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Exploring Turkish K-12 pre-service and in-service teachers' STEM self-efficacy: A systematic review

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ABSTRACT Teachers' self-efficacy in teaching STEM subjects is a crucial factor influencing the overall effectiveness of STEM education. Teachers have a major role in fostering students' interest and engagement in STEM disciplines. To address this importance, a systematic review of STEM self-efficacy with Turkish in-service and pre-service teachers at the K-12 level was conducted. This review included 25 empirical studies from ERIC, WoS, Scopus, and DergiPark databases. The analysis first focused on the descriptive characteristics of the studies, including their distribution over time, methodologies, and research designs. Subsequently, emerging themes categorized into key factors influencing STEM self-efficacy among pre-service and in-service K-12 teachers. We found that a high level of STEM attitudes, awareness, and comprehensive professional development programs significantly affected teachers' self-efficacy in teaching STEM. Demographic variables, such as gender, area of specialty, pre-service teachers' year of enrollment, in-service teachers' experience, and graduate degrees also play an important role in their STEM self-efficacy. Challenges in implementation, such as classroom management, resource constraints, and student readiness are barriers to STEM self-efficacy. This study draws attention to the critical need for comprehensive professional development to improve STEM self-efficacy and to effectively integrate STEM education in K-12 settings.

Keywords: *K-12 teacher education, STEM education, STEM self-efficacy*

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INTRODUCTION

Interest in STEM (Science, Technology, Engineering, and Mathematics) education, both in research and in practice, has been steadily growing worldwide (Kennedy & Odell, 2014; Li et al., 2020), with a similar trend observed in Türkiye (Çepni, 2018; Yılmaz et al., 2018). Nonetheless, there is no clear consensus within the educational community regarding a precise definition of STEM education (Wang et al., 2011) or regarding the best practices for its instruction (Thibaut et al., 2018). However, STEM education is commonly conceptualized as an interdisciplinary approach to teaching and learning that integrates science, technology, engineering, and mathematics with real-world problems (Stohlmann et al., 2012). Although these four disciplines are frequently mentioned together, pioneering studies in the literature broadly include efforts to integrate into two or more subject areas (Johnson, 2013; Kelley & Knowles, 2016; Sanders, 2009). STEM education extends across both formal and informal learning environments at all levels from early childhood to postdoctoral studies (Gonzalez & Kuenzi, 2012). Regardless of whether students pursue careers in STEM, it is essential for everyone to develop a foundational level of literacy in these disciplines to make informed decisions and tackle today's complex personal and societal challenges. (National Research Council [NRC], 2011). Additionally, developing STEM literacy increases individuals' decision-making abilities by enabling them to better understand and address real-world issues related to their lives and the environment.

Upon examining Türkiye's STEM education initiatives, it was observed that since 2014 such efforts have largely focused on 21st-century skills, though STEM education was not explicitly emphasized at that time. Research on STEM education has increased significantly since 2014 (Herdem & Ünal, 2018; Tezel & Yaman, 2017). Notably, significant advancements related to STEM education have been made by the Turkish Ministry of National Education, especially regarding the middle school science curriculum after 2018 (Ministry of National Education [MoNE], 2018). Despite the lack of a comprehensive national STEM education policy, various public and private educational institutions have implemented diverse STEM-related practices (Ay & Seferoğlu, 2020).

Conceptual Framework

Undoubtedly, the teaching profession and its definition have been undergoing transformation in line with the momentum of STEM education. Teachers are the key to implementing this curriculum by following the needs and developments in the field of education globally. They are expected to implement innovative educational methods and environments in their classrooms to meet this need. Çorlu, Capraro, and Capraro (2014) emphasized that it is necessary to teach new methods and techniques to pre-service and in-service teachers. Learning new strategies is only part of the equation. For these strategies to be effective, teachers must be confident and willing to implement them successfully in classroom (Darling-Hammond, & Baratz-Snowden, 2007). Therefore, teachers' content knowledge and willingness to learn new pedagogies are key factors that increase the success of STEM education (Nadelson & Seifert, 2017). Teacher confidence known as self-efficacy, are critical factors for successful implementation of new strategies in STEM education (Cerit, 2013).

In Social Learning Theory by Bandura (1977), self-efficacy, one of the important parameters, is defined as "Beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). People tend to engage in behaviors that they believe will achieve their desired outcomes and avoid behaviors that are associated with unsatisfactory outcomes (Schunk, 2012, p. 121). Bandura (1997, p. 79) explains the four main sources underlying self-efficacy: mastery experience, vicarious experience, verbal persuasion, and physiological and affective states. Mastery experiences are often effective sources of information that directly demonstrate one's ability to overcome challenges, achieve success, and strengthen efficacy beliefs. Vicarious experiences refer to changing efficacy beliefs through comparison with the achievements of others. Verbal persuasion is the situation in which encouragement and criticism about whether a person has certain abilities in a situation affect the perception of self-efficacy. Physiological and emotional states represent the perception of self-efficacy of being able to withstand stress and tension in line with the expectation of the individual. In this context, the individual's idea of succeeding or failing to solve a problem affects the individual's self-efficacy (Schunk, 2012, p. 121). Teachers' self-efficacy should be considered an important factor affecting the teaching and learning processes (Hoy & Spero, 2005).

K-12 STEM Teachers' Self-efficacy

In the 21st century, teachers are expected to create more dynamic environments by implementing innovative educational methods in their classrooms. To meet these demands, teachers need to attend in-service training from subject matter experts with regular support and constantly update their knowledge in these areas. Teachers are expected to be able to interact with students by incorporating concepts from science, mathematics, technology, and engineering into their lessons in an integrated manner. As education systems around the world increasingly prioritize STEM integration, the demand for STEM teachers worldwide will increase (Radloff & Guzey, 2016). Hence, K-12 STEM teacher training is crucial for preparing educators to effectively engage and implement STEM subjects in today's classrooms (Stohlmann et al., 2012). Teachers are considered the most influential factor for students' interest and learning in STEM subjects (Kelley et al., 2020). Shernoff and their colleagues (2017) noted several barriers to implementation and potential support for integrated STEM curriculum and education. Teachers in their study emphasized the need for more effective training to implement STEM in the classroom. Stohlmann and their colleagues (2012) highlighted the importance of teachers' content knowledge, effective pedagogy approaches, and self-efficacy. In this regard, they stated that it is a critical factor for teachers to feel competent in implementing STEM education.

Self-efficacy plays a significant role in teachers' own motivation and classroom practice (Menon & Sandler, 2016). Although efforts to increase teachers' self-efficacy in STEM span from pre-service education to in-service professional development, these efforts are often in short-term contexts, making it difficult to assess their long-term impact (Menon et al. 2024). It is crucial for teachers to feel competent about STEM and to have high self-efficacy levels when they start their careers. Therefore, it is important for them to be exposed to STEM education before starting their profession (Radloff & Guzey, 2016). Teachers' self-efficacy, specifically their confidence in their instructional abilities (Holzberger et al., 2013), is a pivotal factor in shaping learning environments and influencing students' academic experiences (Bandura, 1997, p. 240; Holzberger et al. 2013; Kelley et al. 2020; Nadelson et al. 2012; Sharma et al. 2012; Tai et al. 2012; Yoon et al. 2014;).

In the context of the growing recognition of and need for STEM education in Türkiye, Corlu (2014) emphasized that teachers start their careers without having the necessary integrated STEM knowledge. Teachers need to be equipped with adequate training and support. Teachers as the primary facilitators of STEM education need to have high levels of self-efficacy to create effective learning environments and encourage student engagement. However, in Türkiye, there is a notable absence of comprehensive national policies and systematic teacher training programs targeting both pre-service and in-service teachers. For instance, Corlu (2012)'s study with pre-service mathematics or science teachers found that pre-service teachers' departments, their past experiences, their concerns about the future after graduation, and their self-evaluations towards science and mathematics affect their STEM education teaching self-efficacy. The literature also reveals significant gaps in teachers' understanding of STEM practices, their self-efficacy in implementing STEM curricula, and the availability of professional development opportunities.

Given the need for STEM education, it is crucial to examine what factors, as well as how such factors, may influence pre-service and in-service teachers' STEM self-efficacy. While previous reviews in Türkiye have examined teacher self-efficacy across disciplines (Baysal & Mutlu, 2021; Cansoy et al., 2018), no review to date has specifically addressed STEM self-efficacy of preK-12 pre-service and in-service teachers. However, it is worth noting that there are existing literature reviews on STEM teacher self-efficacy at the international level (Liu et al., 2025; Margor & Kettler, 2019; Zhou et al., 2023; Zhou et al., 2025). A clear understanding of STEM self-efficacy among pre-school and primary school teachers in Türkiye and the factors influencing it can guide the design and implementation of more effective professional development and training programs. It can also provide practical support to school administrators, mentors, and teacher educators. This study aims to make a unique contribution by systematically synthesizing empirical research conducted in Türkiye, and by highlighting trends, needs, and assessment results from existing research on STEM self-efficacy of pre-service and in-service teachers at the pre-school and primary school levels.

Aim and Problems of the Study

This study aims to draw attention to the importance of K-12 STEM pre-service and in-service teachers' self-efficacy levels towards teaching STEM and to examine studies conducted in Türkiye. Below are the two research questions of the current study.
1. What are the key characteristics (publication years, methodology, method design) of the empirical studies conducted in Türkiye regarding the STEM self-efficacy of K-12 in-service and pre-service teachers?
2. What are the emerging themes and findings of the empirical studies?

METHODOLOGY

Through a systematic literature review, this study identifies and synthesizes previous research in the field, thereby supporting future studies in this area.

Literature Search

The search was most recently conducted in December 2024 within four bibliographic databases: (a) the Educational Resources Information Clearinghouse (ERIC), (b) Web of Science (c) Scopus (d) DergiPark. The search used STEM, teacher, and self-efficacy as keywords. Specifically, the following keywords (query) were deployed using Boolean operators: "pre-service STEM teacher" OR "in-service STEM teacher" OR "teacher" AND "STEM" OR "STEM Education" AND "self-efficacy". No specific year range was used for the search, so that a more comprehensive trend in this line of work in Türkiye could be revealed. In the initial search, 79 articles were collected for analysis. Eighteen duplicate articles were subsequently removed from the results. Additionally, studies outside the purpose of the systematic review (N = 39), such as those focusing on student self-efficacy, were excluded from the analysis. Finally, total of 25 study included in this review (Figure 1).

Inclusion and Exclusion Criteria

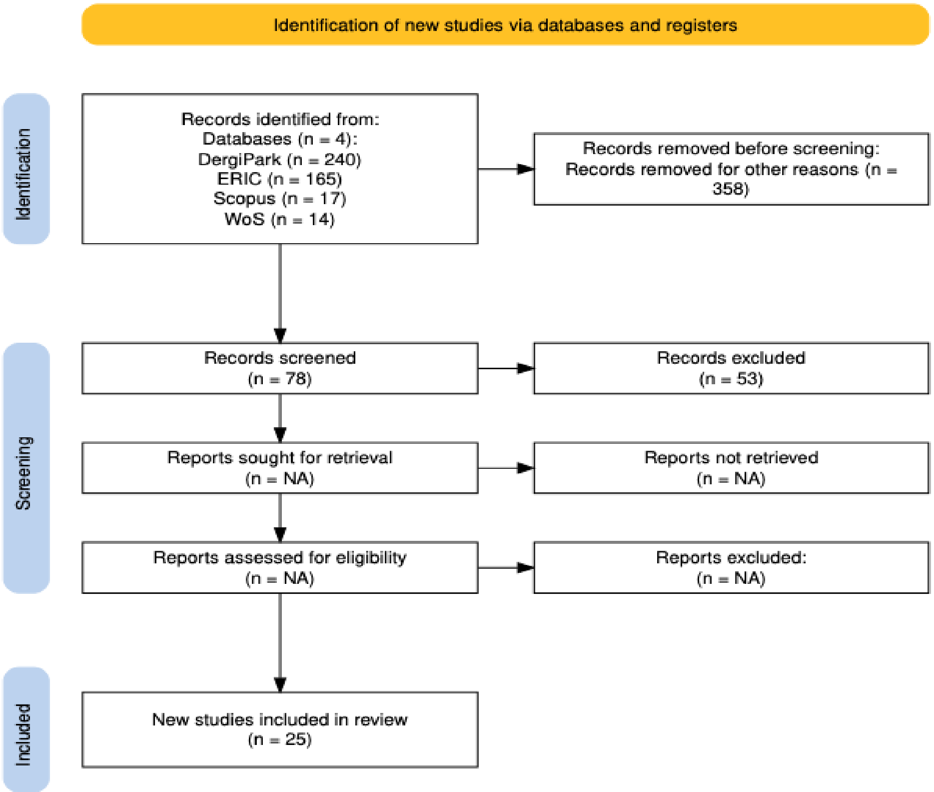
The reviewed articles were identified from specific databases, namely ERIC, Scopus, WoS (Web of Science), and DergiPark, to ensure relevance for the research.

Studies were included based on the following criteria developed by researchers:
1) Pre-service or in-service PreK–12 teachers, regardless of grade level or subject specialization, focusing on STEM education.
2) Empirical studies using qualitative, quantitative, or mixed methods approaches.
3) Studies conducted in Türkiye.
4) Studies published in English or Turkish, hence likely accessible to a broader readership.
5) Studies whose findings are directly aligned with the research questions of this review.

The exclusion criteria were developed by the researchers to ensure consistency, relevance, and reliability as follows:
1) Non-scholarly publications, conference proceedings, and technical reports were excluded due to differences in methodological rigor and reporting standards.

2) Master's and doctoral theses were excluded because they often address multiple variables with broader research objectives, making it difficult to compare and examine their effects on STEM self-efficacy levels.
3) Only journal publications were included to maintain consistency in exploring contributing factors for STEM self-efficacy levels among pre-service and in-service PreK-12 teachers.

Figure 1.
PRISMA Flowchart Tool Retrieved from Haddaway et al. (2022)



Selection Process

The authors examined the titles and abstracts of the relevant articles published in English. Full texts of potentially eligible articles were then independently assessed by the authors, with any discrepancies resolved through discussion. For Turkish articles, the first author conducted the initial screening due to linguistic reasons. All articles were collected and reviewed manually without the use of automated software tools.

Data Extraction

Data was manually extracted and compiled into a tabular form, which includes information on the authors, publication year, methodology, population and sample size, data collection tools, and key findings of included papers (Appendix 1).

Data Analysis

Analysis Related to Research Question 1

Data extracted from the 25 studies was analyzed using a descriptive content analysis to answer Research question 1, which pertains to the STEM self-efficacy among K-12 teachers in Türkiye. Each article was evaluated and categorized according to the following five key descriptive characteristics: year of publication, methodological designs, participant demographics, and data collection instruments (Appendix 1). A graphical distribution of the selected studies by year was studied to examine the scholarly trend in this area. Then these studies were categorized into different groups based on their methodological approaches employed for data analysis. Additionally, the frequency and percentage for each of the identified methodological approaches were calculated. This analytical analysis contributed to a structured presentation of both the temporal distribution and research paradigms in the existing literature

Analysis Related to Research Question 2

To answer Research question 2, the emerging themes and findings related to the STEM self-efficacy levels of K-12 pre-service and in-service teachers were identified by using thematic analysis. The aim was to provide a comprehensive understanding of the factors, challenges, and perceptions that influence teachers' STEM self-efficacy. Below is a table containing the categorization of themes, codes, and definitions that emerged from the studies addressed in this systematic review.

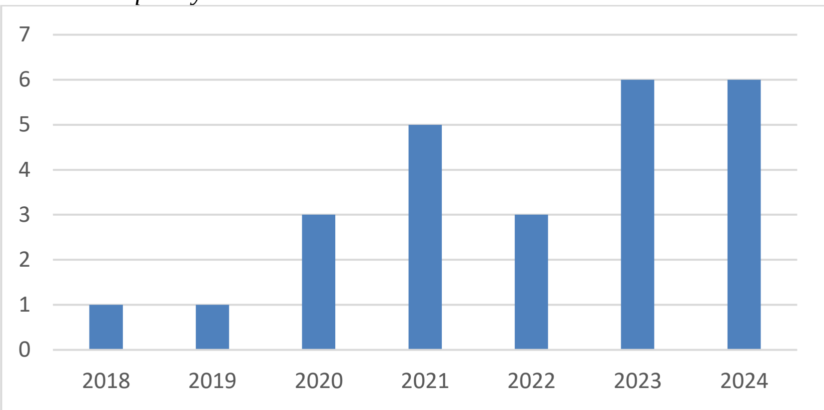
Table 1.
Codebook of Themes, Codes, and Their Definitions

Theme	Code	Definition
Factors that influence STEM Self-efficacy	STEM Awareness, Attitudes, and Concerns	In-service and pre-service teachers' level of awareness and level of attitudes toward STEM education, including concerns about its implementation.
	Demographic Variables	Differences by gender, specialization, teaching experience, school type, grade, and level of education.
	STEM Instructional Competencies	Differences in in-service and pre-service teachers' instructional competencies related to STEM.
	Professional Development (PD) and Training Programs	Differences in whether they have received PD or training in STEM and STEM education.
[Possible] Challenges in STEM Implementation	Classroom Management and Resources	Issues include resource constraints, time constraints, and classroom dynamics in teachers' integration of STEM.
	Students' Readiness and Interest in STEM	Variations in students' academic readiness and interest in STEM disciplines.
	Lack of In-Service Training and Professional Development	Need for STEM education in pre-service or in-service PD programs.
	Interdisciplinary STEM Integration and Content Knowledge	Challenges in integrating interdisciplinary STEM approaches into their curricula and lesson plans.
Perceived STEM Self-Efficacy	In-service and pre-service teachers' willingness to implement STEM	Teachers' willingness and motivation to implement STEM practices.

FINDINGS

This section reports analysis of key descriptive features of the studies included in this study. The descriptive characteristics of the studies, including year of publication, methods, method design, number of participants, data collection tools, are detailed in Appendix 1.

Figure 2.
Publications Distribution Frequency over the Years



Over the years, a growing trend has been observed in the number of studies investigating K-12 teachers' STEM self-efficacy in Türkiye (Figure 2). From 2018, there has been a moderate research interest in exploring K-12 teachers' STEM self-efficacy. It is shown that interest in studies in this field has increased in the last 4 years.

Table 2.
Frequencies and Percentages of Method and Method Designs Used

Method	Frequency (f)	Percentage (%)	Method design	Frequency (f)
Quantitative	12	48	Survey method	5
			Descriptive model	2
			Quasi-experimental model	2
			Correlation model	2
Qualitative	1	4	Causal design	1
			Case study	1
			Convergent parallel design	3
			Embedded design	4
Mixed-Method	12	48	Sequential explanatory	2
			Concurrent design	1
			Case study	1
			Phenomenology	1
Total	25	100	Total	25

Among those reviewed, twelve studies were conducted with quantitative methodology, another twelve were conducted with mixed methodology, and only one study was conducted with qualitative methodology. Many of the empirical studies used quantitative methods, accounting for 48% (n=12) of the reviewed literature. These studies mainly used survey designs including correlational and predictive models (f = 5). Only one study used qualitative methodology with a case study design (f = 1). The mixed methods (48%, n=12) category includes a combination of quantitative and qualitative, primarily with three designs, convergent parallel design, embedded design, and a sequential explanatory design. In a convergent parallel design (f = 3), qualitative and quantitative data are collected concurrently but analyzed separately. In an embedded design (f = 4), qualitative or quantitative data are collected, but one is more dominant than the other. Finally, in a sequential explanatory design (f = 2) a two-stage approach is used to collect and analyze quantitative and qualitative data.

Factors that Influence STEM Self-Efficacy

STEM Awareness, STEM Attitudes, and Concern Levels

Our review shows that many studies explored how the relationship between pre-service and in-service teachers' STEM self-efficacy (STEM SE) relates to their STEM awareness, STEM attitudes, and concern levels.

Teachers' STEM awareness is comprised of their understanding of STEM and its interdisciplinary nature, and their readiness to teach STEM education (Bakirci, & Karisan, 2018). Teachers' STEM attitudes can be defined as a teacher's willingness and disposition to implement STEM instruction in their classrooms (Thibaut et al. 2019) Furthermore, teachers' concerns regarding STEM education are primarily related to the difficulties and obstacles that teachers anticipate or encounter when planning, implementing, and evaluating STEM education (Shernoff et al. 2017). Table 3 shows the key information of such studies, including participants, variables under investigation, and major findings.

Table 3.
Findings able regarding to STEM Awareness, STEM Attitudes, and Concern Levels

Study	Participants	Variables	Findings
Ateş & Sungur Gül (2023)	Pre-service mathematics and science teachers	STEM SE; STEM concerns	High self-efficacy beliefs towards STEM education.
Er & Başeğmez (2020)	Pre-service mathematics and science teachers	STEM SE; STEM attitudes	Moderate self-efficacy levels. STEM awareness significantly predicted STEM SE.
Çavaş et al. (2024)	Pre-service elementary and science teachers	STEM SE; STEM attitudes	A positive correlation between participants' STEM attitudes and STEM classroom application self-efficacy.
Gülpınar & Bakır (2023)	Pre-service and in-service science teachers	STEM SE; STEM attitudes	Both groups have an overall positive perception of STEM self-efficacy and STEM attitudes.
Yaman & Aşilioğlu (2021)	Primary and secondary teachers	STEM SE; STEM awareness; STEM attitudes	Teachers exhibited a high level of awareness about STEM education linked to positive perceptions of STEM intra-class practice self-efficacy.
Erol & Canbeldek Erol (2023)	Preschool teachers	STEM SE; STEM attitudes	High level of STEM attitudes is linked to high STEM SE
Demirkol et al. (2022)	Middle school teachers	STEM SE; STEM attitudes	Weak to moderate positive relationships between attitudes and self-efficacy beliefs.

STEM Instructional Competencies

In this study, STEM instructional competencies are key professional knowledge components that relate to teachers' self-efficacy in STEM teaching. From the studies, strong relationships have been identified between science teachers' self-efficacy in classroom instruction and their Technological Pedagogical Content Knowledge (TPACK) framework developed by Mishra and Koehler (2006), Significant predictive relationships were found between technological pedagogical engineering knowledge (TPEK), technological pedagogical science knowledge (TPSK), and self-efficacy in teaching integrated STEM (ISTEM) (Yildiz Durak et al., 2023). They found that science teaching self-efficacy influences teachers' TPSK and ISTEM knowledge. Also, Gürler (2021) aimed to determine whether the STEM self-efficacy of primary pre-service teachers can serve as a predictor of their critical thinking dispositions. Critical thinking dispositions, including analyticity, open-mindedness, inquisitiveness, self-confidence, truth-seeking, and systematicity, can enable individuals objectively to evaluate complex knowledge and develop understandings within specific domains (Cubukcu, 2006). Gürler (2021) found that teacher candidates often possess a high-level STEM self-efficacy. In addition, they also found a positive relationship between their STEM self-efficacy and critical thinking dispositions.

Ugraş and Çelik (2024) explored the relationships between 21st-century skills, computational thinking (CT) skills, and self-efficacy levels in STEM implementation. They found a positive correlation between self-efficacy in STEM implementation and both computational thinking skills and 21st-century skills.

As defined by Wing (2006), "CT includes solving problems, designing systems, and understanding human behavior by using the basic concepts of computer science." (p.33). Ugraş and Çelik (2024) highlighted that 21st-century skills and computational thinking skills played a significant role in shaping teachers' STEM implementation self-efficacy levels (Ugraş & Çelik, 2024).

Erol and Canbeldek Erol (2023) examined the connections between preschool teachers' attitudes toward STEM education, their constructivist beliefs, and STEM self-efficacy. Erol and Canbeldek Erol (2023) refers to teachers' constructivist beliefs, representing the idea that students play an active role in the construction of knowledge, where the teacher acts as a guide, and the focus is on a learning process that develops students' inquiry and problem-solving skills. The researchers found positive correlations between these factors, with constructivist beliefs serving as a partial mediator between self-efficacy and attitudes toward STEM education. This mediating role suggests that constructivist beliefs help explain how self-efficacy influences attitudes toward STEM education, shaping the strength or direction of this relationship. Similarly, Çavaş et al. (2024) examined the role of STEM attitudes in mediating the relationship between STEM pedagogical content knowledge (CK) and self-efficacy with regards to STEM intra class practice. Their results show that teachers' attitudes toward STEM can help explain how their pedagogical content knowledge influences their confidence in implementing STEM practices in the classroom, and that attitudes are a contributing factor to this effect.

Professional Development and Training Programs

Professional development (PD) or training programs focusing on STEM education and practices are another important influencing factor, as they significantly affect teachers' STEM self-efficacy levels. The professional development (PD) and training programs discussed here examine the participation of K-12 pre-service and in-service teachers in training programs of varying contents, scopes, and durations (short-term or long-term) designed by researchers, Despite the variations, these professional developments' focus on teacher training and aim to improve participants' beliefs, knowledge, skills, and outcomes (Laurer, 2014). They include structured educational activities that examine the developmental effects on various variables, with a primary focus on teachers' self-efficacy. Table 4 provides a detailed overview of the studies examining the effects of PD and training programs on teachers' STEM self-efficacy. Here, the studies are organized by focus of the program, program duration, participants' characteristics, and their major findings.

Table 4.
Findings of Professional Development and Training Programs

Study	Focus of the Program	Duration	Participants	Findings
Salar (2021)	Arduino-based STEM activity training	2 hours	PSTs	Participants reported high self-efficacy toward STEM following the training.
Dokumacı Sütçü et al. (2023)	STEM training program	5 days	Elementary and middle grade STEM teachers	Teachers experienced positive effects on their self-efficacy in STEM applications.
Çetin (2021)	STEM activities designed using ADDIE (Analysis, Design, Development, Implementation, and Evaluation) Model	8 weeks	Pre-service elementary teachers	The study revealed that their post-test STEM self-efficacy levels were higher than their pre-test levels.
Günşen & Gök Çolak (2024)	STEM Projects for Disaster Awareness	8 weeks	Pre-service preschool teachers	Pre-test and post-test averages of the participants were compared, there was a statistically significant difference between the pre and post-test scores regarding their STEM self-efficacy in favor of the post-test.

Table 4. (Continued)
Findings of Professional Development and Training Programs (Continued)

Study	Focus of the Program	Duration	Participants	Findings
Timur et al. (2021)	STEM Web 2.0 Applications	8 weeks	PSTs	STEM Web 20.0 activities positively affected participants' STEM self-efficacy and Web 2.0 rapid content development self-efficacy.
Timur and Belek (2020)	STEM PD Program	10 weeks	PSTs	The PD program positively contributed to participants' science teaching self-efficacy and STEM intention levels.
Yıldırım and Sidekli (2018)	STEM education training program	10 weeks	Pre-service mathematics teachers'	STEM applications positively affected their mathematical literacy, self-efficacy, and technological pedagogical content knowledge.
Arslan and Yıldırım (2020)	STEM education training program	10 weeks	PSTs	STEM applications significantly improved their STEM self-efficacy, pedagogical knowledge, and content knowledge.
Ozturk et al. (2019)	STEM laboratory course	14 weeks	PSTs	Their self-efficacy beliefs towards implementing STEM activities in their future lessons increased positively.
Dökme and Koyunlu Ünlü (2023)	Skill-based STEM Enriched PD program	14 weeks	PSTs	The program significantly increased participants' STEM self-efficacy. However, no significant difference was found in their STEM concern levels.
Akçakın and Cebesoy (2024)	STEM-based Module	14 weeks	Preservice mathematics teachers	After the program, participants' post-instruction of Mathematics Teaching Efficacy Beliefs and outcome expectancy beliefs significantly increased.
Şahin et al., (2024)	STEM PD program on pedagogical competencies	10 months	25 teachers working with gifted students	STEM applications positively affected teachers' STEM self-efficacy, mathematical literacy, computational thinking, and technological pedagogical knowledge.

Table 4 shows that professional development (PD) programs of varying durations consistently yield positive effects on pre-service and in-service teachers' STEM self-efficacy. While short-term programs (ranging from a few hours to a few days) generate immediate improvements in self-confidence, medium-term programs (8-14 weeks) are shown to support the development of pedagogical knowledge and practical application skills. Long-term programs (spanning several months) yield more comprehensive results, leading to improved STEM self-efficacy and competencies such as technological pedagogical content knowledge and computational thinking.

[Possible] Challenges in STEM Implementation

The classroom application of STEM education faces several challenges, particularly as pre-service and in-service K-12 teachers navigate various aspects and contexts of STEM teaching and learning. This section categorizes these challenges into common themes identified from the reviewed studies, specifically with a focus on factors influencing teachers' STEM self-efficacy levels.

Classroom Management and Resources

Attention has been given to the challenges in effective management of classroom dynamics and time constraints during STEM activities related to teachers' STEM self-efficacy. Gülpınar and Bakır (2023) stated that teachers expect difficulties with classroom management when carrying out STEM projects, and that these activities were likely to require more time than traditional ones. Similarly, Turhan and Kırındı (2022) reported that science teachers were concerned about time constraints when implementing

STEM education. In addition, limited access to materials and resources due to costs was seen as a significant obstacle to STEM implementation. These issues were also expressed by Dokumacı Sütçü et al. (2023), who observed that primary school teachers were likely to encounter difficulties in managing large class sizes and limited resources when implementing STEM education.

Students' Readiness and Interest in STEM

Students' levels of readiness and interest in STEM subjects are also an important factor, influencing teachers' self-efficacy for implementing STEM in their classrooms. A study conducted by Demirkol et al. (2022) found that teachers' self-efficacy beliefs have a strong effect on students' interest in STEM careers. However, according to Gülpınar and Bakır (2023), teachers think that some students may have low levels of STEM preparation, which may affect their interest and participation in these subjects. In Turhan and Kırındı (2022), participants stated that in addition to student academic levels, test-oriented education systems make STEM implementations in the classroom more difficult.

Lack of Pre-Service Training and In-Service Professional Development

A significant obstacle to effective STEM implementation is the lack of adequate in-service training for teachers, thus affecting their STEM self-efficacy levels. Many science teachers report that they do not have access to professional development opportunities in STEM education (e.g., Gülpınar & Bakır, 2023). Similarly, Turhan and Kırındı (2022) noted that a lack of sufficient knowledge about STEM among experienced science teachers contributed to their unwillingness to implement it in their classrooms. Salar (2021) concluded that pre-service teachers feel unprepared for in-class implementation of STEM education. Yıldırım and Sidekli (2018) stated that pre-service mathematics teachers feel inadequate in implementing STEM applications in their classrooms.

Interdisciplinary STEM Integration and Content Knowledge

Integrating multiple disciplines and possessing the necessary content knowledge is critical to effective STEM education. Akcakin and Cebesoy (2024) found that pre-service mathematics teachers feel they lack content knowledge to integrate STEM disciplines. Dokumacı Sütçü and their friends (2023) observed that science teachers who specialize in certain subjects often have difficulty generating integrative ideas within the structure of STEM. Yıldırım and Sidekli (2018) also emphasize that pre-service teachers feel unprepared to teach their subjects in an interdisciplinary manner and to associate STEM content with real-life applications.

Additionally, teachers face difficulties with the engineering design process and problem-solving aspects of STEM education. Dökme and Koyunlu Ünlü (2023) found that pre-service science teachers had difficulty in choosing appropriate topics with defining problems within the STEM framework, as well as engineering design processes. Similarly, Akcakin and Cebesoy (2024) uncovered that pre-service mathematic teachers find integrating engineering challenging.

Perceived STEM Self-Efficacy and Willingness

Teachers' self-efficacy and willingness to implement STEM are crucial factors. Our reviewed studies indicated that pre-service and in-service teachers felt unprepared for STEM classroom applications, although they showed interest in using STEM in their future teaching, especially if adequate training was provided (Çetin, 2021; Salar,2021; Turhan & Kırındı, 2022; Öztürk et al., 2019). In Akcakin and Cebesoy (2024)'s study, a few pre-service mathematics teachers expressed that they lacked personal interest; however, after the interventions, the participants showed increased interest and curiosity about STEM education. Most science teachers are willing to stay updated on developments in STEM education (Turhan & Kırındı, 2022).

In some studies, participants' opinions about STEM education and its benefits are discussed. Science teachers think that STEM offers opportunities to develop skills such as critical thinking, problem solving, collaboration, and creativity skills (Turhan & Kırındı, 2022). In Öztürk and their colleagues (2019) study, pre-service early childhood teachers stated that developing integrative STEM lesson plans was very helpful for their future profession. Additionally, they pointed out that STEM activities supported a collaborative learning environment and helped them develop creative skills, especially when facing real-life problems. Similarly, elementary STEM teachers who participated in training on STEM applications stated that they found STEM to be both enjoyable and productive. They reported gaining new ideas relevant to their fields and broadening their perspectives through hands-on experiences. Overall, they indicated that these outcomes made a significant contribution to their professional development (Dokumacı Sütçü et al., 2023) and the content quality of their lesson plans (Şahin et al., 2024) They also emphasized the importance of integrating different disciplines in teaching STEM (Yıldırım & Sidekli, 2018). In a study conducted by Günşen (2024), preschool teacher candidates participated in developing and implementing STEM activities aimed to increase disaster awareness in their classroom teaching. These participants reported that they gained disaster awareness, and that this process contributed to their learning of STEM education practices. The findings show that classroom practices produce results compatible with the field knowledge and high STEM self-efficacy levels of teacher candidates.

DISCUSSION

When examining the temporal distribution of empirical studies on the STEM self-efficacy of K-12 teachers in Türkiye over the years, there is a clear upward trend in the interest and commitment to the subject, indicating growing attention and focus on this area.

Various methods are used in research on the STEM self-efficacy of K-12 pre- and in-service teachers in Türkiye. Findings indicate that the most preferred method is quantitative measurement of self-efficacy levels through survey or questionnaire studies. Subsequently, the inclusion of mixed methods highlights the need for integrating quantitative and qualitative data to provide a more comprehensive view of these topics. Qualitative methodologies were underrepresented only by one case study. This trend highlights the need for more qualitative insights that can deepen our understandings of the contextual and nuanced factors underlying STEM self-efficacy, a sentiment raised by Ramakrishnan and Salleh (2018). The abundance of quantitative studies show that STEM self-efficacy is often treated largely as a measurable construct. However, the lack of in-depth qualitative analyses to closely observe the development of STEM self-efficacy over time and uncover its underlying causes is noteworthy. The current situation does not provide sufficient practical insights for stakeholders such as researchers, teachers, administrators, and policymakers. Robust qualitative analyses can shed light on teachers' development by examining teachers' readiness levels, willingness or reluctance, and the reasons behind teachers' classroom practices, all of which will in turn affect their STEM self-efficacy.

Factors that Influence STEM Self-Efficacy

Reviewed studies consistently reveal that pre-service and in-service K-12 teachers exhibit positive attitudes and heightened awareness toward STEM education, factors that strongly predict their self-efficacy.

Despite acknowledging their own limitations in STEM content knowledge, K-12 teachers expressed a strong desire to integrate STEM practices into their teaching. This signals a teacher's recognition of the critical role that STEM education plays in preparing students for future success. A study by Shahali and Halim (2024) shows that teachers' self-efficacy is positively associated with their STEM attitudes, which in turn supports improved STEM teaching practices. Similarly, research suggests that teachers with stronger STEM self-efficacy also report more favorable STEM attitudes and STEM awareness (Maslamany et al. 2025; Wu et al., 2024)

The analyses reveal that STEM self-efficacy cannot be explained solely by the length of teaching experience. Specifically, the finding that novice teachers have higher levels of STEM self-efficacy compared to their more experienced colleagues can be linked to Bandura's concept of mastery experiences. This result may be attributed to the relatively recent inclusion of STEM education in Turkish educational policies. The fact that new teachers have been exposed to STEM education more recently during their training may also contribute to this difference. This highlights that the expose and recency of STEM-specific experiences, rather than the length of teaching experience, are important in determining self-efficacy levels. Additionally, pre-service teachers' STEM self-efficacy levels increase as their grade levels increase. Pre-service teachers’ experiences gained through previous methods courses influence their beliefs about STEM education (Menoon et al., 2025). Although self-efficacy is not always reported by grade level, studies suggest that pre-service teachers’ STEM self-efficacy tends to be higher over time as they complete STEM methods courses, design STEM lesson plans, and engage in hands-on activities (Menoon et al., 2023). Teachers' backgrounds in teaching subject/disciplinary content are also related to their STEM self-efficacy levels (We et al., 2024). Moreover, differences were observed by areas of specialty, with pre-service science teachers showing higher STEM self-efficacy than pre-service mathematics teachers. Further studies support our results; teachers with a graduate degree demonstrate higher STEM self-efficacy levels than teachers hold undergraduate degrees (Sellami et al., 2024). The type of schools (private vs. public) also plays a role, with private school teachers demonstrating higher STEM self-efficacy levels than public school teachers. Research from international contexts supports that private school teachers in STEM disciplines have a higher level of self-efficacy compared to public school teachers (Sellami et al., 2024). This suggests that private schools generally have more resources, support, and environmental conditions that can facilitate differentiated instruction and innovative practices (Ünsal & Çetin, 2019). Teachers working in private schools also may have the opportunity to participate in more professional training, seminars, and workshops than teachers working in public schools. Furthermore, private school teachers tend to have smaller class sizes than public school teachers, which allows for easier implementation of hands-on and active learning practices (Wright et al., 2019). Considering all these factors, private school teachers may be more likely to implement practices aligned with the interdisciplinary and hands-on features of the STEM curriculum, reflecting the influence of these environments on teachers’ self-efficacy. Regarding gender differences, some studies indicate that there are differences in self-efficacy among male teachers, others did not find any significant gender differences. Meta-analytic studies on teachers' self-efficacy in Türkiye indicate that gender does not significantly affect their self-efficacy beliefs (Çelik et al., 2016; Vatan & Toprakcı, 2025). It is noteworthy that teachers' professional experience and characteristics have a greater impact on self-efficacy than gender (Ofem et al., 2021).

Professional development and training programs effectively increase STEM self-efficacy among both pre-service and in-service teachers. These programs appear to influence teachers' STEM self-efficacy in multiple ways. They provide direct mastery experiences through hands-on content and pedagogical training, while indirectly fostering vicarious experiences gained through observing instructors and colleagues, verbal persuasion through modeling and positive feedback, and emotional arousal by increasing teachers' sense of preparedness in STEM teaching. Research shows that well-designed PD programs, whether short-term or long-term, can positively impact teachers' confidence in teaching STEM subjects (Gardner et al., 2019). Specifically, sufficient time should be allocated to PD and training to create lasting change in participants (Liu et al., 2025). The effectiveness of these programs may depend on factors such as duration, participants’ needs, learning objectives, and the complexity of the content (Liu et al., 2025; Laurer et al., 2014). While the longe-term PD programs are recommended (Guskey & Yoon, 2009), short-term programs can potentially yield similar benefits if they incorporate needs analysis, active learning, and interdisciplinary content rather than focusing on a single discipline (Laurer et al., 2014; Senyigit & Bakırcı, 2025). Considering the findings of these studies, the differences in STEM self-efficacy among teachers participating in the professional development (PD) are believed to result from the variations in program durations, contents, and delivery methods.

Through PD and training programs, teachers can gain the content, pedagogical, and technological knowledge essential for effectively teaching STEM subjects (Asghar et al., 2012). However, for these programs to be effective, it is also important to provide not only temporary training but also continuous support and access to resources. Indeed, previous studies have shown that both in-service and pre-service science teachers have increased their self-efficacy levels after receiving STEM training (Kelley et al., 2020; Menoon et al., 2023; Menoon et al., 2025; Shahali & Halim, 2023; Zhou et al., 2023). Teachers' high STEM self-efficacy levels are critical to the effectiveness and quality of STEM classroom teaching practices (Fulton et al., 2010). In this context, the support and resources provided to teachers are key, as STEM tools, mentoring opportunities, and access to learning communities can allow teachers to continuously improve their practices. Such support mechanisms can increase teachers' self-efficacy and allow them to effectively guide students during instruction. NRC (2011) emphasized in its STEM report that policy makers need to invest in professional development and continuous learning opportunities for teachers.

[Possible] Challenges in STEM Implementation

Various challenges will negatively affect the effective use of STEM education in classroom practices and teachers' self-efficacy. Ejiwale (2013) identified some main obstacles hindering the successful implementation of STEM education as follows: a shortage of qualified teachers, inadequate professional development opportunities, low student motivation and the inability to establish personalized connections with students, lack of institutional support and interdisciplinary research collaboration, lack of laboratory facilities, and deficiencies in practical training. Classroom management and resource constraints are serious issues as teachers express their concerns about time management and limited access to materials. Additionally, student preparation and interest can influence teachers' self-efficacy in teaching STEM. Teachers' STEM self-efficacy is influenced not only by personal knowledge but also by factors such as administrative support and peer support at school (Sokha, 2024). Our reviewed literature highlights that both pre-service and in-service K-12 teachers tend to have negative opinions about STEM applications for similar reasons (Alagöz & Sözen, 2021; Atalay & Armağan, 2023; Yıldız, 2021).

Students' conceptual understanding of STEM disciplines, their readiness levels, and their attitudes towards learning play a significant role in teachers' STEM self-efficacy beliefs. These experiences in the classroom function as mastery experiences for teachers. At the same time, students' level of engagement and openness to learning can also influence teachers' feelings and stress levels regarding STEM practices, thus shaping teachers' self-efficacy perceptions through physiological and affective states. Teachers' self-efficacy is dynamic in interaction with students' learning outcomes and is influenced by students' performance and participation levels (Tschannen-Moran & Hoy, 2007).

The interdisciplinary nature of STEM education poses implementation challenges for subject-specific teachers. However, as noted in the study by Nadelson et al. (2013), there is a direct link between a teacher's subject matter knowledge and their teaching confidence and self-efficacy. As this difficulty stated by participants, they do not consider themselves sufficient in content knowledge or skills in interdisciplinary integration and therefore have a low level of self-efficacy. These are critical challenges for teachers to generate innovative and integrated ideas during instruction on engineering design processes. Studies show that although teachers are aware of integrated STEM, they feel inadequate in this field and are reluctant to apply it in the classroom (Salar, 2021). Studies draw attention to the current negative apprehension of preK-12 teachers (El-Deghaidy & Mansour, 2015; Herdem & Ünal, 2018; Günşen et al., 2019; Yıldız, 2021).

Perceived STEM Self-Efficacy and Willingness

Teachers' self-efficacy and willingness to implement STEM in their classrooms are critical for the successful implementation of STEM in educational settings. In this process, teachers gain mastery experiences, such as collaborative group experiences and hands-on activities, and improve implementation skills by overcoming physiological and emotional factors such as stress and feeling unprepared. Teachers' learning within a community of practice significantly impacts their STEM self-efficacy levels (Kelley et al., 2020).

The results showed that although most teachers initially felt unprepared, they demonstrated a high level of willingness to adopt STEM practices if sufficient training provided. For example, teachers indicated that they hesitated to teach other disciplines or develop lesson plans due to the multidisciplinary nature of STEM. In this context, enhancing STEM literacy, knowledge of STEM disciplines, self-efficacy, and willingness has a significantly positive impact (Tang et al., 2025). These analyses revealed that teachers are becoming more aware of the benefits of STEM in developing students' 21st-century skills such as critical thinking, creativity, and problem-solving. Increasing teachers' self-efficacy through supportive training programs can further enhance their willingness to implement STEM practices (Gardner et al., 2019; Margot & Kettler, 2019).

CONCLUSION AND RECOMMENDATIONS

In Türkiye, university faculties of education are responsible for training both current K-12 teachers and prospective teachers. The need for adequate STEM-focused course content and practical learning activities is generally acknowledged by the studies included in this systematic review. Although prospective teachers' STEM self-efficacy tends to increase as they progress through their academic programs (probably due to acquiring theoretical knowledge and basic training in STEM), this may not always be reflected in their ability to effectively apply STEM in real classroom settings. In-service teachers also report a need for more hands-on, practical training in STEM to bridge the gap between theory and practice. Therefore, it is important to revise the curricula of Turkish faculties of education to include the practical dimension of STEM education and provide more opportunities for experiential learning. In this regard, it is of great importance for Türkiye to restructure its pre-service teacher training programs and in-service teacher PD programs for the PreK-12 level.

Although studies of K-12 teachers demonstrate high levels of STEM self-efficacy, there has been limited focus on how pre-service teachers utilize STEM activities as part of their classroom instruction. Teachers' self-efficacy in teaching STEM content plays an important role in how they structure course content, manage classroom activities, and reflect on these processes. Without in-depth classroom studies, it is difficult to understand how these self-efficacy beliefs translate into teachers' practice, as well as how their self-efficacy changes. Uncovering these dynamics are critical to closing the gap between teacher preparation and classroom practices. Examining these dynamics through teachers' classroom experiences will contribute to our insight into K-12 teachers' STEM self-efficacy.

Continuing professional development programs and training in STEM education for current K-12 teachers are still limited. Many participants state that they do not have sufficient knowledge about STEM education and do not feel competent to practice it in their classrooms. In Türkiye, it is important to provide comprehensive and sustainable opportunities of professional development to pre-service and in-service teachers. It is important that the universities responsible for training teachers in Türkiye design these programs in accordance with the needs of the 21st century student skills. Accordingly, Turkish Ministry of National Education may develop policies to emphasize the importance of STEM education and support practices in this field. Furthermore, the necessary resources and environments should be provided to support teachers' STEM classroom practices. Such development can contribute to improving the quality of STEM education in Türkiye, which ultimately will contribute to students' interest, success, and better preparation for their future careers in these fields.

Overall, studies highlight the importance of improving K-12 STEM teachers' self-efficacy through professional development programs, trainings, seminars, workshops, and other supportive resources. Empowering teachers with the knowledge, skills, and instructional strategies necessary to teach STEM subjects effectively can increase their confidence in teaching STEM, thereby improving student engagement and success in these fields.

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APPENDICES

Appendix 1: Detailed Table of Studies Included in The Literature Review

Author(s) and years	Method	Method design (Model of research)	Population and sample size	Data Collection Tools
Yildiz Durak, Atman Uslu, Canbazoğlu Bilici & Güler (2023)	Quantitative	Partial least squares-structural equation modeling (PLS-SEM)	216 Science teachers	1. TPACK for I-STEM survey, 2. Design thinking in teaching survey, 3. Computational thinking survey, 4. Science training self-efficacy survey.
Gürler (2021)	Quantitative	Correlational survey model	295 primary school teacher candidates (1st, 2nd, 3rd, and 4th years)	1. Self-Efficacy Scale for STEM Practices 2. Critical Thinking Disposition Scale
Demirkol, Kartal, & Tasdemir (2022).	Quantitative	Predictive correlational survey	421 middle school students 160 science and mathematics teachers	1. STEM Attitudes Scale 2. Teacher Self-Efficacy Scale for STEM Practice, 3. STEM Career Interest Scale (STEM-CIS) from students
Yaman & Aşilioğlu (2022)	Quantitative	Descriptive model	5515 K-12 teachers (Science, Mathematics, CIT, Technology and Design, Elementary)	1. STEM awareness scale 2. Attitude Scale for STEM education 3. STEM intra-class practice self-efficacy perceptions scale
Erol & Canbeldek Erol (2023).	Quantitative	Survey model	211 early childhood teachers	1. Instructional beliefs questionnaire 2. Self-efficacy in STEM Education scale 3. STEM education attitude scale
Ateş & Sungur-Gül (2023)	Quantitative	Survey method	390 pre-service science and mathematics teachers (1st, 2nd, 3rd, and 4th years)	1. Self-efficacy and Concerns about STEM Education
Yaman & Aşılıoğlu (2021)	Quantitative	Descriptive model	609 teachers (Science, Mathematics, CIT (computer and instructional technology), elementary, technology design)	1. STEM intra class practice self- efficacy perceptions scale
Timur et al., (2021)	Quantitative	Quasi-experimental design (pre-test/post-test control group design)	42 pre-service science teachers (4th year)	1. STEM Applications Teacher Self-efficacy Scale 2. STEM practices and Web 2.0 Rapid Content Development Self-Efficacy Belief Scale

Appendix 1: Detailed Table of Studies Included in The Literature Review (Continued)

Author(s) and years	Method	Method design (Model of research)	Population and sample size	Data Collection Tools
Çavaş et al., (2024).	Quantitative	Causal design	345 pre-service teachers (elementary teachers, science teachers; 3rd, and 4th years)	1. STEM pedagogical content knowledge scale (STEM-PCK) 2. Attitude Scale for STEM education (STEMAS) 3. STEM intra class practice self-efficacy perceptions scale (STEMICPSEPS)
Çetin (2021)	Quantitative	Quasi-experimental design (pre-test/post-test control group design)	60 pre-service science teachers (3rd year)	1. STEM Awareness Scale 2. Self-Efficacy Belief Scale in Science Teaching 3. Inquiry Skills Scale
Er & Başeğmez, (2020)	Quantitative	Correlation research model	373 pre-service science and mathematics teachers (1st, 2nd, 3rd, and 4th years)	1. Teacher Self-Efficacy Scale Related to STEM Practice 2. STEM Awareness Scale
Uğraş & Çelik (2024)	Quantitative	Relational survey model	444 elementary teachers	1. STEM Implementations Teacher Self-Efficacy Scale 2. Computational Thinking Skill Scale 3. 21st Century Skills Self-Efficacy Perception Scale
Salar, (2021)	Qualitative	Case study methodology	15 pre-service science teachers (3rd and 4th years)	1. Demographic information form, 2. Open-ended questionnaire (awareness, school dimension, STEM concepts, self-efficacy)
Akçakın & Cebesoy (2024).	Mixed method	Concurrent mixed method design	23 4th year preservice mathematics teachers	1. Mathematics Teaching Efficacy Belief Instrument (MTEBI) 2. Open-ended questionnaire
Günşen & Çolak (2024).	Mixed method	Embedded experimental design	45 4th year pre-service early childhood teachers	1. Disaster Awareness Perception Scale 2. STEM Applications Teacher Self-Efficacy Scale 3. STEM Projects Evaluation form

Appendix 1: Detailed Table of Studies Included in The Literature Review (Continued)

Author(s) and years	Method	Method design (Model of research)	Population and sample size	Data Collection Tools
Gülpinar & Bakir (2023)	Mixed method	Convergent parallel design	177 Pre-service Science Teachers, 45 in-service Science teachers	4. Teacher Efficacy and Attitudes Towards STEM Survey 5. STEM Awareness Scale 6. Semi-structured interviews
Dökme & Koyunlu Ünlü (2023)	Mixed method	Embedded design	20 pre-service science teachers (3rd year)	1. Self-efficacy and Concerns about STEM Education instrument 2. Interview forms 3. Self-reports 4. Focus group interviews 5. Video Analysis
Erol & İvrendi, (2024)	Mixed method	Phenomenology design	12 early childhood teachers	1. Teacher Self-Efficacy Scale for STEM Practices Scale 2. Teacher Beliefs Survey 3. Scale on the Attitudes towards STEM Education 4. Semi-Structured Interview Protocol
Yıldırım & Sidekli (2018)	Mixed method	Quantitative weighted study	29 mathematics pre-service teachers (4th year)	1. Mathematical Literacy Self-Efficacy Scale 2. Mathematical Thinking Scale 3. Technological Pedagogical Area Information Scale 4. STEM Interview Form
Öztürk et al., (2019).	Mixed method	Case study	18 pre-service science teachers (3rd and 4th year)	1. STEM Applications in Science Education Self-Efficacy Scale 2. Interview Protocol
Şahin, Sarı, & Şen (2024)	Mixed Method	Convergent parallel design	25 science gifted student teachers (Physics, Chemistry, Biology, Science education)	1. Teachers' self-efficacy towards STEM practices scale 2. Computational Thinking scale, 3. Entrepreneurship scale 4. Evaluation form for STEM education 5. STEM integration curriculum assessment (STEM-ICA) 6. STEM scenario criteria rubric
Dokumacı Sütçü, Bilgiç Uçak & Toprak (2023)	Mixed Method	Embedded design	31 teachers (17 STEM branches, 14 elementary)	1. STEM Practices Teacher Self-Efficacy Scale 2. Qualitative Interview Form

Appendix 1: Detailed Table of Studies Included in The Literature Review (Continued)

Author(s) and years	Method	Method design (Model of research)	Population and sample size	Data Collection Tools
Turhan & Kırındı (2022)	Mixed Method	Sequential explanatory	50 science teachers	1. STEM practices teacher self-efficacy scale 2. STEM teacher interview form
Timur, B., & Belek, (2020)	Mixed Method	Sequential explanatory	52 pre-service Science teachers (3rd year)	1. Teacher Self-efficacy Belief Scale 2. Science Teaching Self-Efficacy Beliefs Scale 3. STEM Teaching Intention Scale 4. Semi-structured interviews
Arslan, & Yıldırım, (2020)	Mixed Method	Convergent parallel design	20 pre-service science teachers (3rd year)	1. Pre-service teacher interview forms 2. Self-efficacy belief scale in science teaching