, parametric tests were used in the data analysis. The t test was used and $p < 0.05$ was considered significant.

Analysis of the Qualitative Data: The data about teachers' views on STEM education were analysed using content analysis. Content analysis is used to derive concepts and relationships that can explain the collected data (Yıldırım&Şimşek, 2013). The interview data were transcribed verbatim using Microsoft Word. The transcribed data were divided into sections to determine what each section mean and the meaningful sections were coded. Following the coding process, the common aspects of the codes were found and the categories (themes) of the research findings were framed.

To ensure validity and reliability in this process, two independent coders coded the concepts and establish themes. The intercoder agreement was measured using the reliability formula proposed by Miles and Huberman (1994) and found to be 92%, indicating that the two coders devised similar codes and themes.

RESULTS

Results on Teachers' Awareness of STEM Education

The findings on teachers' awareness of STEM education is shown in Table 3.

Table 3. Findings on teachers' mean pretest and posttest STEM awareness scores

	N		SD	t	p	Cohen's d
Posttest	64	64.60	5.54	3.17	.002	.39
Pretest	64	62.20	5.36			

According to Table 3, the teachers' mean score on the STEM Awareness Scale was 62.20 before the training, while it was 64.60 after the training. The results of the dependent samples t-test showed that there was a significant difference between the mean pretest and posttest scores ($p < .05$). The effect size of the difference was measured using Cohen's d and was found to be .39, indicating a moderate effect size. A Cohen's d of 0.2 represents a small effect size, a Cohen's d of 0.5 represents a medium effect size, and a Cohen's d of 0.8 represents a large effect size (Büyüköztürk, Çokluk,&Köklü, 2014).It can thus be said that the in-service STEM training was effective in increasing teachers' awareness of STEM.

Results on Teachers'Views on STEM Education

Table 4 shows the findings on the approaches and methods that the teachers used in their classes.

Table 4. Findings on the approaches and methods used by the teachers in their classes

Codes	f	%	Categories	f	%
Problem-solving	5	8.93			
Making connections - giving examples from everyday life	4	7.14			
Asking for ideas	1	1.79			
Brainstorming	2	3.57			
Induction - deduction	1	1.79	Alternative approach	21	37.50
Establishing a cause-effect relationship	1	1.79			
Practice	1	1.79			
Drama	3	5.35			
Research	2	3.57			
Play	1	1.79			
Lecture	12	21.42			
Conducting experiments	4	7.14			
Question writing activities	1	1.79	Traditional approach	35	62.50
Question and answer	7	12.50			
Presentation	3	5.35			
Project-based	2	3.57			
Showing/demonstrating and having students do	4	7.14			
Working together	1	1.79			
Visual material	1	1.79			

According to Table 4, the methods that the teachers most commonly use in their classes were lecture (21.42%), question and answer (12.50%), and problem-solving (8.93%).The responses were subsumed under two categories: the alternative approach and the traditional approach. Accordingly, the teachers most commonly (62.5%) prefer to use the traditional approach in their classes. Example responses are given below:

T_3: I also use the lecture method. The problem-solving method, question and answer, induction, and deduction. Sometimes I follow a general-to-specific order and other times I ask students to make generalizations.

Table 5 shows the findings on the teachers' reasons for participating in in-service STEM training.

Table 5. Findings on teachers' reasons for participating in in-service STEM training

Codes	f	%	Categories	f	%
To integrate learning into students' lives using simpler materials	1	3.03	To establish connections	2	6.06
To associate with science	1	3.03			
To learn different information from different people	1	3.03	Contribution to teachers/personal development	12	36.36
Out of curiosity	2	6.06			
To keep up with the times	2	6.06			
To understand STEM	1	3.03			
To raise awareness on behalf of teachers	1	3.03			
To have a better command of subjects	1	3.03			
To be happy	2	6.06			
To improve myself	2	6.06			
To be able to use what has been learned in classes	1	3.03	To incorporate different activities (contribution to the lesson)	7	21.21
To provide children with different activities	1	3.03			
To implement STEM in classes	1	3.03			
To create different activities	1	3.03			
To make mathematics fun	1	3.03			
To improve the quality of education	1	3.03			
To offerdifferent opportunitiesto students	1	3.03			
To be helpful to students	1	3.03	Contribution to Students	7	21.21
To be able to better communicate learning outcomes to students	1	3.03			
Awareness on behalf of students	1	3.03			
To make contributions to students	1	3.03			
To make students happy	1	3.03			
To be able to give correct answers to students' questions	1	3.03			
To understand subjects more deeply	1	3.03			
To use real technologies in classes	1	3.03	To learn/use technology	5	15.15
To learn technology	1	3.03			
To keep up with evolving technology	1	3.03			
To learn 3D printers	1	3.03			
To learn robotics coding	1	3.03			

As shown in Table 5, the teachers participated in the in-service STEM training mostly to improve themselves (6.06%), understand STEM (3.03%), implement STEM in their classes (3.03%), and keep up with evolving technology (3.03%). The teachers' responses were subsumed under five categories. The category with the highest percentage was contribution to teachers (36.36%), followed by contribution to the lesson (21.21%) and contribution to students (21.21%). The teachers stated that they intended to learn and use technology (15.15%) and establish connections (6.06%) thanks to in-service STEM training. The following are some examples of responses given by the teachers:

T_2: The main reason was that I wanted to improve myself. I also wanted to have some material to guide students to projects. I think STEM is really important and will be used in the next term. So it is always good to have knowledge.

Table 6 presents the findings from the teachers' responses concerning the characteristics that STEM courses must have.

Table 6. Findings on the must-have characteristics of STEM courses

Codes	f	%	Categories	f	%
Practice	2	6.89	Practice-based	4	13.79
Activities to improve problem-solving skills	2	6.89			
It must transform projects into products	1	3.44	Product-based	4	13.79
It must achieve concrete outcomes	1	3.44			
Product	2	6.89			
Connected to real life	1	3.44	Associated with life	4	13.79
It must facilitate solving problems in life	1	3.44			
It must touch students' daily life	1	3.44			
It must allow a given problem to be solved realistically	1	3.44			
It must develop multiple perspectives	1	3.44	It must help adopt different points of view	2	6.89
It must help ask the question 'why' logically	1	3.44			
Collaborative learning	1	3.44	Collaborative learning	2	6.89
It must bring out the feeling of 'us'	1	3.44			
Separate time - separate lesson	1	3.44	Separate time	3	10.34
Separate time	2	6.89			
Teachers must be trained	3	10.34	Teachers must be trained	4	13.79
Willing teachers	1	3.44			
Workshop	3	10.34	Separate setting	3	10.34
Collaboration between disciplines	2	6.89	Collaboration	2	6.89
Budget	1	3.44	Budget	1	3.44

As seen in Table 6, the most common responses concerning the must-have characteristics of STEM courses were teacher training (10.34%), product (6.89%), separate time (6.89%), and collaboration between disciplines (6.89%). The responses were subsumed under ten categories. The categories with the highest percentage were practice-based (13.79%), product-based (13.79%), associated with life (13.79%), and teachers must be trained (13.79%), followed by separate time (10.34%) and separate setting (10.34%). Additionally, the teachers also pointed to helping adopt different points of view (6.89%), collaborative learning (6.89%), collaboration (6.89%), and a separate budget (3.44%). The following are some examples of responses given by the teachers:

T_6: There must be collaboration. It is impossible without collaboration between disciplines. The subject includes drawing, for example, you should get help from other teachers. If a project is undertaken, everyone has to contribute and help.

Table 7 shows the findings from the teachers' responses concerning how they plan to use STEM in their lessons.

Table 7. Findings on teachers' views on how to implement STEM in their lessons

Codes	f	%	Categories	f	%
Helping students do what they think	1	8.33	Practising	3	25
Different practices	1	8.33			
Practising with curious students	1	8.33			
Cooperating with teachers of other lessons	1	8.33	Collaborating	4	33.33
Collaboration with other teachers	2	16.66			
Choosing a science subject and doing practical work in company with the science teacher	1	8.33			
Drawing connections between lessons	1	8.33	Establishing connections	3	25
Associating with everyday life	1	8.33			
Associating with other lessons	1	8.33			
Helping students discover themselves	1	8.33	Student-centred	1	8.33
Emphasizing communication and collaboration	1	8.33	Highlighting 21st-century skills	1	8.33

As seen in Table 7, the most common responses concerning how to implement STEM in classes were collaboration with other teachers (16.66%), collaboration between disciplines (8.33%), practising with curious students (8.33%). However, a teacher reported that she or he could not implement STEM education in her or his classes.

The teachers' responses were subsumed under five categories. The teachers were thinking to implement STEM by collaborating (33.33%), practising (25%), establishing connections (25%), being student-centred (8.33%), and highlighting 21st-century skills (8.33%).The following are some examples of responses given by the teachers:

T_7: We need to collaborate more with more teachers.

Table 8 displays the findings from the teachers' responses concerning the contribution of STEM to their lessons.

Table 8. Findings on teachers' views on the contribution of STEM to their lessons

Codes	f	%	Categories	f	%
Increases students' awareness	1	5.88	Increases students' interest	2	11.76
Increases levels of interest	1	5.88			
Facilitates experiential learning	3	17.64	Meaningful and permanent learning	5	29.41
Students learn better	1	5.88			
Ensures permanent learning	1	5.88			
Students express themselves in different ways	1	5.88	Develops ways of thinking	3	17.64
Develops divergent thinking	1	5.88			
Teaches versatile thinking	1	5.88			
Makes students active	1	5.88	Active participation	3	17.64
Ensures the participation of all students	2	11.76			
Helps students produce	1	5.88	Promotes students' development	4	23.52
Develops problem-solving skills	1	5.88			
Enhances students' imagination	1	5.88			
Heightens the sense of accomplishment	1	5.88			

As shown in Table 8, the teachers explained the contribution of STEM education to their lessons as follows: it facilitates experiential learning (17.64%), ensures the participation of all students (11.76%) and increases students' awareness (5.88%). The responses were subsumed under the following five categories from the most to the least common: meaningful and permanent learning (29.41%), promotes students' development (23.52%), develops ways of thinking (17.64%), active participation (17.64%), and increases students' interest (11.76%). Examples of teachers' responses are as follows:

T_{15}: I think that associating with everyday life will increase students' interest.

Table 9 displays the findings from the teachers' responses concerning the contribution of implementing STEM in their lessons to themselves.

Table 9. Findings on teachers' views on the contribution of STEM education to themselves

Codes	f	%	Categories	f	%
Professional satisfaction	3	14.28	Professional satisfaction	3	14.28
Being happy	3	14.28	Feeling positive	7	33.33
Feeling peaceful	2	9.52			
Enjoyment	1	4.76			
Being motivated	1	4.76			
Self-development	1	4.76	Personal development	6	28.57
Prepares the teacher for the future	1	4.76			
Promotes personal development	1	4.76			
Encourages doing plenty of research	1	4.76			
Both students and teachers learn	2	9.52			
Increases effectiveness	1	4.76	Efficient teaching	4	19.04
Facilitating	2	9.52			
Makes teaching more practical	1	4.76			
Teachers' contribution to the satisfaction of the need for semi-skilled labour	1	4.76	Contribution to the business world	1	4.76

As shown in Table 9, the teachers reported that they would experience professional satisfaction (14.28%), both students and teachers would learn (9.52%), and it would be facilitating (9.52%), promote personal development (4.76%). The responses were subsumed under five categories as follows: feeling positive (33.33%), promotes personal development (28.57%), efficient teaching (19.04%), professional satisfaction (14.28%), and contribution to the business world (4.76%). The following are some examples of teacher responses:

T_3: Professional satisfaction. I will be happier as the quality of education increases.

Table 10 shows the findings on the teachers' responses concerning the contribution of STEM education to the country.

Table 10.Findings on teachers' views on the contribution of STEM education to the country

Codes	f	%	Categories	f	%
Serve the development of the country	2	11.76	Country development	4	23.52
Material and spiritual gain	1	5.88			
Reduction of external dependence	1	5.88			
People produce	4	23.52	Producer society	4	23.52
People become happy as they produce	2	11.76	Contribution to individuals	7	41.17
People choose the profession that they would like to practise	2	11.76			
Helps realize the potentials of people	2	11.76			
Prevents making people uniform	1	5.88			
Satisfies the need for semi-skilled workers	2	11.76	Contribution to the business world	2	11.76

According to Table 10, the teachers reported that when STEM education is implemented, people will produce (23.52%) and will be happy as they produce (11.76%), it will serve the development of the country (11.76%), help realize the potentials of people (11.76%), and external dependence will be reduced (5.88%).The teachers' responses were subsumed under four categories as follow: contribution to individuals (41.17%), country development (23.52%), producer society (23.52%), and contribution to the business world (11.76%). The following are some examples of responses given by the teachers:

T_{12}: I think that we can evolve into producer society through STEM. And people choose the profession that they would like to have. As students' area of interests is identified at an early age, more precise guidance can be provided. It raises awareness. It prevents making people uniform

Table 11 presents the findings the challenges that teachers may face during the implementation of STEM education.

Table 11. Findings on teachers' views on the possible challenges to the implementation of STEM education

Codes	f	%	Categories	f	%
Students'understanding the principle and getting ready	1	3.57	Failure to understand STEM	7	25
Resistance from teachers or administrators	1	3.57			
Likelihood of being side-lined or discarded over time	1	3.57			
Failure to build the communication between the school, students and parents	1	3.57			
Criticism from parents	3	10.71			
Overcrowded classrooms	2	7.14	Classroom management/control	6	21.42
Maintaining discipline	3	10.71			
Chaos in the classroom	1	3.57			
Need for workshops	1	3.57	Inappropriate setting	4	14.28
Classroom desk arrangement	2	7.14			
Classroom setting	1	3.57			
Lack of time	2	7.14	Time	2	7.14
Teachers' constant preparedness	2	7.14	Workload	4	14.28
Increased workload	2	7.14			
Inadequate job security	1	3.57	Inadequate job security	1	3.57
Exam-based education system	1	3.57	Inappropriate education system	2	7.14
Lack of integration into curricula	1	3.57			
Lack of material	2	7.14	Cost	2	7.14

As shown in Table 11, the teachers reported the following challenges to the implementation of STEM education: criticism from parents (10.71%), maintaining discipline (10.71%), overcrowded classrooms (7.14%), teachers' constant preparedness (7.14%), increased workload (7.14%), and exam-based education system (3.57%). The teachers' responses were subsumed under seven categories as follows: failure to understand STEM (25%), classroom management/control (21.42%), inappropriate setting (14.28%), workload (14.28%), lack of time (7.14%), inappropriateeducation system (7.14%), inadequate job security (3.57%), and cost (7.14%). The following are some example responses:

T_6: Activities and practices usually fail to reach all students in overcrowded classrooms.

Table 12 displays the findings what can be done to implement STEM education.

Table 12. Findings on teachers' views on what can be done to implement STEM education

Codes	f	%	Categories	f	%
Having a workshop	4	14.81	Setting preparation	10	37.03
Suitability of the out-of-the-classroom setting	1	3.70			
Having empty spaces in the classroom	1	3.70			
Suitability of schoolyards for STEM	1	3.70			
Environmental conditions	1	3.70			
Suitability of the classroom setting	2	7.40			
Must be left to the discretion individuals	2	7.40	Must be discretionary	3	11.11
Must be an elective course	1	3.70			
Must be extracurricular	1	3.70	Must be independent of lessons	2	7.40
Must not be rated or graded	1	3.70			
There must be materials	4	14.81	Material supply	4	14.81
Teachers must be trained	1	3.70	Teachers must be supported	3	11.11
Eager teachers must be encouraged	1	3.70			
Administrators should collaborate with teachers	1	3.70			
Budget	1	3.70	Budget	1	3.70
Must be implemented from nursery school	1	3.70	Must start in preschool	2	7.40
Must be implemented at early ages	1	3.70			
Proper planning	2	7.40	Effective planning	2	7.40

As seen in Table 12, the teachers reported that for the implementation of STEM education, materials (14.81%), discretion (7.40%), proper planning (7.40%), teacher training (3.70%), and budget (3.70%). The responses were subsumed under the following eight categories: setting preparation (37.03%), material supply (14.81%), must be discretionary (11.11%), teachers must be supported (11.11%), must be independent of lessons (7.40%), must start in preschool (7.40%), effective planning (7.40%), and budget (3.70%). The following are some examples of responses given by the teachers:

T_7: If children start to receive STEM education in nursery school, there will be no trouble because they are used to it. But if you attempt to teach STEM at the eighth-grade level, I think children will not be able to produce these projects because their skills have not developed earlier.

Table 13 displays the findings the opportunities that STEM education will provide.

Table 13. Findings on teachers' views on the opportunities of STEM education

Codes	f	%	Categories	f	%
Individuals become productive	3	10.34	Personal development of students	8	27.58
Individuals become self-confident	2	6.89			
Children have developed imagination	1	3.44			
Happy people	1	3.44			
Students love school	1	3.44			
Developing problem-solving skills	4	13.79	Development/acquisition of problem-solving skills	5	17.24
Implementing solutions to problems	1	3.44			
Acquisition of different point of views	2	6.89	Developing perspectives	3	10.34
Changing perspectives on life	1	3.44			
Improving the quality of education	2	6.89	Improving education	5	17.24
Increasing efficiency	2	6.89			
Devising a new teaching method specific to our culture	1	3.44			
Developing the economy of the country	2	6.89	Country development	3	10.34
Enabling the country to progress	1	3.44			
Raising team awareness	1	3.44	Collaboration	3	10.34
Prevents self-centredness	1	3.44			
Solidarity and sharing	1	3.44			
Facilitating production	1	3.44	Production	2	6.89
Highlighting production	1	3.44			

According to Table 13, the teachers explained the opportunities that STEM education will provide as follows: developing problem-solving skills (13.79%), individuals become productive (10.34%), acquisition of different point of views (6.89%), developing the economy of the country (6.89%), raising team awareness (3.44%). Additionally, a teacher stated that if STEM education is adapted to our culture before implementation, better outcomes will be achieved. This answer was included in any category.The teachers' responses were subsumed under seven categories as follows: personal development of students (27.58%), development/acquisition of problem-solving skills (17.24%), Improving education (17.24%), developing perspectives (10.34%), country development (10.34%), collaboration (10.34%), and production (6.89%). The following are some example responses:

T_4: I think that it helps individuals to become those who produce but do not merely consume.

DISCUSSUON AND CONCLUSION

With the increasing importance attached to STEM education in Turkey, the awareness and competence of teachers have become even more important. In this study found that in-service training is effective in raising teachers' awareness of STEM education. Similarly, KoyunluÜnlü, and Dere (2019) found that STEM-related lessons heightened preservice teachers' awareness of STEM education. Karakaya, Ünal, Çimen, and Yılmaz (2018) also reported that in-service training increased science teachers' awareness of STEM.

This study also sought to explore the views teachers about the STEM education. To this end, the teachers were first asked how they teach their lessons. They reported that they generally prefer traditional approaches and methods. They also reported making use of alternative approaches. The teachers stated that they participated in the in-service STEM training to make contributions to students and lessons and to implement STEM in their classes. Additionally, before the training, some teachers were thinking of STEM as robotics and coding and some were expecting to learn how to use a 3D printer; however, after the training, they realised that STEM was not a Lego game or robotic coding. Likewise, Yıldırım and Türk (2018) reported a change in such preconceptions or misconceptions of preservice teachers after a 12-week STEM course.These results suggest that after in-service training, the teachers had a certain level of knowledge and awareness of STEM education and its benefits.

With respect to the must-have characteristics of STEM lessons, the teachers reported that teachers must be trained in STEM and there must be workshops and activities to develop problem-solving skills. Bakırcı and Kutlu (2018) observed that teachers have a lack of knowledge of STEM education. Preparing and supporting teachers for STEM education is a must to achieve the goals of STEM education (Stohlmann, Moore, &Roehrig, 2012). Uğraş (2017) showed that preschool teachers would like to receive STEM training and implement STEM in their lessons. Similarly, Wang, Moore, Roehrig, and Park (2011) noted that science, mathematics and engineering teachers were aware that they need more field knowledge for STEM integration. In the present study, the teachers stated that STEM education should be based on activities that improve problem-solving skills. The problem-solving process plays a key role in integrated STEM disciplines (Wang et al., 2011). In-service training help teachers to be aware of the skills to be acquired through STEM training.

Previous research has discussed that STEM education develops 21st-century skills, stimulates creativity and curiosity, and facilitates the integration of what is learned into everyday life (Eroğlu&Bektaş, 2016; Thomas, 2014; Wang, 2012, Yıldırım&Türk, 2017). In the same vein, in this study, the teachers were planning to implement STEM through collaboration and in a student-centred manner by establishing connections and highlighting 21st-century skills.

The teachers listed the contribution of implementingSTEM to their lessons courses as follows: it facilitates permanent and experiential learning, encourages all students to participate in classes, promotes students' imagination, divergent thinking, and problem-solving skills, and strengthens their sense of accomplishment. Previous studies have also shown that STEM education improves students' skills and abilities(Acar, 2018; Kwon, Nam, & Lee, 2012; Park, Nam, Moore, &Roehring, 2011; Şahin, Ayar, &Adıgüzel, 2014).Similarly, Bakırcı and Kutlu (2018) reported that science teachers believe that the STEM approach fosters experiential learning and improves students' various skills. These results suggest that teachers are aware of the contributions of STEM education.

The present study also investigated the contribution of implementing STEM education to teachers themselves. The teachers reported that the greatest contribution of implementing STEM education to themselves is professional satisfaction, positive feelings, and efficient teaching. Additionally, they stated that it also contributes to the business world. In accordance with the present finding, previous studies have demonstrated that teachers from different disciplines believe that STEM facilitates teaching lessons and increases students' interest in lessons (Özbilen, 2018; Uğraş, 2017).

The teachers expressed the contribution of implementing STEM education to the country as follows: it contributes to the development of the country, meets the need for semi-skilled workers, reduces external dependence, and brings happiness to the society. These are in line with the competencies which are defined in the curricula designed by the Ministry of National Education (MEB) as competencies to be developed in individuals and specified in the Turkish Qualifications Framework (TQF) (MEB, 2018a, 2018b).

The teachers listed the challenges that may be faced during the implementation of STEM education as follows: classroom management, the lack of time, setting, and materials, the need for teachers to be always prepared, and increased workload. TarkınÇelikkıran and AydınGünbatar (2017) stated that preservice teachers had difficulty in obtaining information, finding materials, and designing products to implement STEM. The lack of time, budget, and in-service training has also been reported as possible challenges to STEM education (Eroğlu&Bektaş, 2016; Uğraş, 2017). These results match those observed in the present study.

In addition, the teachers stated that for the effective implementation of STEM education, there must be a suitable setting and adequate supplies, teachers must be given adequate and relevant training, sufficient budget must be allocated, and STEM must be sufficiently integrated into curricula. Teacher training, collaboration, and material and time requirement have been emphasized in several studies (Bakırcı&Kutlu, 2018; Eroğlu&Bektaş, 2016; Özbilen, 2018; Uğraş, 2017; Wang et al., 2011). The teachers also stressed that STEM education must start in preschool. Given that the impact of integrated STEM education is greater at younger ages, it is critical to start STEM education early (Becker&Park, 2011; Murphy&Mancini-Samuelson, 2012; Lamb, Akmal&Petrie, 2015).

The teachers' views on the opportunities that STEM will provide were as follows: it helps individuals develop problem-solving skills and different perspective and become productive individuals, improves the economy of the country, and promotes collaboration. The STEM approach is fundamentally based on these purposes. The United States, falling behind in the Space Race, realized that the future of nations depends on individuals who work in the fields of science, technology, engineering, and mathematics and thus devised the STEM approach (Koehler et al., 2016). The STEM approach is also of key importance to foster collaboration, communication, and critical and creative thinking of students that will contribute to the development of the national economy in the future (Hernandez, 2014).

All these results indicate that the teachers had an awareness of STEM education before the in-service training; however, they also had various misconceptions. Although STEM education entered Turkey later compared to other countries, it has quickly become popular. The rapid rise to prominence has also led to misconceptions about STEM and information pollution. Therefore, teachers who implement STEM education should be trained by experts who have proven their competence in this field. Accordingly, a possible recommendation might be to increase training that STEM education experts give to teachers from different disciplines.

It is apparent from the responses of the teachers that they have knowledge of STEM education but abstain from implementing it. Teachers' lack of knowledge in different areas might cause them to refrain from implementing STEM education. Therefore, teacher training can involve practices that require collaboration among different disciplines.

The teachers emphasized that STEM education was not properly integrated into curricula and there was not enough time to teach the learning outcomes through STEM. The Ministry of National Education (MEB, 2018a, 2018b) partly mentions STEM in curricula but tries to emphasize it. For teachers to clarify their ideas on practice and implement STEM education in their lessons, curricula, learning outcomes, and course duration can be rearranged in accordance with STEM education.

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