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EXAMINING TEACHERS' VIEWS ON STEM EDUCATION

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Abstract:
The aim of this study is to reveal the opinions of teachers who apply STEM education in science and mathematics lessons about this education. The research is designed according to a case study of qualitative research methods. The study group of the research consists of four STEM educated teachers. Semi-structured interview form was used as data collection tool in the study. The data were analysed by content analysis. Within the scope of the validity and reliability of the data obtained from the research, participant confirmation and expert control strategies were used. As a result of the research, the teachers stated that STEM education is related to the fields of science, mathematics, engineering and technology. They stated that STEM is a necessity of our age and includes basic skills. In addition, regarding the in-class implementation of STEM-based activities, the participants emphasized that STEM practice increase student success, improve students' sense of self-confidence, make learning easier and permanent, associate lessons with daily life, conduct lessons with fun, and ensure collaborative learning. However, during the implementation of these activities, teachers stated that they mostly experienced problems with classroom management, implementation of the activities and lack of equipment.

Keywords: STEM, STEM education, STEM-based activities, semi-structured interview

1. Introduction

One of the most important factors in raising individuals who adapt to the age we live in today is our education system. Through our education system, individuals are expected

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to have the skills of thinking, questioning, researching, making inventions, solving problems and working in collaboration with the developments in scientific and technological fields. In this context, STEM education, which enables students to see the knowledge and skills they have acquired within the scope of Science, Technology, Engineering and Mathematics courses as parts of a whole, is seen as an important tool in scientific progress (Lacey & Wright, 2009; MoNE, 2016).

2. Literature Review

STEM education refers to teaching and learning in the fields of science, technology, engineering and mathematics, and generally includes educational activities at all grade levels (Moore, Johnston & Glancy, 2020; Kennedy & Odell, 2014). The STEM concept, which was used for the first time by Ramaley, the director of education of the National Science Foundation in the United States, is the abbreviation of STEM for the English equivalent of science, technology, engineering and mathematics branches (Bybee, 2010; Carter, 2013; Thomas, 2014; Sahin, Ayar & Adıgüzel, 2014; Voutour, 2014; Chute, 2009; Moomaw, 2013). From this point of view, STEM education, which enables students to establish and apply the theoretical knowledge and skills they have acquired in the fields of science, technology, engineering and mathematics, on the one hand mediates the emergence of new products and inventions, on the other hand, provides students' interest, curiosity, creativity, motivation. It enables the development of 21st century skills such as collaboration, problem solving, and critical thinking (Moore et al., 2020). In addition, STEM education enables students to look at problems from different angles and produce solutions, to think systematically and creatively, to think critically in the face of events, and to develop their skills to produce new products and inventions by doing collaborative work. In this context, classroom activities at all levels related to STEM also help students to notice real-life problems, make plans, develop appropriate solutions, and interpret the results obtained (Bender, 2015; Wang, 2012).

When the literature on STEM approach is examined; it is observed that the national and international studies conducted mostly focus on students and teacher candidates. In this context, when the studies conducted with students are examined, it is seen that the experimental studies conducted generally focus on the effect of STEM education on academic achievement, attitudes towards STEM, creativity and problem solving skills (Ciftci, Topcu & Erdogan, 2020; Cho & Lee 2013; Donmez & Idin, 2020; Miller, 2019, Weber, 2015). Again, in studies conducted on teacher candidates for STEM education, participants' views on STEM education (Akcanca, 2020; Bergsten & Frejd, 2019; Kennedy & Odell, 2014; Yıldırım, 2017; Yıldırım & Altun, 2015; Yıldırım & Türk, 2018) were thoroughly examined. However, in the literature, it is striking that there are a limited number of studies on the teachers' dimension of STEM education (Du Plessis, 2018; Eroglu & Bektas, 2016; Ersoy, 2018; Geiger, 2019). In this context, for example, Du Plessis (2018) concluded that the experiences of teachers are important for the effectiveness and efficiency of STEM education in his research. Again, Geiger (2019), in his study with

teachers in different branches, stated that effective STEM teaching provides an advantage in students' learning outcomes; He concluded that it is an effective tool especially for the absorption of science and mathematics lessons. In addition, Ersoy (2018), as a result of his research with teachers, concluded that classroom teachers' self-efficacy beliefs in STEM teaching are low.

As can be clearly seen from the studies mentioned above, teachers' opinions about STEM education and the application of STEM education in lessons are of great importance in terms of increasing the quality of education and training. From this point of view, it is important to determine teachers' views on STEM education so that they can effectively apply STEM education in their classes. Based on this fact, the aim of this study is to reveal the views of teachers who apply STEM education in their lessons about STEM applications in all dimensions. For this purpose, the problem statement of the research is as follows; "What are the opinions of the teachers (participants) who apply STEM education in their lessons?" Accordingly, the sub-questions of the research are as follows:

1) What are the opinions of the participants on STEM and STEM education?
2) What are the opinions of the participants regarding the classroom implementation of STEM-based activities from the perspective of the teacher?
3) What are the opinions of the participants about the classroom implementation of STEM-based activities in terms of students?
4) What are the opinions of the participants regarding the problems encountered during the implementation of STEM-based activities?

3. Material and Methods

This research is a case study of qualitative research methods. The case study is to examine the existing situation regarding a person, an institution, a group or an environment in depth (Mills & Gays, 2017; Patton, 2015). According to Creswell (2014), a case study is a detailed description of a certain subject or event or an attempt to understand the existing situation in detail. In this study, a case study was chosen from qualitative research methods in order to examine the thoughts and experiences of teachers who apply STEM in their lessons in depth.

3.1. Sample

The study group of the research consists of four teachers selected according to the criterion sampling method among the purposeful sampling methods. As a criterion, the conditions for having a certificate in STEM education, applying STEM education in science or mathematics lessons, and graduating from the education faculty are determined. Four teachers meeting these conditions constituted the study group of the research. One of the teachers in the study group is female and three are male. The age of the teachers varies between 30 and 42, and their professional seniority is between 7 and 16 years. Three of the male teachers in the study group are science and technology teachers and the other female teachers are graduates of mathematics teaching, and all of

these teachers have various certificates on STEM teacher training. In addition, these teachers also worked as trainers in STEM education in different periods.

3.2. Data Collection Tool

The data in the study were collected using a semi-structured interview form developed by the researcher. In this context, an interview form containing the opinions of teachers about the general situation of STEM and STEM education and the implementation process of this education was presented to the opinion of two experts experienced in STEM. Some questions were corrected in line with expert opinions and the form was finalized.

3.3. Collection of Data

The data in the study were collected using a semi-structured interview form developed by the researcher. In this context, an interview form containing the opinions of teachers about the general situation of STEM and STEM education and the implementation process of this education was presented to the opinion of two experts experienced in STEM. Some questions were corrected in line with expert opinions and the form was finalized.

3.4. Data Analysis

Content analysis method was used in the process of data analysis in the study. In content analysis, qualitative data that are similar to each other are interpreted by paying attention to cause-effect relationships under certain themes, categories and codes, and some results are reached (Yıldırım & Şimşek, 2013). In this study, the raw data obtained were read a few times and codes were created to reach meaningful patterns. By comparing these codes, the same codes are grouped under the same category. In addition, the data obtained were presented in tables and supported with direct quotations. During the data analysis process, the teachers in the study group were coded in the form of T1, T2, T3, and T4, starting from the teacher who was interviewed for the first time, in the order of the interview.

Within the scope of the validity and reliability of the data obtained from the research, rich description, diversification, participant confirmation, and expert control strategies were used. (Creswell & Miller, 2000; Merriam, 2013; Patton, 2015). In this context, firstly, the data obtained from the interviews with rich descriptions were presented in tables in order to increase their legibility and comprehensibility in the findings section. In addition, direct quotations were made to clarify the comprehensibility of the categories and codes created with these views. On the other hand, during the coding process of the data, the researcher and another researcher experienced in STEM education made separate coding and the codes created by each coder were checked together. In addition, within the scope of the validity and reliability of the research data, the confirmation of the participants was applied. The tables and explanations obtained for this purpose were submitted to the approval of the participants

and within this scope, the accuracy of the data was confirmed. On the other hand, expert control was applied as the last step within the scope of the validity and reliability of the data. In this context, an expert coder experienced in qualitative research coded two randomly selected interview forms. Miles and Huberman (1994) reliability formula was calculated as .88 for the agreement rate between the researcher and the coder. If this value is above .70, it is an indication that the encoding is reliable.

4. Results

The data obtained from the opinions of the participants in line with the purpose of the research are given below. In this direction, participants were first asked about their general views on STEM and STEM education. The categories and codes prepared as a result of the analysis of the data received from the participants are presented in Table 1.

Table 1: Participant Views on STEM and STEM Education

Category	Codes	f
Scope	Science	3
	Mathematics	3
	Engineering	3
	Technology	3
	Communication	1
	Art	1
Process	Our age needs	2
	Starting from pre-school age	2
	Basic skill	2
Result	Product	3
	The unification of the four disciplines	2

When Table 1 was examined, the participants stated that STEM education was mostly related to the fields of "science", "mathematics", "engineering" and "technology". Regarding this, the participant coded as T3 stated: *"STEM is an applied field. It is about mathematics, science and science, and the combination of these fields to make them tangible and visible."* On the other hand, the participant coded as T2 stated: *"Today, we are in the age of communication. The STEM education we provide also helps us gain the necessary knowledge and skills in adapting and communicating with the changes in the environment and the world".*

In the process category, the participants mostly drew attention to the codes "need of our age", "starting from pre-school period" and "basic skill". For example, the participant coded as T1 stated: *"Actually, STEM is not an easy education. It is necessary to acquire and assimilate some basic skills. It requires the acquisition and assimilation of skills especially in the fields of mathematics, science and coding".*

Finally, in the result category, the participants mostly drew attention to the codes of "product" and "unification of four disciplines". On this subject, the participant coded as T4 stated: *"The students are able to produce new products by combining the four disciplines of our age by turning to the needs of our age.".*

As the second question of the study, the views of the participants regarding the application of STEM-based activities in terms of teachers in the lessons are included in Table 2.

Table 2: Participant Views Regarding the Application of STEM-Based Activities in the Lessons from the Perspective of the Teacher

Category	Codes	f
Positive aspects	Increase in success	3
	Self-confidence	2
	Making learning easier	2
	Permanent learning	2
	Guiding	1
Negatives aspects	Difficulty in classroom management	3
	Lack of infrastructure	3
	Lack of material	1

As seen in Table 2, the participants' views on the in-class application situation of STEM-based activities from the perspective of the teacher are discussed in two categories as positive and negative. According to this, the participants mostly emphasized the codes of "increasing success", "self-confidence", "facilitating learning" and "permanent learning". In this context, for example, the participant coded as T1 stated: *"His positive aspect is very high. If you tell it three times by rote learning, the student may not understand. But with STEM under the guidance of a teacher, you can explain the subject at once because the child does it himself and the subject is fully understood."*

Secondly, in the negative aspects category, the participants mostly expressed the codes of "difficulty in classroom management", "lack of infrastructure" and "lack of materials". In this context, for example, the participant coded as T4 stated: "… *Sometimes I can say that I have difficulty in establishing class domination. When a few people are distracted in the classroom, it is very difficult to recruit them back to the class. You have to move the students step by step, from the bottom to the top, as if building a building. Every student should not be obliged to take this training. Those with a science, mathematics and coding basis should participate in STEM education because these issues may not be of interest to all students"* and the participant coded as T3 stated: "…*Sometimes we have difficulty in accessing the internet. In addition, some hardware comes from abroad and some electronics products are not produced in our country. We cannot reach these products*".

As the third question of the research, the views of the participants regarding the application of STEM-based activities in the lessons in terms of the students are included in Table 3.

Table 3: Participants' Views Regarding the Application of STEM-Based Activities in Lessons from the Perspective of Students

Category	Codes	f
Positive aspects	Associating with everyday life	3
	Fun lesson processing	3
	Active learning	2
	Skill development	2
	Self-confidence	2
	Embodying	1
	Cooperative learning	1
Negatives aspects	Insufficient level of readiness	2
	Lack of material	2
	Lack of infrastructure	2
	Inability to complete the project	1
	Student not being supported	1

As can be seen in Table 3, the participants' views on the in-class application situation of STEM-based activities in terms of students are discussed in two categories as positive and negative aspects. Accordingly, in the positive aspects category, the participants emphasized the codes of "associating with daily life", "fun lesson processing", "active learning", "skill development", "self-confidence", "concretizing" and "cooperative learning". In this context, for example, the participant coded as T1 stated: "*His positive side is very high. If you tell it three times by rote learning, the student may not understand immediately. But working with STEM under the guidance of a teacher, with his child friends, he realizes at once for what he does. In addition, children learn the lesson in a fun way by using the materials given to them, by making experiments and establishing new mechanisms*".

On the other hand, in the negative aspects category, the participants mostly expressed the codes of "insufficient level of readiness", "lack of material" and "lack of infrastructure". In this context, for example, the participant coded as T4 stated: *"The student has interest but is not supported. Extra support for students, especially as equipment. Also, the preparedness levels of some children are not enough. Children must have sufficient basic knowledge. For example, he can make a mistake in measuring how many currents he has in the batteries."*.

As the last question of the research, the opinions of the participants about the problems they experience during the implementation of STEM-based activities are included in Table 4.

Table 4: Participant Views Regarding the Problems Encountered in the Implementation Process of STEM-Based Activities

Category	Codes	f
Teacher dimension	Time management	3
	Application of an event	2
Lack of equipment	Lack of material	3
	Lack of infrastructure	1
Teacher dimension	Lack of readiness	2
	Student not being supported	1

When Table 4 is examined, participants stated that they experienced problems in three categories as "teacher dimension", "lack of equipment" and "student dimension" during the implementation of STEM-based activities. Accordingly, the participants mostly emphasized "time management" and "activity implementation" codes in the teacher dimension. In this context, for example, the participant coded as T2 stated: "*Theory and what is thought in practice do not always match. I plan the activity in detail before the lesson. However, while applying it in the classroom, mistakes can arise that I never thought of".*

On the other hand, in the category of lack of equipment, the participants stated that they had problems with "lack of materials" and "lack of infrastructure". In this context, for example, the participant coded as T3 stated: "*We are experiencing a lot of hardware problems. Due to the lack of infrastructure in our region, we cannot always access the internet. In addition, we have difficulties in acquiring the necessary materials to prepare the events".*

Finally, in the student dimension, the participants mostly drew attention to the codes "lack of readiness level" and "student not being supported". In this context, for example, the participant coded as T2 stated: *"The level of readiness of some students is not sufficient. These students have great difficulty while doing the activities. For example, he has to do a calculation, but he cannot get the correct result. This shows that arithmetic skills are not enough".*

5. Discussion

This study was conducted in order to examine the opinions of teachers who apply STEM education in their lessons about STEM applications. Accordingly, teachers stated that STEM education is mostly related to science, mathematics, engineering and technology fields. In addition, it was concluded that the teachers emphasized that STEM education is the need of our age, it covers basic skills, that it should start from pre-school period and that the product is obtained in this process and that four disciplines should be combined. These results are also similar to the relevant literature (Eroglu & Bektas, 2016; Karademir Coskun, Alakurt & Yılmaz, 2020; Kennedy & Odell, 2014; Mataric, 2004; Park et al., 2016; Özbilen, 2018; Stohlmann, 2018; Yıldırım, 2017; Wang, 2012). In this context, for example, Mataric (2004) revealed that STEM studies should be implemented from the pre-school period and that education about STEM is important for all age groups from primary education to university level. On the other hand, Eroglu and Bektas (2016) found that as a result of their studies with STEM education teachers, they think that STEM-based activities establish a link between science and technology, engineering and mathematics. Similarly, Kennedy and Odell (2014) stated that teachers, students and parents should be a constant part of STEM education curriculum and that instead of only strengthening mathematics and science lessons in schools, technology and engineering fields should be associated with these courses and these four disciplines should be combined in an integrated manner. They reached the conclusion that they emphasized.

In the context of the second sub-dimension of the study, the participants regarding the classroom application of STEM-based activities in terms of teachers revealed that students' success and self-confidence increased, learning became easier and learning was permanent. These results are also similar to the relevant literature (Bakırcı & Kutlu, 2018; Cho & Lee, 2013; Kızılay, 2018; Miller, 2019; Stohlmann, 2018; Özbilen, 2018). In this context, for example, Miller (2019), as a result of his work with students in Australia, concluded that STEM education improves mathematical knowledge and thinking in students, increases their high-level thinking skills and provides permanent learning in them. Similarly, Cho and Lee (2013), in their study with sixth grade elementary school students, revealed that the lesson plans prepared on the basis of STEM education developed creative thinking and problem solving skills and increased their learning levels. In addition, Stohlmann (2018) emphasized the importance of associating mathematics with other disciplines in STEM education and proposes different models on this subject in order to increase student success and provide meaningful learning.

According to the third sub-question of the research, the participants about STEM-based activities in the classroom for students; they demonstrated that such activities are associated with daily life, lessons are conducted as fun, active and cooperative learning is provided and students' skills and feelings of self-confidence increase. These results are also similar to the studies conducted in the relevant literature (Cotabish et al., 2013; Özbilen, 2018; Sahin et al., 2014; Yıldırım, 2017; Yıldırım & Altun, 2015; Wang, 2012). In this context, for example, Sahin et al. (2014), as a result of their research examining the effects of STEM-based activities on students, concluded that the activities implemented helped students to work collaboratively and had an impact on 21st century skills. Again, Wang (2012) found in his study that teachers made the lessons more meaningful for students by associating STEM activities with daily life.

On the other hand, regarding the classroom implementation of STEM-based activities in terms of students, the participants emphasized that they mostly had difficulties due to the insufficient level of readiness of the students. In this context, for example, Maaß, Geiger, Ariza and Goos (2019), in their studies on the development of STEM competencies, found that in international exams such as PISA and TIMMS, the readiness levels and skills in mathematics or science in high economic countries such as Europe, the USA and Australia are not sufficient and that STEM education in mathematics. They emphasized that it would be possible to overcome this problem by integrating them into their lessons.

Within the scope of the last sub-purpose of the study, the teachers at the teacher level of the process of implementing STEM-based activities stated that they faced problems in classroom management and implementation of the activities, they experienced a lack of infrastructure and materials about the lack of equipment; on the student dimension, they emphasized that they had problems due to the lack of readiness level and the lack of support for the student. This result is similar to other studies in the literature (Bergsten & Frejd, 2019; Eroglu & Bektas, 2016; Karademir Coskun et al., 2020; Park et al., 2016; Özbilen, 2018; Yıldırım, 2018; Yıldırım & Türk, 2018; Stolhmann et al.,

2012). In this context, Yıldırım (2018) concluded that during the implementation of STEM-based activities, teachers mostly experienced problems due to the physical structure of the classroom, classroom size and time management. Also, Park et al. (2016) concluded in their study that Korean teachers had problems in accessing necessary materials and classroom management during the implementation of STEM education.

In summary from the results mentioned above, it can be said that the teachers stated that STEM education is mostly related to the fields of science, mathematics, engineering and technology. In addition, it is clearly seen that in STEM education, teachers emphasize that STEM education is the need of our age, it covers basic skills, that the product is obtained in this process that should start from pre-school period, and that four disciplines should be combined. Regarding the classroom application of STEM-based activities for teachers, teachers pointed out that students' success and self-confidence increased, learning became easier, and learning was permanent. Finally, in the teacher level of the implementation process of STEM-based activities, teachers faced problems in classroom management and implementation of the activities, they experienced a lack of infrastructure and materials about the lack of equipment; On the student dimension, they stated that they had problems due to the lack of readiness level and the lack of support for the student. In this context, it can be suggested that teachers should be given practical seminars on STEM education to overcome such problems. In addition, it may be advisable to give trainings especially to teachers on preparing activities and lesson plans suitable for their classes. This study is limited to teachers' views. In this context, it can be contributed to the field by conducting similar researches, qualitative studies in which teachers' lesson practices are observed, or experimental studies to determine the effectiveness of the education provided.

5. Recommendations

As a result of the research, it can be suggested to give practical seminars to eliminate the problems faced by teachers in classroom management and implementation of STEM-based activities. In addition, it may be advisable to give trainings especially to teachers on preparing activities and lesson plans suitable for their classes. In addition, it is recommended to provide the necessary equipment to eliminate the lack of infrastructure or materials in institutions where STEM education is carried out.

6. Conclusion

In summary from the results mentioned above, it can be said that the teachers stated that STEM education is mostly related to the fields of science, mathematics, engineering and technology. In addition, it is clearly seen that in STEM education, teachers emphasize that STEM education is the need of our age, it covers basic skills, which the product is obtained in this process that should start from pre-school period and that four disciplines should be combined. Regarding the classroom application of STEM-based activities for

teachers, teachers pointed out that students' success and self-confidence increased, learning became easier and learning was permanent. Finally, in the teacher level of the implementation process of STEM-based activities, teachers faced problems in classroom management and in the implementation of the activities, they experienced a lack of infrastructure and materials about the lack of equipment; On the student side, they stated that they had problems due to the lack of readiness level and the lack of support for the student.

7. Limitations

This study is limited to the views of teachers experienced in STEM education. In this context, it can be contributed to the field by conducting similar researches, qualitative studies in which teachers' lesson practices are observed, or experimental studies to determine the effectiveness of the education provided. Regarding this process, it is recommended to conduct studies to evaluate the studies conducted by taking the opinions of the students.

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All procedures in this study involving human participants were conducted in accordance with the ethical standards.

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