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Research Article

Examining Teachers' Views on In-Service STEM Education

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Abstract – This study aims to examine the effect of 30 hours of basic level STEM in-service training on teachers' thoughts about STEM education, using quantitative and qualitative methods. In the study designed using a mixed methods approach, an overlapping embedded design was used. For the quantitative part of the study, a one-group pretest-posttest model was adopted; data were collected with the 15-item "Scale of Teachers' Opinions on STEM Education" developed by Çevik (2017). In the qualitative methods, semi-structured interviews were conducted with 9 teachers, and the data were analyzed thematically using NVivo. The study group consisted of 16 teachers from pre-school (43.75%), primary classroom (18.75%), science (12.25%), technology design (12,25%), information technologies (6.25%), and mathematics (6.25%) fields. The findings reveal that there is a prevailing perception that STEM education contributes to the development of students' analytical thinking, problem-solving, and manual skills. In addition, the view that STEM education increases student motivation and relates to daily life became more prominent after the training. Teachers' negative opinions regarding STEM education as requiring a high level of materials and being time-consuming decreased. As a result, it was revealed that STEM education contributed significantly to teachers' professional development and students' academic achievement. However, in order to implement this education effectively, teachers need more support and training. These findings constitute an important basis for the dissemination of STEM education and making teachers competent in this field.

Keywords: STEM education, teacher views, in-service training, mixed method.

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Introduction

STEM (Science, Technology, Engineering, and Mathematics) education is a comprehensive approach that aims to help students develop 21st-century skills such as scientific thinking, problem-solving, innovation, and critical thinking. STEM offers career paths for engineers, scientists, and other science-related fields, while also providing interdisciplinary thinking opportunities for all students (Sahito & Wassan, 2024). While these disciplines are often taught independently in traditional teaching methods, STEM education emphasizes the interconnected nature of these fields. This is particularly important for fostering a multidisciplinary learning approach among preschool and middle school students (Carrell et al., 2010).

Research shows that introducing STEM concepts at an early age increases students' interest in these fields in later years of education (Madden et al., 2013; Roberson, 2015). Developing strong STEM skills at an early age plays a critical role in preparing students for their future professional careers (Madden et al., 2013). Furthermore, today's employers need individuals who possess not only academic knowledge but also skills such as creative thinking, innovation, and problem solving (Techakosit & Nilsook, 2018). In this respect, STEM education is an indispensable educational approach for individuals to adapt to the requirements of the digital age.

However, students' success in STEM fields is directly related to the qualifications of their teachers. High-quality STEM education is largely dependent on teacher competence in terms of creating supportive learning environments, encouraging student participation, and strengthening learning outcomes (Rifandi et al., 2020; Roberson, 2015; Roehrig et al., 2021). Teachers must have both content knowledge (Kloser et al., 2018) and the ability to convey this knowledge in a manner appropriate to the students' level in order to effectively teach STEM concepts. Teachers can develop these skills largely through participation in professional development programs.

Professional development is a critical process for teachers to strengthen their pedagogical skills and support student learning (Darling-Hammond et al., 2017). Rifandi et al. (2020) emphasized that teachers need to participate in continuing education to increase their knowledge base. Teachers' effectiveness in STEM education is closely related to their understanding of the curriculum content, their ability to use the material in a pedagogically appropriate manner, and their ability to establish interdisciplinary connections (Kloser et al., 2018). In this context, high-quality professional development programs provide teachers with

structured learning opportunities that can transform their teaching practices (Darling-Hammond et al., 2017).

The literature shows that professional development positively affects teachers' confidence levels, teaching skills, and attitudes toward STEM (Allen & Brasili, 2019; Shaffer & Thomas-Brown, 2015). However, teachers who have not received adequate STEM education may struggle to deliver the curriculum effectively, which can negatively impact student learning outcomes (Madden et al., 2013). Therefore, teachers need to actively participate in in-service training within the scope of STEM education and reflect the knowledge they acquire in classroom practices.

Another important aspect of STEM education for teachers is that it provides them with opportunities to develop their own professional knowledge and skills. During STEM education practices, teachers support their professional development by learning new teaching methods, technological tools, and innovative learning approaches (Nadelson et al., 2013). This can also positively influence teachers' attitudes toward STEM education (Wang et al., 2011). Thus, teachers become key actors who guide their students and direct them toward STEM-related careers (Schmidt & Fulton, 2016).

However, it is known that many educators do not feel sufficiently prepared to teach STEM effectively (Allen & Brasili, 2019). This situation limits both the quality of STEM teaching and student achievement. At this point, supporting teachers with professional development training emerges as a critical necessity. Although interest in STEM education has increased in our country in recent years, the number of studies conducted in this field and studies focusing on teachers' experiences are still limited.

Studies by Wang et al. (2011), Asghar et al. (2012), Herro and Quigley (2017), and Lehman et al. (2014) have shown that collaboration between teachers and STEM education experts increases the effectiveness of STEM applications. This reveals that teachers' practical experiences offer important clues for the development of STEM education policies. Therefore, studies that reveal teachers' understanding of STEM education, their experiences, and their views on these processes will fill an important gap in the literature.

As Wang et al. (2011) also stated, the first step in developing a curriculum that provides high-quality STEM integration is to examine teachers' perspectives and classroom practices. The success of STEM education depends on the development of teachers' knowledge, skills, and attitudes in this field. However, the existing literature is limited in terms of studies

examining teachers' views on STEM education, particularly in terms of changes before and after in-service training. This gap highlights the need for research evaluating the effectiveness of teachers' professional development programs.

In this context, this study aims to examine teachers' views on STEM (Science, Technology, Engineering, and Mathematics) education before and after an in-service training program. The findings of the research are expected to contribute to both teachers' professional development processes and policies and practices related to the implementation of STEM education at the school level.

Research Problem

The main problem of the research is articulated as follows: "As a result of teachers' participation in the 30-hour STEM basic level in-service training program, has there been a statistically significant change in their general thoughts about STEM education?" Answers to the following sub-problems are also sought based on this problem. In this context, it is thought that the study may contribute to the literature in this field and guide other studies to be conducted.

1. What are the opinions of the teachers about the effects of the STEM in-service training they attended on their professional skills, application competence, and personal development?

2. What are the teachers' opinions on their positive and negative experiences in applying STEM education and the impact of these experiences on the teaching process and student learning outcomes?

Method

This research is a mixed-method study in which qualitative and quantitative methods are used in conjunction. It is stated that the mixed method provides a more meaningful handling of the problem situation, valid results and a clearer understanding of the problem by using qualitative and quantitative methods together rather than applying them separately (Cresswell & Plano Clark, 2011). In this study, the embedded mixed method was utilized due to the simultaneous collection of qualitative and quantitative data (Cresswell, 2008). This design enables the development of a larger framework with more data (Cresswell & Plano Clark, 2011). Methodological diversity is also provided by using quantitative and qualitative data together (Denzin, 2010). In this way, mixed methods provide a holistic perspective to the

research by clarifying the research results more clearly in cases where qualitative and quantitative approaches alone are insufficient (Özmen & Karamustafaoğlu, 2019).

Quantitative Dimension of the Research

In this study, the change in teachers' views on STEM education before and after receiving the STEM basic level in-service training was examined. In this context, a pretest-posttest, one-group, simple experimental design model was used in the quantitative dimension of the study. In this model, there is only one experimental group. STEM basic level in-service training was organized by the first researcher for one week, consisting of 30 hours in total. In addition to providing theoretical information about STEM, the teachers developed STEM projects and prepared technology-oriented learning scenarios. A pretest was administered to the group before an experimental intervention, and a posttest was administered after the STEM basic level in-service training. The same measurement tools were used in both applications.

Qualitative Dimension of the Research

In the qualitative dimension of the study, interviews were conducted with teachers who received STEM basic level in-service training and their opinions on the training were collected. A semi-structured interview form was prepared by reviewing the relevant literature. Expert review and rich description methods were used to ensure the validity of the study. The prepared form was examined by two teachers and an additional faculty member who are experts in the field. Necessary arrangements were made in line with the opinions of the experts regarding the interview form. In addition, the form was language-checked by a Turkish teacher. The interviews were conducted one-on-one and in quiet environments, to allow the teachers to express themselves in the best way possible. The first researcher provides detailed information such as the place where the research was conducted, who participated, and how the observation was made while describing the situation in question in the study. This is expressed as the method of rich description, and detailing the data contributes positively to validity (Birgin, 2021). The recordings obtained from the interviews were listened to meticulously at different times, and were transcribed. Themes were created with the data collected from the interviews, and consistency was ensured by the researchers by examining them at different times. In addition, the appropriateness of these themes was checked by a field expert, and the themes were finalized in line with the expert's opinion. In the qualitative dimension of the study, an easily accessible sampling strategy was adopted. In

this context, interviews were requested from all participants, and 9 teachers agreed to participate in the interview.

Participants

The announcement of the STEM Basic Level In-Service training, and the training was held with teachers who voluntarily requested to participate in the course after the announcement. The field information of the participant teachers is presented in Table 1.

Table 1 Fields Distribution of Teachers Participating in STEM Education

Fields	f	
	Quantitative	Qualitative
Pre-school	7	5
Primary classroom	3	2
Science	2	1
Technology and design	2	1
Information technology	1	0
Mathematics	1	0
Total	16	9

When Table 1 is examined, it shows that teachers from various fields participated in the course, and the highest participation was from preschool teachers. The distribution of teachers participating in in-service STEM education shows that the training is attractive to teachers in different fields.

Data Collection Tools and Data Analysis

In this study, quantitative data were collected using the "Teachers' Views on STEM Education" (TOSE) scale developed by Çevik (2017). The scale, consisting of 3 sub-dimensions and 15 items, is a five-point Likert-type scale ranging from "strongly disagree" (1) to "strongly agree" (5). The scale was applied to 247 teachers, and the reliability coefficient for the overall scale was calculated as .82 (first sub-dimension .81, second sub-dimension .71, third sub-dimension .70). SPSS statistical program was used to analyze the data collected using the scale. A semi-structured interview form developed by the researchers was used to collect qualitative data. Qualitative data were analyzed using NVIVO software.

Findings and Results

The findings related to the analysis of the data collected in this study, which examined teachers' views on STEM basic level in-service training, are presented in this section.

Findings related to the analysis of quantitative data

Before analyzing the data collected within the scope of the research, a normality test was applied to test whether the normality assumption was met. Table 2 presents the results of the normality test.

Table 2 Normality Analysis of the TOSE Scale

	N	Skewness	Kurtosis	Skewness Std. Error	Kurtosis Std. Error	z-statistic
STEM pretest	16	-.430	-.949	-.564	1.091	-.76
STEM posttest	16	-.960	-.110			-1.70

One of the methods used to assess normality is the z-statistic. A z-statistic ($P < .005$) less than 1.96, obtained by dividing the skewness coefficient by its standard error, indicates that the data set is normally distributed (Büyüköztürk, 2020). Based on this, it was concluded that the data showed normal distribution. For the analysis of normally distributed data, a dependent groups t-test was conducted to examine the difference between pretest and posttest scores. The results of the analysis are presented below.

Table 3 Related Groups t-Test Analysis for the Comparison of Pretest - Posttest Averages of the TOSE Scale

	N	$\bar{X}$	SS	df	t	P
STEM pretest	16	3.871	.387	15	-2.700	.016
STEM posttest	16	4.054	.337			

As seen in Table 3, there was a statistically significant difference between the pretest and posttest scores ($t(-2.700)$, $p < 0.05$). When the pretest mean score (3.871, SD = 0.387) was compared with the posttest mean score (4.054, SD = 0.337), it was seen that the posttest scores were significantly higher than the pretest scores. The eta-squared value indicating the degree to which the independent variable affects the dependent variable is described as a small effect size at 0.01, a medium effect size at 0.06, and a large effect size at 0.14 (Büyüköztürk, 2020). The effect size of the scale was calculated as Cohen's d = 0.51, indicating a medium effect size.

Table 4 Pretest - Posttest Averages for the Items of the TOSE Scale

	Scale of teachers' opinions about STEM education	Pretest	Posttest
1	STEM education contributes to increasing students' manual skills	4.2	4.75
2	STEM education improves students' analytical thinking skills	4.1	4.65
3	STEM education motivates students to learn	4.3	4.81
4	STEM education increases students' problem solving skills	4.12	4.68
5	STEM education practices increase students' self-confidence	4.05	4.75
6	STEM education supports students to gain a critical perspective	4.15	4.52
7	It is inevitable that STEM education reflects from the classroom to daily life	4.02	4.56
8	High-level materials are needed for STEM education	3.35	2.75
9	STEM education practice negatively affects classroom dominance in the lesson	2.75	2.18
10	STEM education activity wastes a lot of time in class	2.75	2.43
11	STEM education activities should be included in curricula	4.56	4.82
12	STEM education requires the teacher to use technology in the lesson	3.75	4.81
13	STEM education practices are an opportunity for teachers to improve themselves	4.32	4.75
14	Teachers should take an active role in STEM education activities	3.93	1.75
15	Teachers can easily plan STEM education in in/out-of-class activities	3.75	4.32

Table 4 shows the pretest and posttest comparisons of the mean scores for each of the items of the TOSE scale. According to these data, the following findings were.

1. The perception that STEM Education contributes to the development of students' analytical thinking, problem-solving and manual skills and increases their self-confidence has strengthened.

2. The view that STEM Education is related to daily life and contributes positively to students' motivation has increased.

3. The perception that high level materials are needed for STEM education, that education causes a loss of time, and that it has a negative impact on classroom management has weakened.

4. The view that technology-oriented activities to be prepared within the scope of STEM Education should be included in the curriculum was strengthened.

5. The view that STEM Education can be easily implemented in lessons and thus offers a development opportunity for teachers has been strengthened.

6. The perception of the teacher taking an active role in STEM education activities has weakened.

Findings related to the analysis of qualitative data

The findings related to qualitative data were grouped under 5 themes: the effect of STEM education on personal development, the skills developed by STEM education, the integration of STEM education into courses, the difficulties encountered in STEM education, the contribution of STEM education to professional development, and the role of the teacher. The findings related to the themes are presented below in the form of models.

Theme 1: Impact of STEM education on personal development

Some of the teachers' on the theme of The effect of STEM education on personal development are presented below.

> T5: "STEM education gave me a brand new perspective. I think especially my problem-solving and innovative thinking skills have improved. Also, my confidence in using technology has increased. This training has been a great opportunity not only for my professional but also for my personal development."
>
> T4: "Thanks to STEM education, my desire for continuous learning and discovery increased. In particular, I think my creative thinking and analysis skills and my communication skills have improved while doing group work. In addition, I learned to use technology more effectively."

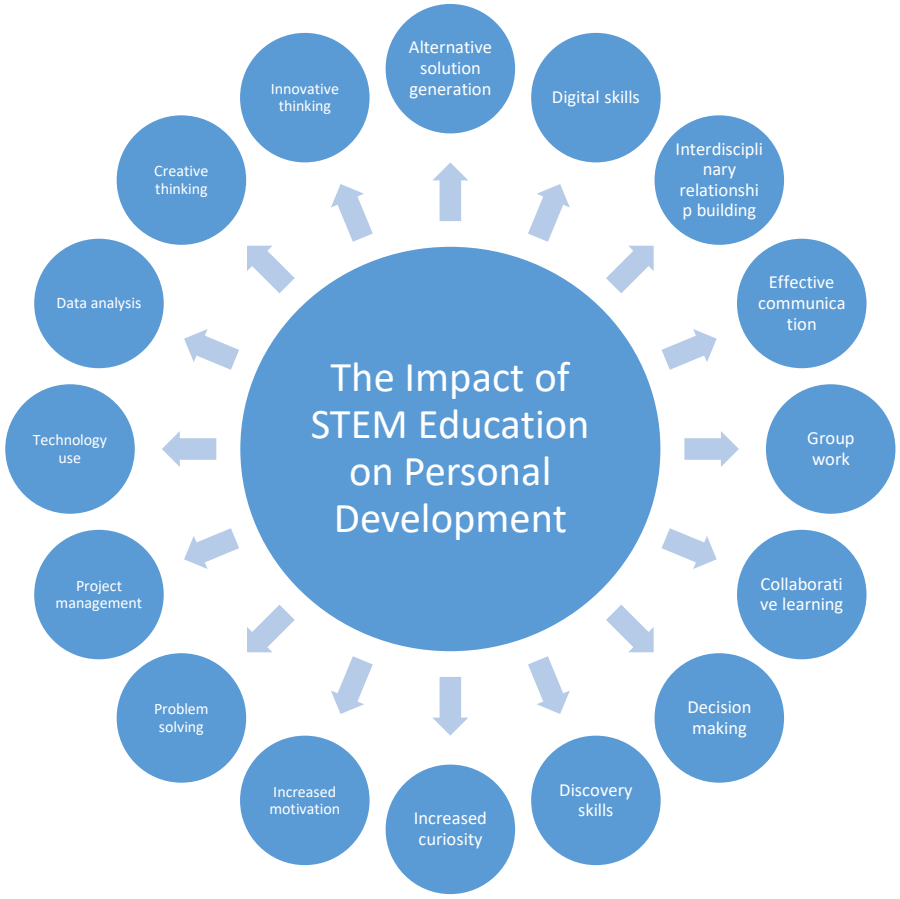

Figure 1 The Effect of STEM Education on Personal Development

Theme 2: Skills developed by STEM education

Some of the teachers' views on the theme of "skills developed by STEM education" are presented below.

> T2: "STEM education contributed significantly to my creative-solution-generating skills. I can now analyze complex problems more easily and produce creative solutions. I also find myself more successful in using resources and time efficiently."
>
> T1: "This training contributed greatly to my innovative idea generation and design skills. In addition, I gained valuable information on how to use technology more effectively. Thus, I can both use technology more effectively in my lessons and guide my students in this regard."

Figure 2 Skills Developed by STEM Education

Theme 3: Integration of STEM education into lessons

Some of the teachers' views on the theme of "Integration of STEM education into lessons" are presented below.

T4: "STEM education enabled me to use project-based learning methods more frequently in my lessons. We conduct design and modeling studies with students. I make the lessons more meaningful by making connections between disciplines. Integrating technology into lessons makes the learning process more effective."

T3: "Thanks to STEM education, I started to use experimentation and observation methods more in my lessons. Designing science experiments with students increases their curiosity. I also make the learning process more interactive by integrating technology into the lessons. Inquiry-based learning methods have also become an indispensable part of my lessons."

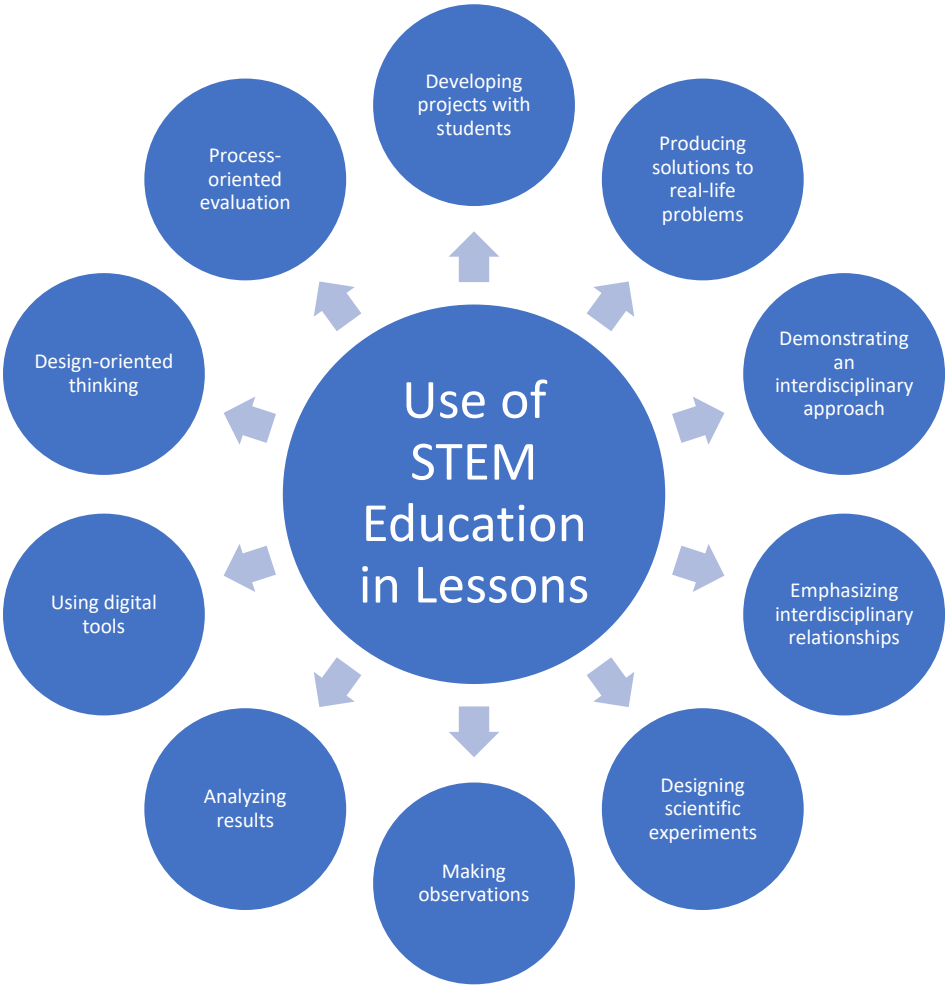

Figure 3 Integration of STEM Education into Lessons

Theme 4: Challenges in STEM education

Some of the opinions of the teachers on the theme of "Challenges encountered in STEM education" are presented below.

T7: "We had difficulties with time management during STEM education. We needed more time to complete the projects. Also, lack of technical knowledge and materials slowed down the progress of the projects."

T9: "During STEM education, we had difficulties due to a lack of technical knowledge and access to materials. In solving complex problems, we especially sometimes become stuck.

There were differences of opinion in teamwork and this slowed down the process. However, these difficulties led us to find more creative solutions."

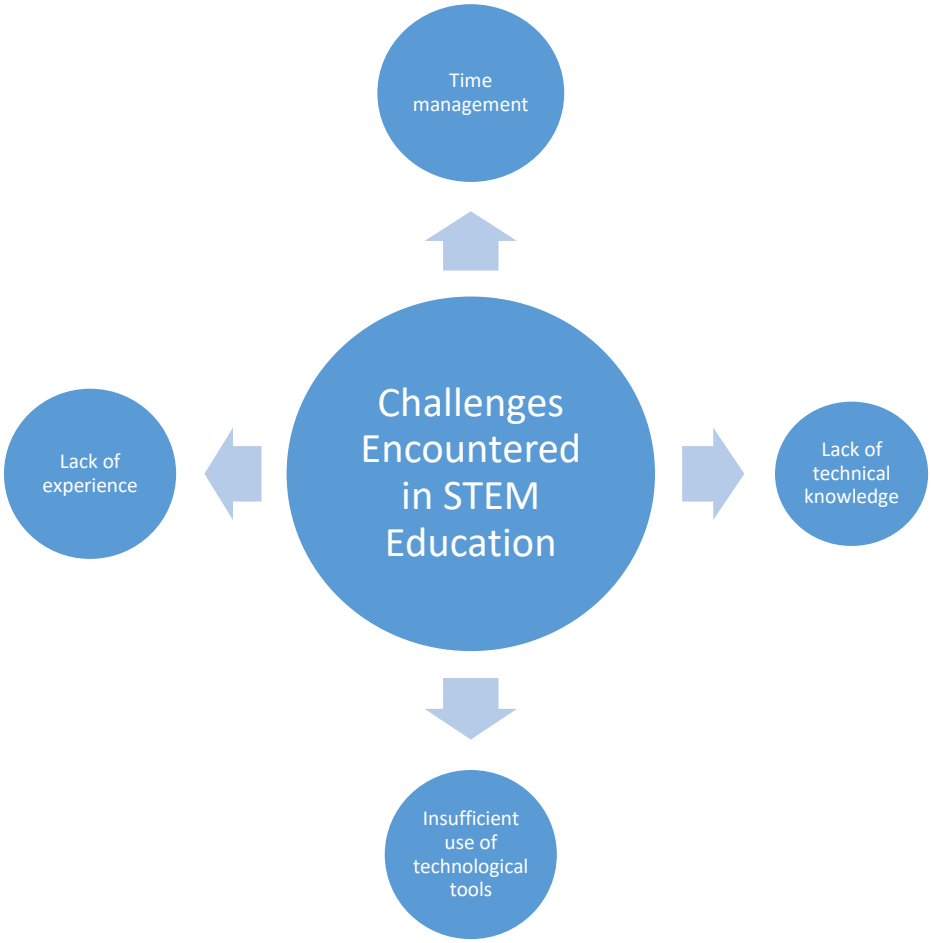

Figure 4 Challenges Encountered in STEM Education

Theme 5: The contribution of STEM education to professional development and teacher role

Some of the opinions of the teachers on the theme of "contribution of STEM education to professional development and teacher role" are presented below.

T8: "It is evident that STEM education contributed greatly to my professional development. I improved my leadership role while guiding students. I adopted the culture of continuous learning also by sharing knowledge and experience with my colleagues. This training enabled me to continuously improve as a teacher."

T6: "Thanks to STEM education, I use more project and activity-based methods in my lessons. Ensuring students' active participation makes them more involved in the learning process. Also, while guiding students, it has been a great source of motivation for me to reveal their creativity. This training has been an opportunity for me to renew myself as a teacher."

Figure 5 Contribution of STEM Education to Professional Development and Teacher Role

Discussion and Conclusions

This study aimed to examine how teachers' views on STEM (Science, Technology, Engineering, and Mathematics) education changed before and after the basic level in-service training program. Teachers from various fields participated in the study (Table 1). The fact that the participants came from different fields (preschool, classroom teaching, science, technology design, IT, mathematics) supports the "interdisciplinary nature of STEM," which is one of the basic assumptions of the study. Among the teachers participating in the study, preschool teachers had the highest proportion in quantitative (43.75%) and qualitative (55.50%) groups, reflecting a special interest among educators at this level in the STEM approach. This can be interpreted as a result of the growing awareness of the pedagogical importance of STEM education in early childhood (Madden et al., 2013; Sahito & Wassan, 2024) or as a consequence of early STEM-oriented policies in Türkiye.

The findings of the study revealed that STEM education contributed significantly to teachers' professional development and students' academic achievement. In addition, it was observed that teachers' perceptions of STEM education changed positively after the training. These findings support the notion that STEM education is an effective tool in developing students' 21st century skills (Carrell et al., 2010; Techakosit & Nilsook, 2018).

The findings of the study show that teachers' perceptions that STEM education contributes to the development of students' analytical thinking, problem-solving, psychomotor skills, and self-confidence are strengthened. This finding reveals that STEM education is effective in developing students' cognitive and psychomotor skills and aligns with studies in the literature (Sahito & Wassan, 2024). In addition, the strengthening of the perception that STEM education increases students' self-confidence indicates that this educational approach supports students' academic achievement, which is in line with the literature (Madden et al., 2013).

Teachers' views that STEM education increases students' motivation and is relevant to daily life became more evident after the training. This finding suggests that STEM education can encourage students to pursue STEM careers in the future by increasing their interest in these fields and enabling them to find solutions to real-world problems. In the literature review, it was determined that there are studies, (Daugherty et al., 2014; Kiazai et al., 2020; Madden et al., 2013; Rifandi et al., 2020) that support this result of the study.

Before the training, teachers' perceptions that STEM education requires a large amount of materials, causes time loss, and negatively affects classroom management weakened after the training. This shows that teachers' prejudices towards STEM education can be reduced with hands-on training and are in line with the literature (Darling-Hammond et al., 2017).

From the interviews with teachers, it was determined that teachers started to use methods such as project-based learning, interdisciplinary approaches, and inquiry-based learning more frequently when integrating STEM education into lessons. In particular, it was stated that experiments and observation methods were used more effectively in lessons. These findings reveal that STEM education supports student-centered teaching strategies and makes lessons more interactive. The findings obtained from the quantitative data reveal that STEM education should be integrated into the curriculum. Teachers' confidence in implementing this education in lessons has been reinforced, and that STEM education offers a professional development opportunity for teachers, which is in line with the literature (Stehle & Peters-Burton, 2019). On the other hand, the weakening of the perception that the teacher should

take an active role in STEM education activities demonstrates that teachers adopt STEM education as a more student-centered approach. This finding, supported by the literature (Sahito & Wassan, 2024), reveals that STEM education creates a learning environment that encourages students' active participation, .

The findings of the study show that for STEM education to be successful, teachers should receive more training and support in this field. In this context, it is important to expand in-service training programs and increase teachers' knowledge and skills related to STEM education. This is supported by the results of studies in the literature (Karaduman & Eti, 2023; Mcdonald, 2016; Susilo & Sudrajat, 2020). In addition, the findings show that STEM education contributes significantly to the professional development of teachers. In the interviews, teachers stated that thanks to this training, they improved their leadership skills, adopted a culture of continuous learning by collaborating with their colleagues, and were able to guide students more effectively. These findings suggest that STEM education diversified teachers' pedagogical approaches and helped them in adopting an innovative teaching approach. In particular, teachers had the opportunity to improve their knowledge and skills by using new teaching methods and technological tools in the STEM education process, which is in line with the literature (Mcdonald, 2016).

The teachers participating in the training were from different fields shows that STEM is adopted as an interdisciplinary approach. The fact that preschool teachers participated in the training the most can be interpreted as indicating that STEM education is more important in early childhood. This may indicate that the awareness that the foundations of STEM should be laid at an early age has become widespread. In addition, the fact that preschool and classroom teacher candidates have received education in many disciplines in our country can be interpreted as a reason these teachers are more interested in STEM education.

Some challenges were encountered in STEM education. Time management, lack of technical knowledge, and inadequate materials were the main challenges for teachers. In addition, disagreements during teamwork made it difficult for the process to progress. Such difficulties are also frequently encountered in the literature (İnançlı & Timur, 2018; Saraç & Doğru, 2021) and show that appropriate support mechanisms should be provided to make STEM training more efficient.

Recommendations

- STEM education should be initiated at the pre-school and primary school levels, and students should be encouraged to take an interest in these fields.
- Regular in-service training programs should be organized to improve teachers' knowledge and skills in STEM education.
- STEM education should be further integrated into school curricula, and this educational approach should be supported by projects and activities that students can relate to daily life.
- Collaboration and experience sharing among teachers on STEM education should be encouraged, and workshops, seminars, and online platforms should be created for this purpose.
- Awareness-raising activities should be conducted among teachers, students, and parents about the importance of STEM education. These efforts should include information on how STEM education will contribute to students' future careers.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

The authors have no competing interests to declare that are relevant to the content of this article.

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CRediT author statement

Hüseyin Yolcu: Investigation, Conceptualization, Methodology, Formal Analysis, Writing -Original Draft, Data curation.

Orhan Karamustafaoğlu: Validation, Writing - Reviewing & Editing.

Research involving Human Participants and/or Animals

This study has been deemed appropriate in terms of scientific research ethics by the Ethics Committee of the Social Sciences at Amasya University, with its approval dated November 11, 2024, and numbered E-30640013-108.01-226207.

Hizmet İçi STEM Eğitimi Hakkında Öğretmenlerin Görüşlerinin İncelenmesi

Özet:

Bu çalışma, 30 saatlik temel seviye STEM hizmet içi eğitiminin öğretmenlerin STEM eğitimi hakkındaki düşünceleri üzerindeki etkisini nicel ve nitel boyutları kullanarak incelemektedir. Karma yöntem temelinde tasarlanan çalışmada, örtüşen gömülü tasarım kullanılmıştır. Nicel boyutta, tek gruplu ön test-son test modeli benimsenmiş; veriler Çevik (2017) tarafından geliştirilen 15 maddelik "Öğretmenlerin STEM Eğitimi Hakkındaki Görüşleri Ölçeği" ile toplanmıştır. Nitel boyutta, 9 öğretmenle yarı yapılandırılmış görüşmeler yapılmış ve veriler NVivo kullanılarak tematik olarak analiz edilmiştir. Çalışma grubu, okul öncesi (43,75%), ilkokul (18,75%), fen (12,25%), teknoloji ve tasarım (12,25%), bilişim teknolojileri (6.25%) ve matematik (6.25%) alanlarından 16 öğretmenden oluşmuştur. Bulgular, öğretmenlerin STEM eğitiminin öğrencilerin analitik düşünme, problem çözme ve el becerilerini geliştirdiğini algıladıklarını göstermiştir. Ayrıca, STEM eğitiminin öğrenci motivasyonunu artırdığı ve günlük yaşamla ilişkili olduğu görüşü, eğitimden sonra daha belirgin hale gelmiştir. Öğretmenlerin, STEM eğitiminin yüksek düzeyde materyal gerektirdiği ve zaman alıcı olduğu yönündeki olumsuz görüşleri azalmıştır. Sonuç olarak, STEM eğitiminin öğretmenlerin mesleki gelişimine ve öğrencilerin akademik başarısına önemli ölçüde katkıda bulunduğu ortaya çıkmıştır. Ancak, bu eğitimi etkili bir şekilde uygulamak için öğretmenlerin daha fazla desteğe ve eğitime ihtiyacı vardır. Bu bulgular, STEM eğitiminin yaygınlaştırılması ve öğretmenlerin bu alanda yetkin hale getirilmesi için önemli bir temel oluşturmaktadır.

Anahtar kelimeler: STEM eğitimi, öğretmen görüşleri, hizmet içi eğitim, karma yöntem.

References

Allen, M., & Brasili, A. (2019). *STEM education: A review of the contribution of the disciplines of science, technology, engineering and mathematics*. Routledge.

Asghar, A., Ellington, R., Rice, E., Johnson, F., & Prime, G. M. (2012). Supporting STEM education in secondary science contexts. *The Interdisciplinary Journal of Problem-based Learning, 6*(2), 85-125. https://doi.org/10.7771/1541-5015.1349

Birgin, O. (2021). Geçerlik ve değerlendirme standartları. S. B. Demir & M. Bütün (Eds.), In *Nitel Araştırma Yöntemleri* (pp. 245-250). Siyasal.

Büyüköztürk, Ş. (2020). *Sosyal bilimler için veri analizi el kitabı*. Pegem Akademi.

Carrell, S. E., Page, M. E., & West, J. E. (2010). Sex and science: How professor gender perpetuates the gender gap. *The Quarterly Journal of Economics, 125*(3), 1101-1144. https://doi.org/10.1162/qjec.2010.125.3.1101

Creswell, J. W. (2008). *Research design: Qualitative, quantitative, and mixed methods approaches.* (3rd ed.). Sage.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research.* (2nd ed.). Sage.

Çevik, M. (2017). STEM awareness scale (STAS) development study for secondary school teachers. *International Journal of Human Sciences, 14*(3), 2436-2452. https://www.j-humansciences.com/ojs/index.php/IJHS/article/view/4673/2265

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development.* Learning Policy Institute.

Denzin, N. K. (2010). Moments, mixed methods, and paradigm dialogs. *Qualitative Inquiry, 16*(6), 419-427. https://doi.org/10.1177/1077800410364608

Daugherty, M., Carter, V., & Swagerty, L. (2014). Elementary STEM education: The future for technology and engineering education?. *Journal of STEM Teacher Education, 49*(1), 45–55. https://doi.org/10.30707/JSTE49.1Daugherty

Herro, D., & Quigley, C. (2017). Exploring teachers' perceptions of STEAM teaching through professional development: implications for teacher educators. *Professional Development in Education, 43(3)*, 416-438. https://doi.org/10.1080/19415257.2016.1205507

İnançlı, E., & Timur, B. (2018). Science teachers' and prospective teachers' views on STEM education. *International Journal of Science and Education, 1*(1), 48-68. https://dergipark.org.tr/en/pub/ubed/article/438856

Karaduman, B., & Eti, İ. (2023). STEM for everyone: The views of educational staff working in a STEM education center on STEM education. *Trakya Education Journal, 13*(1), 209-225. https://doi.org/10.24315/tred.1022582

Kiazai A. N., Siddiqua, N., & Waheed, Z. (2020). Challenges in implementing STEM education and role of teacher education programs in mitigating these challenges. *International Journal of Distance Education and E- Learning, 5*(2), 123-137. https://doi.org/10.36261/ijdeel.v5i2.1047

Kloser, M., Wilsey, M., Twohy, K. E., Immonen, A. D., & Navotas, A. C. (2018). "We do STEM": Unsettled conceptions of STEM education in middle school S.T.E.M. classrooms. *School Science and Mathematics, 118*(8), 335-347. https://doi.org/10.1111/ssm.12304

Lehman, J. D., Kim, W., & Harris, C. (2014). Collaborations in a community of practice working to integrate engineering design in elementary science education. *Journal of STEM Education: Innovations and Research, 15*(3), 21-28. https://jstem.org/jstem/index.php/JSTEM/article/view/1901

Madden, M. E., Baxter, M., Beauchamp, H., Bouchard, K., Habermas, D., Huff, M., ... & Plague, G. (2013). Rethinking STEM education: An interdisciplinary STEAM curriculum. *Procedia Computer Science, 20*, 541-546. https://doi.org/10.1016/j.procs.2013.09.316

Mcdonald, C. (2016). STEM education: A review of the contribution of the disciplines of science, technology, engineering and mathematics. *Science Education International, 27*(4), 530-569. https://eric.ed.gov/?id=EJ1131146

Nadelson, L. S., Callahan, J., Pyke, P., Hay, A., Dance, M., & Pfiester, J. (2013). Teacher STEM perception and preparation: Inquiry-based STEM professional development for elementary teachers. *The Journal of Educational Research, 106*(2), 157-168. https://doi.org/10.1080/00220671.2012.667014

Özmen, H., & Karamustafaoğlu, O. (Eds.), (2019). *Eğitimde araştırma yöntemleri.* Pegem.

Rifandi, R., Rahmi, Y. L., & Indrawati, E. S. (2020). Pre-service teachers' perception of science, technology, engineering, and mathematics (stem) education. *Journal of Physics Conference Series, 1554*, Article 012062. https://doi.org/10.1088/1742-6596/1554/1/012062

Roberson, T. L. (2015). STEM-ulating young minds: Creating science-based programming @ your library. *Journal of Library Administration, 55*(3), 192–201. https://doi.org/10.1080/01930826.2015.1034041

Roehrig, G. H., Dare, E. A., Ring-Whalen, E., & Wieselmann, J. R. (2021). Understanding coherence and integration in integrated STEM curriculum. *International Journal of Stem Education, 8*(2), 1-21. https://doi.org/10.1186/s40594-020-00259-8

Saraç, E., & Doğru, M. (2021). Examination of prospective primary teachers' STEM education design and implementation experiences. *Journal of Science Teaching, 9*(1), 1-37. https://dergipark.org.tr/en/download/article-file/2581402

Sahito, Z., & Wassan, S. H. (2024). Literature review on STEM education and its awareness among teachers: An exploration of issues and problems with their solutions. *Sage Open*, *14*(1). https://doi.org/10.1177/21582440241236242

Schmidt, W. H., & Fulton, L. (2016). Transforming teacher education through clinical practice: A national strategy to prepare effective teachers. *Journal of Teacher Education, 67*(4), 263-272. https://eric.ed.gov/?id=EJ919045

Shaffer, D. W., & Thomas-Brown, K. (2015). Enhancing teacher competency through co-teaching and embedded professional development. *Journal of Education and Training Studies, 3(*3), 117-125. http://dx.doi.org/10.11114/jets.v3i3.685

Stehle, S. S., & Peters-Burton, E. E. (2019). Developing student 21st century skills in selected exemplary inclusive STEM high schools. *International Journal of STEM Education, 6*(39), 1-15. https://doi.org/10.1186/s40594-019-0192-1

Susilo, H., & Sudrajat, A. K. (2020). STEM learning and its barrier in schools: The case of biology teachers in Malang City. *Journal of Physics Conference Series, 1563*(1). https://doi.org/10.1088/1742-6596/1563/1/012042

Techakosit, S., & Nilsook, P. (2018). The Development of STEM literacy using the learning process of scientific imagineering through AR. *International Journal of Emerging Technologies in Learning, 13*(1), 230-238. https://doi.org/10.3991/ijet.v13i01.7664

Wang, H. H., Moore, T. J., Roehrig, G. H., & Park, M. S. (2011). STEM integration: Teacher perceptions and practice. *Journal of Pre-College Engineering Education Research, 1*(2), 1-13. https://doi.org/10.5703/1288284314636