TRANSFORMATION IN EDUCATION: STEM APPLICATIONS

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PREFACE

The STEM approach supports the development of skills such as problem solving, research, collaborative work, production, and technological literacy, thereby strengthening individuals' academic achievements as well as their life skills. It is known that STEM activities, especially when implemented from an early age, keep students' curiosity alive, contribute to the development of positive attitudes towards learning, and prepare them for future careers. This work aims to serve as a guiding resource for educators, teacher candidates, families, and readers interested in STEM education. I hope this book adds value to the world of education and the journey of learning, contributing to a better understanding of the opportunities and benefits offered by STEM education.

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1. INTRODUCTION

For centuries, countries have been competing to stay one step ahead of other nations in areas such as economics, medicine, education, industry, and manufacturing, just as they do today. During and after World War II, many innovations were produced using STEM principles, but STEM education has not been reflected in schools as an applicable system. When we look at the impact on education of the United States' space efforts and its failure in mathematics in international exams, which began when Russia launched its Sputnik satellite and the US began to question its engineering skills and future workforce, we see that the main goal of the STEM approach, which first emerged in America, is to train “qualified human resources” (Uz, 2022).

Although the term STEM brings the same concepts to everyone's mind, different researchers assign various meanings to STEM. When the literature in the field is examined, researchers' definitions of STEM education are as follows (Aslan and Bektaş, 2019).

STEM is an acronym formed from the initial letters of the disciplines of science, technology, engineering, and mathematics. This approach can be defined as the integration of science, technology, engineering, and mathematics into a new interdisciplinary subject in schools (Çorlu

et al., 2012). In Turkey, the Turkish word "FeTeMM," which is an abbreviation of the words technology, science, engineering, and mathematics, is used as the equivalent of the word STEM (Çorlu et al., 2014).

One goal of STEM education is to help individuals understand the connections between STEM disciplines. Individuals who understand these connections can engage with STEM fields, such as engineering design, by drawing on different disciplines like mathematics; apply two or more STEM disciplines to solve a problem or complete a project; support integrated learning experiences; and develop the ability to draw on disciplinary knowledge to know when to apply it (Honey et al., 2014).

STEM education can be seen as a method for ensuring the integration of subjects. Just as teaching subjects independently of each other in traditional education does not provide a high level of meaningful and lasting learning, teaching STEM disciplines independently of each other can lead to similar results. Therefore, the integration of STEM disciplines must be ensured (Bybee, 2013).

Many countries, including Turkey, are aware that keeping pace with this rapid change requires serious reforms starting with the education system. As of 2016, the new education curriculum has undergone a fundamental change. With the draft program published in 2017, Engineering Applications has been added to the curriculum as a unit. Engineering design process education was added to the curriculum at the end of the year as "Applied Science" (MEB, 2017). However,

spreading STEM activities across all units can develop many skills in students and also support the retention of these skills and knowledge (Uz, 2022).

Engineering and design skills are utilized in the implementation of STEM. The inclusion of this skill in the teaching program has contributed to the spread of STEM in Turkey. It can be said that a science course centered on the STEM-based learning model will contribute to increasing students' academic achievement in science, developing their interest and desire to solve everyday problems, gaining the ability to strive to solve problems rather than ignoring them, and, in addition, developing affective skills related to the course (İnce, 2024).

Ultimately, STEM education is a holistic approach that brings together the fields of science, technology, engineering, and mathematics with the aim of developing people's 21st-century skills. Historically, this approach has become increasingly important, especially during periods of heightened technological competition, and plays a critical role in developing a qualified workforce. In countries such as Turkey, the integration of STEM into the education system supports students' interdisciplinary thinking, problem-solving, and creative production skills, making learning permanent and meaningful through engineering and design-oriented applications. In this context, expanding STEM education beyond specific courses to encompass the entire curriculum will contribute to individuals becoming more equipped for both academic and social life.

2. THE HISTORICAL AND PEDAGOGICAL FOUNDATIONS OF THE STEM CONCEPT

The historical and pedagogical foundations of the STEM concept form the cornerstones of modern educational approaches. From a historical perspective, the STEM approach emerged as a teaching model aimed at the interdisciplinary integration of science, technology, engineering, and mathematics to respond to the demands of the 21st century. This approach was shaped, particularly in parallel with industrial revolutions and technological developments, by the influence of international education policies aimed at developing engineering and scientific thinking skills (Dilaver Türe, 2023). From a pedagogical perspective, STEM is consistent with student-centered activities, problem-solving teaching strategies, and approaches that encourage critical thinking. In this context, students' active participation is ensured through applied learning, experimental studies, and projects; thus, the goal is to concretize abstract concepts and achieve lasting learning (Ceylan & Karahan, 2021).

At the core of STEM pedagogy lie the principles of establishing interdisciplinary connections, generating solutions appropriate to real-life problems, and supporting creativity. In line with these principles, STEM applications at the elementary school level enable students to grasp the meaning of knowledge and develop practical skills, in addition to fundamental concepts (Cengiz, 2024). Pedagogical approaches that have evolved over time, supported by the integration of technological tools and innovative teaching methods, stimulate

curiosity and strengthen learning motivation in young minds (Gulamova & Özerbaş, 2025). In conclusion, when examined through its historical development and pedagogical foundations, the place of the STEM concept in education, with its structure based on interdisciplinary integration and active learning, makes valuable contributions to the learning process in primary school.

STEM education was first proposed in the United States in 1980. Subsequently, the United Kingdom and Japan also actively implemented various legislative proposals, and STEM education rapidly developed worldwide. STEM education emphasizes the cross-integration of multiple disciplines by rationally integrating the four disciplines of Science, Technology, Engineering, and Mathematics to improve the overall quality of students (Tanır, 2025).

Engineering activities and goals, one of the areas included in the STEM approach, are important and can be naturally motivating. This is because they are related to a natural desire to create something and are fueled by a curiosity to learn how things work. Design-based activities can provide a deep conceptual understanding of a field's knowledge and principles and support the development of self-guided research skills (Atabaş, 2020).

When reviewing the literature on STEM, it is evident that new fields have been added to STEM. By adding art to the fields represented by STEM, new educational programs based on STEM have emerged with abbreviations such as STEM+A, STEAM, or STEM+Art; by adding entrepreneurship, STEM+E; and by adding coding and programming,

STEM+C or STEM+Computing. In our country, there are also institutions and researchers who translate and adapt STEM into Turkish and use it as FeTeMM or BiLTeMM (Nişan, 2024).

In conclusion, STEM education, with its historical origins and pedagogical foundations, is at the center of the modern understanding of education; it aims to integrate the disciplines of science, technology, engineering, and mathematics to impart the skills required in the 21st century. Shaped by international education policies, this approach is notable for its student-centered, problem-solving, and application-based learning structure. STEM activities implemented from the elementary school level deepen students' conceptual understanding while also supporting their creativity and research skills. Over time, with the integration of fields such as art, entrepreneurship, and information technology into this structure, STEM has become a multidimensional and flexible education model. In Turkey, this approach, integrated into the education system with local adaptations such as FeTeMM and BiLTeMM, stands out as an important tool for nurturing qualified individuals for the future.

3. THE PURPOSE AND SIGNIFICANCE OF STEM EDUCATION

STEM education was first proposed in the United States in 1980. Later, the United Kingdom and Japan also actively implemented various legislative proposals, and STEM education rapidly developed worldwide. STEM education emphasizes the cross-integration of multiple disciplines by rationally integrating the four disciplines of

Science, Technology, Engineering, and Mathematics to improve the overall quality of students (Tanır, 2025).

The historical and pedagogical foundations of the STEM concept form the cornerstones of modern educational approaches. Historically, the STEM approach emerged as a teaching model aiming for the interdisciplinary integration of science, technology, engineering, and mathematics fields to respond to the needs of the 21st century. This approach was shaped, particularly in parallel with industrial revolutions and technological developments, by the influence of international education policies aimed at developing engineering and scientific thinking skills (Dilaver Türe, 2023).

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As a result, STEM education has become part of the modern educational approach with its historical development and pedagogical foundations. This approach, which has spread worldwide since the 1980s, aims to promote the well-rounded development of students by logically and holistically integrating the fields of science, technology, engineering, and mathematics. With its student-centered, problem-solving, and hands-on learning approach, STEM deepens conceptual understanding and increases learning motivation, especially at an early

age. Over time, with the inclusion of fields such as art, entrepreneurship, and information technology, STEM-based education models have become more flexible and inclusive. Integrated into the education system in Turkey through local adaptations such as FeTeMM and BiLTeMM, this approach plays an important role in nurturing creative and solution-oriented individuals who develop interdisciplinary thinking skills.

The important role of the STEM concept in education, with its structure based on interdisciplinary integration and active learning, makes valuable contributions to the learning process in educational settings.

4. TYPES OF STEM

STEM education is a dynamic approach that focuses on developing students' problem-solving, creative thinking, and critical analysis skills through the integration of science, technology, engineering, and mathematics disciplines (Sefunç & Abbak, 2025). However, efforts to provide broader and more inclusive learning experiences by going beyond these core disciplines and integrating different fields have gained momentum in recent years.

In this context, different combinations such as STEM+A, STEM+E, STEM+C, and STEM+Art are opening new horizons in interdisciplinary teaching and applications (Ceylan, 2025).

4.1 STEM+A Model

It aims to equip students with innovative and creative problem-solving skills by emphasizing applied and real-life activities in addition to mathematics and science-based content (Yıldız Aslan, 2024).

4.2. STEM+E Model

By integrating engineering and technology into educational processes, it ensures that technological developments contribute directly to learning (Bybee, 2010).

4.3. STEM+C Model

This model focuses on communication and information sharing, accelerating and enabling the flow of information through the use of information technologies (Bybee, 2010).

4.4. STEM+Art Model

STEM+Art integration combines art with science and engineering, emphasizing aesthetics and creativity and encouraging interaction between different disciplines (Bybee, 2010).

Each of these approaches enables the development of innovative methodologies in education with an interdisciplinary perspective and offers solutions suitable for different learning styles. Furthermore, the implementation of these models has been shown to create an innovative and holistic educational environment where students gain not only theoretical knowledge but also practical skills for application. Therefore, these approaches, which bring together different disciplines

and encourage multifaceted thinking, contribute to the development of new strategies in educational policies and practices.

5. BENEFITS OF STEM PRACTICES

Individual development is of fundamental importance for triggering the development of society and future generations. Accordingly, developing creative, critical thinkers who question, research, reflect, take responsibility for their own learning, and acquire communication and life skills is one of the fundamental goals of developed societies. Students are expected to possess these skills and be able to apply them in different situations. Education systems are being reviewed and structured accordingly (Sağdıç, 2025).

STEM education plays an important role in enabling 21st-century students to think critically, become information and technology literate, explore, understand the world, and be entrepreneurial and collaborative. Through STEM education, students grow into individuals who solve various problems, design products, are confident, innovative, think logically, offer different solutions, are creative, and are also technologically literate (Hişmi, 2022).

STEM education plays a significant role in developing individuals' higher-order thinking skills, such as problem-solving, decision-making, and critical thinking. This has led to updates and reforms in science education programs in developed countries, including the United States, South Korea, China, Finland, Singapore, and Australia,

as well as in developing countries such as Portugal, Spain, and South Africa (Ayuso et al., 2022; Wang et al., 2020).

Since STEM education is an interdisciplinary approach based on the integration of disciplines, and it is known that children learn best through the integration of disciplines, it is stated that many areas of children's development can be supported through STEM education and that STEM education positively affects children's development (Moomaw and Davis, 2010). In other words, the STEM education approach can be structured by establishing relationships between disciplines and focusing on a specific discipline or disciplines in the context of real-life problems (Bozkurt Altan and Hacıoğlu, 2018).

STEM education is used to improve student learning. An increasingly widespread trend in academia, STEM education is used to address real-life situations through a design-based problem-solving process (Williams, 2011). In STEM education, the teaching and learning approach is based on the integration of two or more STEM components or a STEM component with other disciplines (Becker & Park, 2011).

The first step in STEM education is for students to discover a problem that arouses their curiosity in their educational environment. While searching for different solutions to this real-life problem, they are expected to focus on a specific area (Barell, 2007). Bybee (2013) states that STEM education should be instilled in children at an early age, noting that children who are introduced to STEM at a young age increase their critical thinking and reasoning skills, develop an interest

in advancing their careers in later life, gain experience by connecting with the world around them, and acquire a sense of curiosity and discovery. STEM education aims to develop children's imagination, combine mathematical and scientific knowledge with technology and design, and develop solutions to problems through problem-based learning and original scientific inquiry. Therefore, it differs from the traditional educational approach in early childhood education (Özok Bulut, 2025). Children can explore the world through STEM education, learn concepts related to science, engineering, and mathematics while building bridges and buildings with simple materials, and develop scientific process skills, executive function skills, and gross and fine motor skills (Özçelik and Akgündüz, 2018).

The teaching of science and the scientific process is expected to foster students' scientific creativity. Therefore, it is desirable that thematically applied STEM education also develops students' scientific creativity (Yıldız, 2023). Mathematical literacy and STEM education will inevitably influence an individual's ability to find creative and logical solutions to any problem they encounter in real life. This is because one of the goals of STEM education and mathematical literacy is to achieve this, and relevant studies show positive results in this direction (OECD, 2019).

As a result, STEM education, which supports the multidimensional development of individuals, stands out as an effective tool for imparting the skills required in the 21st century. Thanks to its interdisciplinary structure, STEM combines science, technology,

engineering, and mathematics in a holistic approach, aiming to develop students' higher-order cognitive skills such as critical thinking, problem solving, decision making, and creativity. When implemented from an early age, it nurtures children's curiosity, supports their scientific process skills, motor development, and mathematical literacy, and raises them to be productive individuals who are proficient in technology and capable of generating solutions to real-life problems. In this respect, STEM education is of strategic importance for both individual and social development and is considered a fundamental element in the restructuring of contemporary education systems.

6. STEM PRACTICES IN TURKEY

Countries have chosen to integrate STEM education into their systems in different ways within the framework of their economic, social, academic, and cultural conditions (Karahan, 2019). In many countries around the world, STEM education has been introduced for students to ensure sustainable economic development. Efforts to integrate STEM education into the education system have begun and are continuing in Turkey as well, in order to sustain its economic development (MEB, 2016). While transitioning to STEM education in Turkey, the goal is to equip children with an interdisciplinary perspective on science, technology, engineering, art, and mathematics from an early age, thereby fostering inquiry, problem-solving, research, aesthetic perspective, and product development skills (MEB, 2016).

In recent years, the science teaching program in Turkey has been updated, and efforts have been made to incorporate STEM education into the program in a way that covers all units independently of science, engineering, entrepreneurship applications, and achievements (Hacıoğlu & Başpınar, 2020). In its STEM report, MEB (2016) stated that it is not indifferent to STEM education and has prepared an action plan. This report addresses the following issues:

- Specific STEM centers should be established in Turkey to provide STEM education.
- The STEM centers to be established should collaborate with universities.
- Universities should conduct research related to STEM education.
- Teacher candidates should be trained to adopt the STEM education approach.
- Current teachers should be equipped to adopt the STEM education approach through in-service training.
- Current curricula should be updated to include STEM education.

Looking at how STEM applications are addressed in Turkey's teaching programs, it would not be wrong to say that, specifically in science classes, they are mainly applied only in science, engineering, and entrepreneurship applications and in end-of-year science fairs. However, STEM-related activities beyond what is specified in the science teaching program have begun to spread from preschool to

university in our country (Yıldız, 2023). In recent years, many universities in Turkey have added elective courses on STEM to their teaching programs for teacher candidates. Some universities have also established STEM centers to support STEM-related workshops (Fındık, 2023).

The implementation of STEM education and the promotion of 21st-century skills throughout lifelong learning, starting from preschool education and including university education in Turkey, is emphasized in the 2016 report published by the Ministry of National Education's Innovation and Education Technologies unit (MEB YEĞİTEK) and in the 2023 Education Vision document and Lifelong Learning Strategy plans. emphasized in the 2023 Education Vision document and the Lifelong Learning Strategy plans. In our country, it is seen that the MEB has been working on STEM education at all levels of education, private and state universities have established STEM laboratories and science centers, and municipalities have opened science centers and museums (Nişan, 2024).

In conclusion, STEM education is a strategic approach that is being integrated into the education system in line with Turkey's economic and social development goals. In parallel with global developments, the aim is to spread this model, which brings together the disciplines of science, technology, engineering, art, and mathematics, across all levels of education, from early childhood to higher education and lifelong learning. Action plans prepared by the Ministry of National Education, updated curricula, elective courses offered at universities,

and established STEM centers contribute to the institutionalization of developments in this field. STEM education plays a significant role in cultivating qualified individuals for the 21st century by developing students' skills in inquiry, problem solving, research, and creative thinking.

7. STEM PRACTICES AT THE ELEMENTARY SCHOOL LEVEL

STEM education is one of the most important learning approaches aimed at developing 21st-century skills in the classroom. STEM education is an interdisciplinary learning approach that combines problem-solving skills with science, technology, engineering, and mathematics to solve real-world problems (Fajrine et al., 2020). It aims to develop individuals' creativity, different perspectives on problems, questioning, research, interaction with other subjects, producing an outcome, and problem-solving skills (Fındık et al., 2023).

STEM (Science, Technology, Engineering, and Mathematics) applications play an important role in education during this period, which is a fundamental stage in the cognitive, emotional, and motor development of primary school students. The purpose of these applications is to provide students with an interdisciplinary approach, develop their problem-solving skills, and encourage innovative thinking (Yılmaz, 2023). Furthermore, STEM activities initiated at the elementary school level support the natural path of learning by keeping children's curiosity alive and enabling them to make

discoveries. In this context, STEM activities integrated into educational programs allow students to relate abstract concepts to concrete examples, thereby increasing comprehension and retention (Karataş, 2021).

At the elementary school level, it is important to prepare STEM-focused activities both to enhance students' experiences and to increase the retention of learning. This is because STEM activities ensure that students are active in the teaching and learning process (Bransford et al., 2000). In Turkey, due to the central placement exam (LGS), a test-focused teaching process is applied, especially at the middle school level, and teachers generally emphasize curriculum education. This situation makes it difficult to implement integrated STEM applications. However, the pressure of exams at the elementary school level is not as great as at the middle school level. In fact, the Ministry of National Education has abolished exams administered at the 4th grade level in elementary schools. It can be said that this situation provides favorable conditions for implementing STEM education in elementary schools (Uştu, 2019).

STEM projects implemented in elementary schools are generally multidisciplinary teaching environments where various disciplines are intertwined. Thanks to these environments, students encounter real-life problems and learn to establish interdisciplinary connections. These activities, carried out using games and basic technological tools, also promote the development of manual skills and the consolidation of collaboration skills (Uzun, 2022). Students' active

participation and involvement in the discovery process increases the permanence of learning while also strengthening their self-confidence. For this reason, STEM applications in elementary school aim not only to convey scientific concepts but also to ensure fundamental life skills such as critical thinking, creativity, and solution-orientedness (Taş, 2023). At this point, STEM activities supported by effective teaching strategies and appropriate materials enrich learning processes and increase children's interest levels.

Karakaya et al. (2019) stated in their study that teamwork is important in the implementation of STEM activities at the elementary school level. They stated that bringing together students with different ideas and abilities within the scope of STEM activities would be beneficial in terms of communication, efficiency, and time management. Various studies have shown that work done in the field of STEM has a positive impact on education and teaching processes and on student learning (Becker & Park, 2011; Gökbayrak & Karışan, 2017; Radloff & Guzey, 2016). Therefore, educational activities at the elementary school level should be supported by STEM applications and integrated into lessons in a planned manner by educators, as they present a holistic perspective across disciplines/subjects. However, Sungur et al. (2022) found in their study that STEM applications and their effectiveness are generally researched at the middle school level. Nevertheless, they determined that more research is needed at the elementary school level and other educational levels, and that in almost all studies, students had positive attitudes toward STEM and

that the activities had a positive effect on students' academic achievement. Considering these results, it is thought that STEM applications at the elementary school level will have a positive impact on students' academic achievement.

In conclusion, STEM education is an interdisciplinary learning approach that supports students' cognitive, affective, and motor development, particularly at the elementary school level, and aims to equip them with 21st-century skills. This approach contributes to the development of students' basic life skills, such as problem solving, critical thinking, creativity, and collaboration, while increasing the permanence of learning and strengthening their self-confidence. The relatively low pressure of exams at the elementary school level provides a favorable environment for STEM applications; game-based and hands-on activities encourage active student participation. Research shows that STEM activities carried out in this age group positively affect academic achievement and develop positive attitudes towards STEM in students. Therefore, STEM applications carried out at the elementary school level with a planned and holistic approach stand out as an important educational strategy that supports both individual development and the goal of training qualified human resources for the future.

8. INCLUSIVE STEM PRACTICES FOR STUDENTS WITH SPECIAL NEEDS

Inclusivity and STEM applications for students with special needs are among the fundamental elements in implementing the principle of

equality in education. These applications should be designed to ensure the active participation of students with different abilities and needs in the learning process (Kılıç, 2024). First, physical accessibility must be ensured, and classroom environments must be adapted for use by individuals with visual, hearing, or mobility impairments. Digital materials and learning technologies should be adaptable to various learning styles and special needs, thereby optimizing students' learning experiences according to their diverse requirements (Saraçoğlu, 2024).

In inclusive STEM practices, the fundamental goal is to view students' differences as opportunities and bring out their potential in the best possible way. In this context, it is important for teachers to develop flexible materials suitable for different learning styles and needs, and to provide individual support and adaptations (Yolcu & Doğan, 2022). Furthermore, it is necessary to use positive and supportive language in teaching environments to reduce prejudices and attitudes that may hinder the participation of students with special needs. In collaboration and group work, attention should also be paid to the development of these students' communication and social skills (Yıldırım, 2023). Curriculum and assessment systems should be designed with sufficient flexibility to take into account different abilities and learning paces, ensuring that all students can demonstrate achievement on an equal basis. In this way, students with special needs can fully benefit from STEM practices and develop their scientific thinking and problem-solving skills (Kendaloğlu, 2021).

In conclusion, STEM practices designed in accordance with the principles of accessibility and inclusivity are important steps that enable students to realize their potential. These approaches form a fundamental basis for ensuring equity in education and supporting the development of all students in line with their abilities. Therefore, educational institutions and teachers should develop innovative and inclusive methods in this field to support the active participation of every student in the learning process. For these practices to be effective, it is necessary to ensure physical accessibility, adapt digital materials to different learning styles, and adopt a supportive approach in instructional environments. Teachers' development of flexible and individualized instructional strategies, the reduction of biases, and the creation of learning environments supported by group work that encourages social interaction make it possible for all students to actively participate in STEM processes. In this context, redesigning curricula and assessment systems with flexible structures that take individual differences into account is of great importance for the sustainability of inclusive STEM education.

9. PARENTAL INVOLVEMENT IN STEM PRACTICES

STEM education is an interdisciplinary educational approach that integrates the disciplines of science, technology, engineering, and mathematics, and focuses on real-life problems, covering all educational levels from early childhood onward (Gonzalez & Freyer, 2014).

The literature clearly demonstrates how important it is for children to participate in STEM education. However, parents may have low levels of knowledge in this area and may lack confidence, which can make it difficult for them to support their children's STEM learning (McClure et al., 2017). The involvement of families in STEM practices increases students' academic achievement, contributes to the development of positive attitudes toward science lessons and learning, and enhances their motivation (Hornby & Witte, 2010; Simkins et al., 2005). Therefore, the participation of families in STEM practices can positively influence students' attitudes toward STEM and their motivation for learning science. However, for this positive impact to occur, it is very important and necessary that families participate in the process in a healthy manner and guide it appropriately (Sağdıç, 2025).

The participation of families and the community in STEM education is one of the important factors that strengthens student motivation and contributes to the diversification of learning environments. Active involvement of families in education allows children to approach the learning process with confidence and can increase their success. This contribution is reflected in the families' interest in their children's education, their support, and their role as models (Mutlu et al., 2025). With the participation of families and the community, students develop critical thinking and problem-solving skills, and their collaboration and communication skills are strengthened.

Furthermore, this involvement helps connect STEM education to real-life experiences and raises students' awareness regarding career planning (Arslan & Batur, 2023). Like other developed countries, Turkey also needs to develop different, new, and innovative ideas to compete with developed nations while cultivating a skilled workforce (Ecevit et al., 2022). For this reason, the participation of parents alongside students in STEM processes is highly important, both for ensuring that students acquire the competencies required by the modern age and for supporting the personal development of the parents themselves.

In conclusion, for STEM education to be effectively implemented and for students to benefit from it to the greatest extent, the active participation of families and the community is crucial. Involving families in STEM processes not only increases students' academic achievement and their interest in learning science, but also supports the development of critical thinking, problem-solving, and communication skills.

This participation helps children approach the learning process with confidence, strengthens the connection between STEM education and real-life experiences, and enhances career awareness. In terms of increasing Turkey's global competitiveness and cultivating a skilled workforce, the conscious and active involvement of parents in this process can be considered a strategic necessity for the development of both students and families.

10. CONCLUSION

STEM education can be considered an approach that brings disciplines together to provide quality learning, apply existing knowledge in daily life, enhance life skills, and foster higher-order and critical thinking (Yıldırım & Altun, 2015). STEM education has now become a necessity for all countries worldwide. Developed countries are moving away from the education systems that emerged with the Industrial Revolution and aim to base their education systems on STEM education. The reason for this shift is that, in today's knowledge society, increasing mental processes and production skills has become a necessity, rather than relying on labor and physical strength (Özdemir, 2016). Consequently, in recent years, STEM education has been implemented for students of different age groups, including preschool, primary, middle, and high school levels (Sungur et al., 2022).

The replacement of the physical labor required during the Industrial Revolution in developed countries with production skills and mental processes today has highlighted the necessity of STEM education. At the core of STEM education are STEM literacy skills (Azgın & Şenler, 2019). The essence of the STEM approach is to cultivate a generation with observation, interpretation, critical thinking, problem-solving, and scientific research skills. STEM aims to educate individuals equipped with the skills required in the information and digital age, capable of solving problems, using technology in all areas, and possessing effective communication abilities. Many countries

around the world have begun incorporating STEM methods into their education curricula (Taş, 2023).

One of the main reasons STEM education reform has been accepted by many countries with economic, geographical, and socio-cultural differences is due to its economic, pedagogical, and professional objectives. Another important goal is to equip students with the critical thinking, problem-solving, and adaptability skills they need in their communities, thereby transforming them into STEM-literate individuals (Karahan, 2019). STEM education can be interpreted as a learning approach that provides students with different perspectives, guides them in many areas, and allows them to enjoy and feel satisfaction during the learning process. STEM education should not be limited to STEM centers; it needs to be expanded across all levels of formal education. By effectively implementing the STEM approach in all formal education stages, the quality and efficiency of teaching can be enhanced (Uyar, 2023).

For STEM education to be successful in Turkey, it is essential to cultivate an interdisciplinary perspective among children from an early age, encompassing Science, Technology, Engineering, Arts, and Mathematics, and to develop skills in inquiry, problem-solving, research, aesthetic thinking, and product creation. Opportunities for children should be increased, students should be encouraged to engage in research-based STEM learning, and their talents and achievements should be recognized (MEB, 2016).

In conclusion, STEM applications play a significant role in developing individuals' analytical thinking, problem-solving, and creativity skills. This interdisciplinary approach provides students with opportunities to connect theoretical knowledge to everyday life and to develop innovative solutions for real-world problems. Through STEM applications, students actively experience experimentation, observation, and conclusion-drawing processes. This not only enhances their academic achievement but also establishes a solid foundation for their future professional lives. Moreover, STEM education transforms individuals from mere consumers of knowledge into producers of knowledge, contributing to societal development. Therefore, expanding STEM applications within education systems is of great importance for both individual development and social progress.

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