



## A study on the readiness of schools for STEM education: are we really ready for it? \*

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### Abstract

To remain competitive in the rapidly evolving global economy, it is essential not only to utilize technology but also to produce it. Achieving this requires the development of skilled human capital across various disciplines. STEM education strengthens students' abilities to foster innovation by enhancing their critical and analytical thinking, and problem-solving skills, while also supporting affective development through increased empathy, ethical awareness, and social responsibility. This is a crucial step for economic growth, driven by the skilled workforce it helps create. However, successfully integrating STEM education into the current educational framework requires adequate preparation. The aim of this study was to assess the readiness of high schools in Ankara for STEM education. To achieve this, interview questions were developed based on the New York City Department of Education (NYCDOE) STEM framework, and interviews were conducted with teachers and administrators from four different types of schools. The schools' readiness was assessed through data analysis and further supported by qualitative themes identified from the interview responses.

### Keywords

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### Introduction

Over the last century, the world has witnessed remarkable advancements in science, economics, and technology. This has led to global competition among countries in areas such as the economy, technology, and defense. To succeed in these fields, nations require a scientifically informed population and a highly educated workforce in science, technology, engineering, and mathematics (STEM) (Chachashvili-Bolotin et al., 2016). Initially introduced and endorsed by the U.S. government in 2009, the STEM initiative aims to develop the human capital necessary for rapid economic growth and global competitiveness (Farina et al., 2016). For countries to remain competitive in the global market, they must adapt their education systems accordingly (Fensham, 2008). STEM education is key to this adaptation, as it enables students to apply their knowledge in practical, real-world contexts. When successfully integrated, STEM education can enhance students' creativity, problem-solving abilities, motivation, and

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overall academic performance. However, implementing STEM education in classrooms presents certain challenges that can affect a school's readiness to adopt this approach. A school is deemed ready for STEM education when its students, teachers, administrators, and physical infrastructure are adequately prepared to support STEM learning. Therefore, ensuring schools are prepared for STEM is a crucial step toward increasing the number of students who meet international STEM standards.

### *STEM Education*

STEM, an acronym for Science, Technology, Engineering, and Mathematics, encompasses a multidisciplinary approach that goes beyond traditional lecture-based teaching strategies. Instead, STEM education emphasizes inquiry and project-based learning, which fosters critical thinking, creativity, innovation, and problem-solving skills among students (Breiner et al., 2012; Morrison, 2006). Beyond cognitive outcomes, STEM education also supports affective development, especially when implemented through real-world, socially relevant issues. In such contexts, students not only learn to solve problems but also develop empathy, ethical awareness, and a sense of social responsibility. For instance, Ozturk and Roehrig (2025) demonstrated that an integrated STEM unit centered on a socio-scientific issue significantly enhanced middle school students' abilities to take others' perspectives, recognize the societal role of science, and engage in nuanced emotional reasoning. Shim (2024) further conceptualized an "empathic STEM" framework, proposing that culturally responsive and human-centered STEM design tasks can foster empathy and ethical awareness among learners, especially in diverse classrooms. Similarly, Bush et al. (2024) argued that empathy-driven design thinking within STEM curricula not only promotes technical problem-solving but also nurtures students' sense of social justice and civic responsibility.

In order to drive advancements in technology and engineering, STEM education must strengthen students' understanding of scientific and mathematical concepts (Hernandez et al., 2014). Consequently, STEM education can be described as an interdisciplinary approach to learning that extends from early childhood through higher education, incorporating a wide range of educational activities (Gonzalez & Kuenzi, 2012). It is vital in today's educational context, as it offers numerous opportunities to connect theoretical knowledge with practical applications. It is a key element in helping nations maintain their competitiveness in the global economy. Focusing on technology and engineering from early childhood to future innovations, STEM education highlights the interconnectedness of science, mathematics, technology, and engineering, which cannot be treated as separate fields. Incorporating STEM education into the curriculum through methods such as inquiry-based learning, the use of digital tools, computer programming, and robotics helps students develop creativity, problem-solving abilities, critical thinking, motivation, and overall academic success.

Acquiring a comprehensive knowledge of STEM disciplines and the interdependence among them is a fundamental step toward attaining STEM literacy. STEM literacy means being able to understand and use ideas from science, technology, engineering, and math so that we can make sense of difficult problems and find better ways to solve them (Balka, 2011). This competence is essential for students to combine key knowledge, skills, and attitudes with the continuously changing technological context. Furthermore, it ensures that students are well-equipped upon graduation to face challenges in the technology-driven world (McDonald, 2016). Therefore, it is imperative for students to possess a deep understanding of the various disciplines in order to advance their careers in STEM.

The progress of modern society is heavily dependent on the integration of various scientific disciplines. Mathematics, in particular, plays a critical role in enabling scientific research, innovation, and technological advancement (Australian Academy of Science, 2006). While science provides students with an understanding of the natural world through the application of principles, concepts, and facts related to subjects such as physics, chemistry, and biology, it is not limited to these fields (National Research Council, 2012). With the help of technology and engineering, students can develop deeper connections between STEM concepts, thereby enhancing their creativity and higher-order cognitive skills. Additionally, engineering and technology practices provide a more comprehensive understanding of these concepts, ultimately enhancing students' motivation and success (Cunningham & Lachapelle, 2014). Moore et al. (2015) suggest that engaging in engineering practices enhances students' interest in STEM fields and careers by encouraging collaboration on problem-solving, fostering patience in managing processes, and utilizing 21st-century technologies to develop solutions.

### *STEM Education in Türkiye*

Studies in Türkiye reveal that many young people are not particularly interested in science or creative thinking (Şahin et al., 2014). International assessments confirm this trend; Turkish students consistently score lower than their peers in other countries in science and math (Anıl et al., 2015; Oral & McGivney, 2013). The PISA National Report (Ministry of National Education [MoNE], 2016a) called for fundamental reforms in how STEM subjects (Science, Technology, Engineering, and Mathematics) are taught across all levels of education. To compete globally and foster innovation, Türkiye urgently needs a generation capable of creative thinking and problem-solving in STEM fields.

In response, both governmental and non-governmental institutions have taken steps to improve STEM education. The Ministry of National Education (MoNE, 2016b) emphasized that STEM is essential for students, teachers, and schools, proposing initiatives such as establishing STEM centers, conducting research, updating curricula, and training educators. Similarly, Turkish Industry and Business Association's (TUSIAD, 2017) report, "STEM Needs in Turkey by 2023," stressed the importance of swiftly forming a national STEM policy in collaboration with all stakeholders. Although the government had initial plans extending until 2019 (Altunel, 2018), recent years have witnessed continued efforts from private institutions, universities, and civil society. Importantly, STEM is not just about performing science experiments or learning to code; it is about equipping students with critical thinking and collaborative problem-solving skills (Bybee, 2013). Across Türkiye, a range of initiatives have emerged, including teacher training programs, STEM kits and public festivals that promote STEM awareness. The Ministry of National Education's (2016) report outlined concrete strategies that align with these activities (Arslan & Arastaman, 2021).

Studies evaluating these efforts suggest that they have begun to yield positive results. According to Çakır and Ozan (2018), STEM implementations in Türkiye have contributed meaningfully to student engagement and achievement in the targeted disciplines, supporting the broader goal of improving STEM education nationwide. In support of this trend, the PISA 2022 results revealed that Türkiye outperformed the average of all participating countries in Mathematics, Reading, and Science literacy (MoNE, 2024). The country has steadily improved in these domains for more than a decade, narrowing its performance gap with OECD countries. This positions Türkiye as one of the few nations to have shown consistent, long-term progress in the quality of education (MoNE, 2024).

To maintain and build on this progress, it is now essential to strengthen teachers' readiness, which plays a pivotal role in the sustained success of STEM education. Teachers need to develop a strong STEM-oriented mindset by moving away from teaching knowledge for its own sake and instead focusing on knowledge that can be applied in real-life context. This shift enables educators prepare students more effectively for real-world challenges by fostering practical application and innovation,

while also helping them develop critical thinking, creativity, and the essential skills needed for the future (Şanlı & Özerbaş, 2021).

### *Readiness*

Readiness is a key factor in successfully completing tasks, as it requires the necessary conditions to achieve a specific goal. Merriam-Webster's Collegiate Dictionary (Merriam-Webster, 1999) defines readiness as "a state of preparation," though this definition is broad and context dependent. Hersey and Blanchard (1988) highlighted the importance of performing tasks willingly when discussing readiness. In the context of STEM education, it is essential to consider the preparedness of both teachers and students to ensure effective implementation. Lynch and Smith (2016) state that when members of a school are prepared to manage change, it signifies their readiness for improvement, underscoring the significance of teacher and student preparedness in achieving success in the evolving context of Science, Technology, Engineering, and Mathematics (STEM) education. In this sense, readiness includes more than just having the right tools or basic knowledge; it also requires motivation, confidence, and openness to new ways of teaching and learning. Hall and Hord (2011) further argue that lasting changes in education depend on support from school leaders, collaboration among teachers, and access to professional development. They also note that change does not occur instantly but is a gradual process through which both individuals and institutions gain understanding, develop skills, and become confident in applying new methods.

### *Teacher Readiness*

"I have come to a frightening conclusion. I am the decisive element in the classroom. It is my personal approach that creates the climate." (Ginott, 1976).

The quote by Ginott (1976) serves as a powerful reminder that teachers play a decisive role in setting the tone of the classroom. Their personal approach and daily mood are key factors that shape the classroom climate and, ultimately, the overall learning experience of their students. The relationship between teachers and students is complex and important, as both are integral to the learning community. Creating a positive and effective learning environment is crucial, and it all begins with the teacher's readiness. In particular, teachers who are open-minded are more likely to create environments that fosters creative thinking, encouraging students to become risk-takers and open-minded individuals (Crane, 2017). Motivation is essential to the teaching process, as it empowers teachers to share knowledge and work interdisciplinarily. Motivated teachers are energized, eager to learn and teach, and utilize their full potential to go the extra mile (Sinclair, 2008).

Teacher readiness becomes even more critical due to the interdisciplinary nature of the content and the need for inquiry-based and student-centered pedagogies. Research shows that even content-proficient teachers may feel unprepared to implement STEM effectively without targeted support (Margot & Kettler, 2019). Moreover, many educators express uncertainty when it comes to integrating engineering principles, using technology tools, or designing cross-curricular projects. Therefore, readiness also includes pedagogical adaptability, technological fluency, and a growth mindset for learning and teaching in rapidly evolving fields. Similarly, Darling-Hammond (2020), emphasizes that teachers feel more prepared when they receive strong support and opportunities for continuous learning, including professional development, peer collaboration, and leadership that values experimentation and risk-taking. As Hall and Hord (2011) argue, readiness is not an instant condition but a gradual process through which teachers build readiness over time by engaging with new methods, reflecting on their practice, and receiving meaningful feedback.

In conclusion, a teacher's readiness forms the foundation for creating a positive and effective learning environment. By maintaining an uncluttered mind, being open-minded, motivated, willing, and capable, teachers can inspire and empower their students to achieve their full potential. In STEM education, teacher readiness acts as a bridge between curriculum goals and actual student engagement. A well-prepared teacher doesn't merely deliver content; they model curiosity, resilience, and the lifelong learning mindset that STEM demands.

### *Student Readiness*

The readiness of both students and teachers is crucial in the learning process, as they mutually influence one another. According to Schunk (2012), readiness refers to what students are able to learn or accomplish at various developmental stages. Factors such as prior knowledge, interests, attitudes, and abilities shape a students' levels of readiness (Çetin, 2016). Learning is described by Arozaq et al. (2017) as a process of behavioral change, and the duration of this process is influenced by the students' readiness (Harman & Çelikler, 2012). When students exhibit a high level of readiness, they tend to perform successfully in activities and experience greater overall satisfaction. Thorndike's Law (Harman & Çelikler, 2012) outlines the following principles:

- When individuals are ready to engage in an activity, they derive satisfaction from participation.
- If individuals are prepared to perform an activity but are not permitted to do so, it may result in frustration.
- Forcing individuals who are unprepared to participate in an activity can lead to anger.

Assessing readiness levels for STEM education helps teachers align their preparation with the needs of their students. Student readiness extends beyond academic ability; it encompassed problem-solving disposition, collaborative skills, and comfort with ambiguity, all of which are essential in inquiry-based learning environments. According to Bybee (2010), effective STEM instruction depends on students' capacity to engage in authentic problem-solving tasks that require both prior knowledge and a willingness to experiment. Moreover, research shows that students' interest in STEM careers is closely linked to their self-efficacy and early exposure to integrated STEM experiences (Radloff & Guzey, 2016). However, without foundational confidence in disciplines such as mathematics or science, they may hesitate to participate actively in cross-disciplinary activities. As Le et al. (2023) point out, even when students are curious about STEM, gaps in fundamental understanding, particularly in mathematics, can limit their engagement. Therefore, teachers must assess not only content knowledge but also emotional and motivational readiness indicators such as persistence, curiosity, and risk tolerance.

Finally, readiness should be understood as a dynamic construct rather than fixed state, as it is influenced by classroom climate, peer interaction, and instructional design. A supportive and responsive environment can enhance even initially unprepared students' readiness over time. Teachers who differentiate instruction based on readiness are better positioned to scaffold learning and foster success among diverse learners in STEM classrooms.

### *NYC STEM Framework*

The NYC STEM Education Framework serves as an effective tool that offers a structured approach for schools seeking to enhance their implementation of STEM initiatives. The framework aims to transform teaching and learning by shifting from multidisciplinary and interdisciplinary approach to a transdisciplinary one, thereby creating a more enriching experience for both students and educators. STEM-educated students develop crucial skills such as critical and interdisciplinary thinking, inquiry-based and real-life learning, and participation in transdisciplinary learning processes (Altunel, 2018).

The study identified several key criteria for assessing schools' readiness levels, including socio-economic disparities, exam-oriented education systems, and teacher training. The framework employed in the research served as an effective analytical tool, providing valuable insights to the study. However, it is important to note that this framework is not designed for direct evaluation of schools; rather, it aims to identify their preparation needs. In this context, readiness refers to a school's capacity to effectively implement STEM education. The framework encompasses various subcategories, ranging from establishing a STEM vision within schools to supporting career planning in related fields. It comprises four main domains and twelve indicators (Table 1), which define the readiness levels categorized as "Early," "Emerging," "Integrated," and "Fully Integrated." A detailed explanation of all domains and indicators is presented below.

#### ***Domain 1: School Vision and Structures for Success***

The STEM mission and vision of the school must be clearly articulated and effectively communicated to all stakeholders, while the school's culture, program evaluation processes, and budgetary resources should be aligned to support these goals. The STEM Mission and Vision indicator helps assess how well the school's staff integrates and embraces the STEM mission and vision, with evidence of commitment reflected in educational plans that incorporating STEM, meetings focused on integration, and professional development opportunities related to STEM. Complementing this, the STEM-centric Culture indicator evaluates the extent to which the school's environment supports STEM learning. A positive culture that encourages innovation, risk-taking, and interdisciplinary collaboration among all members is vital for achieving full integration. Moreover, the acceptance of student-centered inquiry, engineering practices, digital literacy, and project-based learning by all stakeholders, together with access to adequate STEM classes and laboratories, represents additional critical elements for success.

The evaluation of the degree to which STEM education has been implemented is captured within the STEM Program Evaluation indicator. Achieving full integration critically depends on the availability of STEM-rich resources and a leadership team that involves families, school administrators, and other key stakeholders. Another important indicator, Budget and Resource Management, addresses the adequacy of the school's STEM budget and the allocation of funds for related initiatives. Maintaining accurate budget records and having a dedicated team to oversee these finances are essential. However, limited access to technology and other essential resources for STEM education may hinder effective integration.

#### ***Domain 2: Curriculum, Instruction, and Assessment***

This domain emphasizes a transdisciplinary instructional approach that fosters student-centered inquiry, project-based learning, and engineering practices within a STEM-focused curriculum, assessing instructional quality, authentic assessments practices, and staff capacity as key indicators of success. The Academic Rigor and Instructional Quality indicator underscores the necessity of a clearly defined STEM program that promotes critical thinking, real-world problem-solving, and active learning through the application of 21st-century skills. Integrating STEM applications into curricula, lessons, and units, along with adapting teaching practices to align with the school's core mission and vision across all STEM courses, is essential for enhancing integration. The STEM-centric Curriculum indicator further emphasizes the importance of a robust STEM education program that cultivates innovative and critical thinking, engineering design, and scientific literacy. Providing STEM opportunities both inside and outside the classroom enables students to apply STEM concepts in real-world contexts, while dedicating sufficient time to support STEM education further enhances integration.

To evaluate success, the Authentic Assessments indicator emphasizes the effective implementation of authentic assessment tools, such as projects, portfolios, and presentations. The regular use of learning cycles, together with formative and summative assessments, provides students with opportunities for self-assessment and targeted feedback, thereby enhancing integration. The Staff Capacity indicator focuses on improving professional learning in STEM content areas and strengthening teachers' pedagogical expertise. Additionally, the development of an effective collaborative plan among

STEM stakeholders, along with the dissemination of valuable information about STEM opportunities and programs, represents a crucial element of this domain.

### ***Domain 3: Strategic Partnerships***

This domain focuses on STEM partnerships that engage families, universities, community organizations, and businesses. The STEM Partnerships indicator assesses the effectiveness of intentional collaborations in STEM education that involve universities, families, local organizations, and businesses. Successful integration of STEM education depends on collaboration between STEM partners and educators, effective communication with families, and the systematic organization of STEM-related events. Additionally, collaboration with other schools that share similar interests in STEM can further enhance the overall level of integration.

### ***Domain 4: College and Career Readiness***

This domain primarily aims to guide students toward a STEM-oriented career trajectory, beginning in elementary school and continuing through high school. The STEM Pathway Preparation for Elementary School indicator underscores the importance of utilizing resources such as College Talk to foster early awareness of STEM-related careers. To ensure full integration, it is vital to demonstrate evidence of opportunities both inside and outside the school, including guidance on STEM careers for parents, students, and teachers.

The Access to STEM College and Career Opportunities for Middle and High School Students indicator differs from the previous one, focusing specifically on STEM-related college and career opportunities for middle and high school students. Providing guidance to students and families on essential factors such as self-discipline, homework, and GPA is crucial for enhancing career readiness and increasing integration levels. Similarly, the Planning Student Outreach and Support for Pre-K-12 STEM Initiatives indicator highlights the intentional support schools should offer to students and families regarding future STEM careers and related pathways, underscoring the importance of proactive engagement across all grade levels.

**Table 1.** The domains and indicators of STEM Framework

<b>DOMAINS</b>		<b>INDICATORS</b>
Domain 1	School Vision and Structures for Success	*STEM Mission and Vision *STEM-centric Culture *STEM Program Evaluation *Budget/Management of Resources
Domain 2	Curriculum, Instruction and Assessment	*Academic Rigor and Instructional Quality *STEM-centric Curriculum *Authentic Assessments * Staff Capacity
Domain 3	Strategic Partnerships	* STEM Partnership
Domain 4	College and Career Readiness	* Access to STEM College and Career Opportunities for Middle and High School Students *Planning Student Outreach and Support for Pre-K-12 STEM Initiatives

## Method

### *Research Design*

The instrumental case study design was deemed appropriate for this qualitative research. This method allows researchers to examine a specific case, selected for its relevance to the research question, to gain valuable insights or to serve as a tool for testing or illustrating theoretical concepts. Thus, an instrumental case study focuses on a particular problem rather than on the case itself, using the situation to gain a deeper understanding of the issue (Stake, 1995).

In this study, the primary focus is the readiness of high schools, and the inclusion of different school types constitutes multiple cases. Therefore, a multiple-case study approach was adopted. According to Baxter and Jack (2008), this approach is effective for exploring similarities and differences among the cases. Moreover, findings from multiple-case studies tend to be robust and credible (Baxter & Jack, 2008). Engaging in multiple-case research allows for a more in-depth exploration of research problems and contributes to theoretical development (Eisenhardt & Graebner, 2007).

### *Sample*

The high schools in Ankara serve as the cases for this study, focusing on their respective levels of STEM readiness. Four distinct schools were selected for this purpose: one science high school, one private high school, one vocational high school, and one regular public high school. The selection process was guided by a combination of accessibility considerations and purposeful sampling criteria. Initially, the researcher contacted several schools in Ankara with which academic or professional relationships already existed, facilitating access and communication. Although a few schools declined to participate due to administrative workload or scheduling conflicts, the final sample comprised those that responded positively and demonstrated a willingness to participate in the study. The inclusion of four distinct school types was intentional and aimed to capture diverse STEM readiness contexts based on institutional resources, curricular orientation, and student demographics. Practical considerations such as ease of access, variation across school types, and availability of key staff members (e.g., science teachers and deputy principals) also played a role in the final school selection.

Furthermore, the study adopted a multiple-case design in which one school from each type (science, private, vocational, and regular public high schools) was selected. This approach ensured diversity across cases and supported analytic generalization, while maintaining the practicality of the study's scope for detailed analysis. As Baxter and Jack (2008) explain, a multiple-case study allows the researcher to conduct both within-case and cross-case analyses, thereby identifying similarities and differences among the cases. For this reason, including one school from each type was deemed sufficient to ensure variation and enable meaningful comparisons, while keeping the study manageable for in-depth analysis.

The private high school distinguished itself by offering an international curriculum alongside the national one. This school had a diverse student body, including international students and staff, and was equipped with well-maintained laboratories. Thematic classes, such as geography, were commonly offered. While the school had three fully equipped science laboratories, it lacked a computer laboratory.

The science high school, selected based on its performance in the Ministry of Education's high school entrance examination, is recognized as one of the top high schools in both the city and the country. Although structurally similar to the private high school, its laboratories and equipment were comparatively older. This school had two physics laboratories, two chemistry laboratories, and two biology laboratories, all providing sufficient infrastructure for students to carry out projects and experiments. The facility included 16 classrooms, each equipped with an interactive whiteboard and internet access. Notably, this school actively used 3D printers, a feature not found in the other selected schools. Additionally, there were six workshop classrooms available for instructional and extracurricular activities.

Vocational high schools aim to contribute to the national workforce by educating students in technical and applied fields. The vocational high school included extensive facilities and laboratories. There were twelve laboratory and workshop classrooms in total. The laboratory resources were actively utilized. Students who did not pass the national entrance examinations and opted for alternative school types attended regular public high schools. The curriculum at such institution follows the national standard. In the regular public high school, classrooms were equipped with smartboards; however, they were overcrowded, and no laboratories were in use. It was completely exam-oriented school, with a primary focus on university entrance preparation

Given that participants were easily accessible, geographically close, and willing to participate, the sampling method employed can be described as convenience sampling, which is non-random in nature as noted in Dörnyei's (2007) work on research methods. Therefore, purposive sampling was also employed in this study. This approach emphasizes the concept of saturation (Miles & Huberman, 1994), which refers to continuing data collection until no new information emerges. Accordingly, no predetermined sample size was set at the outset of the study. Ultimately, at least one deputy principal or school principal, along with two teachers from each school, participated. In total, nine science or mathematics teachers and four deputy principals or school heads participated in the study. The selection of participants followed a homogeneous sampling strategy, and all interviews were conducted voluntarily.

#### ***Data Collection and Analysis***

The STEM Framework Criteria developed by the New York City Department of Education (NYCDOE) were used in this study to guide construct interview questions. The framework comprises four domains, each containing indicators and corresponding criteria. The indicators within these domains guided the selection of interview questions, and schools' readiness levels were categorized as Early, Emerging, Integrated, or Fully Integrated. To collect meaningful and relevant data, semi-structured interviews were conducted on a voluntary basis. There was no fixed time limit for these interviews, which lasted approximately twenty minutes on average. The interview questions were carefully designed in alignment with the framework, to ensure that the data gathered were purposeful and aligned with the study's objectives.

To ensure the validity and reliability of the interview questions, expert feedback was obtained during the development process. Specifically, two STEM education scholars and one qualitative research specialist were consulted. These experts reviewed the questions for clarity, relevance, and alignment with the NYC STEM Framework, and their feedback was incorporated into the final version. Additionally, the questions were piloted at the researcher's school to assess their clarity, comprehensibility, and flow. Based on pilot results and expert feedback, minor revisions were made to refine the wording and sequencing. The final version of the instrument was approved by the study supervisor, contributing to its content and face validity.

During the analysis phase of the study, all interview audio recordings were transcribed verbatim to ensure accuracy and depth of the data. This included detailed accounts from two science and mathematics teachers and one administrator from each participating school. The analytic process was further supported by memos that the researchers documented before, during, and after the interviews. These memos facilitated the integration of codes and aided in the formulation of interpretive judgements, which is one of the key strengths of qualitative research (Denzin & Lincoln, 2011). Following transcription, the researchers conducted a pre-coding stage by reviewing the transcripts and highlighting relevant segments. The interview questions were structured around the NYC STEM framework, and the responses from both experts and practitioners were analyzed using the Constant Comparative Method (CCM). This method allows for continual comparison between collected data and emerging categories, making it particularly suitable for the objectives of this study (Creswell & Poth, 2016).

The analysis began with open coding, which involved examining key words, phrases, and statements from the interview data. Following Kolb's (2012) recommendation, the researchers compared the data by questioning what was understood and what remained unclear. In the second phase of the analysis, the data was reorganized by establishing connections between categories, ultimately refining the codes to align with the main themes. As a result of this analysis, several themes emerged from practitioners' perspectives regarding the schools' levels of STEM readiness.

In a later stage, primary headings were established under each domain, resulting in a total of twenty-five headings. Each heading contained four distinct indicators, which were scored on a scale from 1 to 4. For Domain 1, three main headings were identified, with four indicators associated with each. Each school was categorized under an indicator based on the outcomes of the interview questions. A summative approach was employed in this section to identify commonly used words and assess their frequency (Hsieh & Shannon, 2005). Although determining the frequency of recurring words may suggest a quantitative analysis (Kondracki et al., 2002), the primary focus remained on content interpretation, thereby characterizing it as a qualitative study (Hsieh & Shannon, 2005).

The four-point scoring system (1 = Early, 2 = Emerging, 3 = Integrated, 4 = Fully Integrated) was directly derived from the NYC STEM Framework, which categorizes school readiness into four levels across each subdomain. Each subdomain in the framework includes observable indicators aligned with one of these readiness levels. During data analysis, participant responses were examined and matched to these indicators based on content analysis and frequency of indicator-related expressions. When responses clearly reflected the characteristics of a particular readiness level, for instance, if a school lacked a STEM mission or practices, it was coded as "1 = Early"; if STEM activities were occasional and fragmented, it was coded as "2 = Emerging"; if STEM was regularly implemented in a structured way, it was coded as "3 = Integrated"; and if it was deeply embedded across the curriculum and school culture, it was coded as "4 = Fully Integrated." This process was consistently applied across all domains and the four selected schools. At the conclusion of the scoring phase, each school's total readiness score, ranging from a minimum of 25 to a maximum of 100, was used to classify its STEM readiness level. Based on this structure, schools scoring between 25 and 43 were classified as Early, those scoring between 44 and 62 as Emerging, scores between 63 and 81 were categorized as Integrated, and scores from 82 to 100 were labeled as Fully Integrated. These intervals were designed to reflect an even distribution across the range of possible scores and to align conceptually with the four-tier framework established by the NYC STEM criteria.

To ensure the reliability of the analysis, the coding process was conducted collaboratively by the primary researcher and two field experts. Each coder independently reviewed and scored the transcribed data. The results were then compared across coders to evaluate inter-coder agreement. Any discrepancies in scoring were discussed and resolved through consensus. This triangulated coding approach enhanced the trustworthiness and consistency of the final scoring across all four domains, thus strengthening the study's methodological rigor.

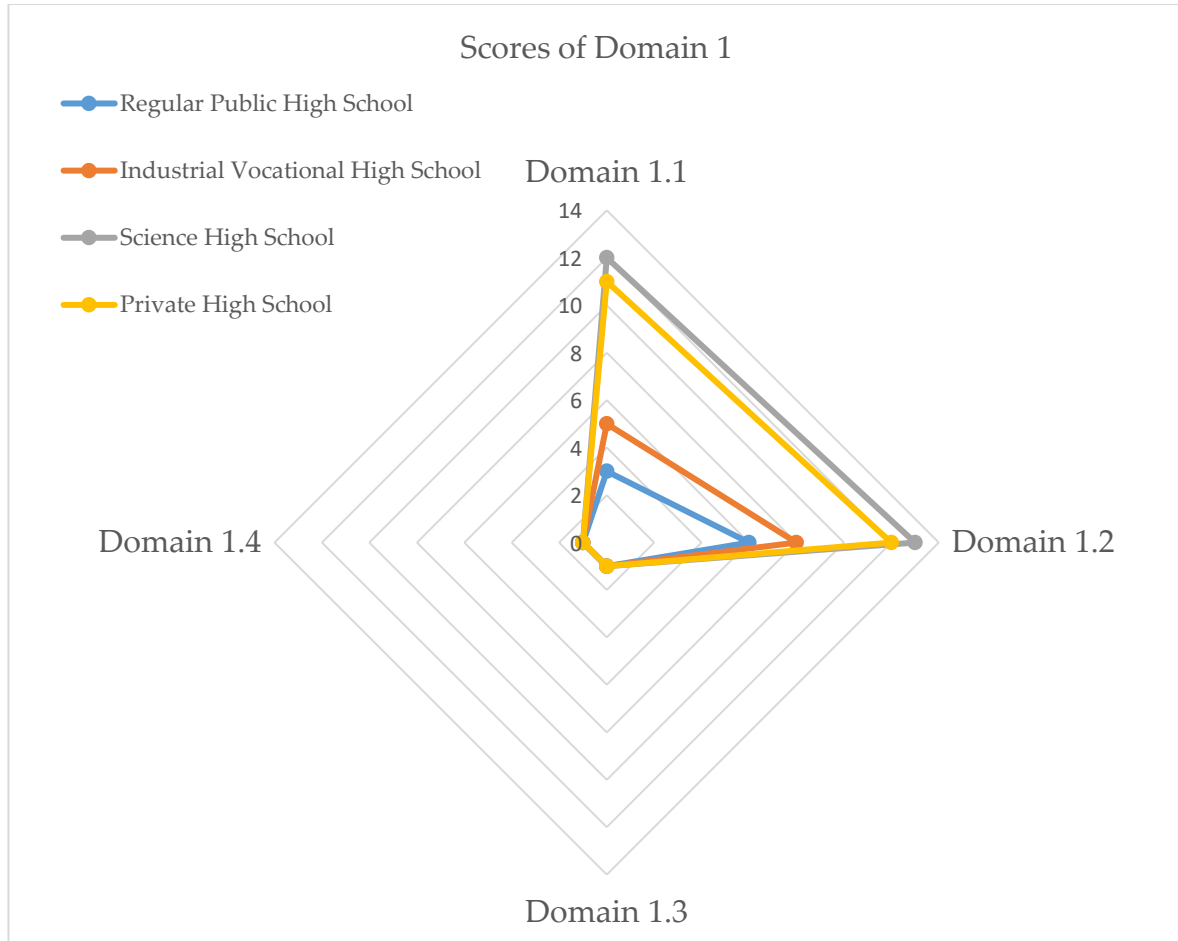
## Results

### *Domain Scores*

The domain scores are presented in the figures below, with Domain 1 focusing on the STEM vision of the schools and the structures necessary for success. This domain comprises four subdomains that collectively assess how well each school articulates its STEM vision and the supporting frameworks in place to achieve it. There were three subcategories under Domain 1.1, which dealt with the goal and vision of STEM. Participants received scores between 4 and 12 from this domain because there was a minimum score of 1 and a maximum score of 4 for each category. Domain 1.2 was about STEM-centric culture and included 4 categories and the scores of participants ranged from 4 to 16. STEM program evaluation was covered in Domain 1.3, and STEM budget was covered in Domain 1.4. The greatest score for these domains is 8, and the lowest value is 4. The highest possible score for participants in this area has been set at 36 out of 100 (Figure 1). Domain 2 included four subdomains and was primarily

concerned with STEM curriculum, instruction, and assessment. Following analyses using the same methodology as previously, the maximum score for this domain was 44 out of 100 (Figure 2). The same process was used for Domains 3 and 4, with a maximum score of 8 and 12 respectively out of 100 (Figure 3).

### *Results of Domain 1 (School Vision and Structures for Success)*



**Figure 1.** Scores of Domain 1

**Domain 1.1 (STEM Mission and Vision):** The data collected from the participants indicated that none of the individuals at the regular public high school were familiar with STEM or expressed any interest in it. In the vocational high school, only a few participants had heard the term but were uncertain about its meaning. Among those who were aware, only a small number expressed interest in STEM education. Some participants believed that STEM referred to an organization established by various institutions, while others correctly identified it as an acronym for science, technology, engineering, and mathematics, or associated it with these disciplines.

Conversely, all participants from both the science high school and the private high school were familiar with STEM education and expressed interest in it. Participants from the private high school described STEM as an "interdisciplinary approach." Consequently, while the regular public high school and vocational high school had not yet established a STEM mission and vision, the science high school had already defined its mission and vision, and the private high school was on the verge of fully implementing them.

The results indicate that participants generally experience confusion regarding the definitions of STEM and STEM education. Teachers at the private high school possess a comprehensive understanding of STEM due to their involvement in the International Baccalaureate (IB) Programme, which emphasizes critical thinking, self-reflection, and interdisciplinary connections. Similarly, participants from the science high school demonstrate a strong understanding of STEM, likely owing to their collaboration with research universities. In light of these findings, it is essential for schools to establish a clear and coherent STEM mission and vision.

In contrast, participants from the other schools demonstrated little interest in STEM, primarily due to the focus on university entrance examinations and concern regarding students' academic performance. The perceived low academic level was identified as a barrier to providing high-quality science, technology, engineering, and mathematics (STEM) education. However, this should not serve as an excuse, as STEM activities can be adapted to suit all educational levels and implemented at any stage of schooling (U.S. Department of Education, 2015). Therefore, although STEM is not currently a priority for these schools, its future integration remains uncertain.

**Domain 1.2 (STEM-centric Culture):** When examining the STEM-centered Culture domain, it becomes evident that the regular public high school and the vocational high school offer only a limited number of STEM-related courses and interdisciplinary teaching opportunities. Although these schools have laboratories, they lack dedicated classes and facilities specifically designed for STEM activities. Participants from the regular public high school noted that overcrowded classrooms hinder the effective implementation of STEM education.

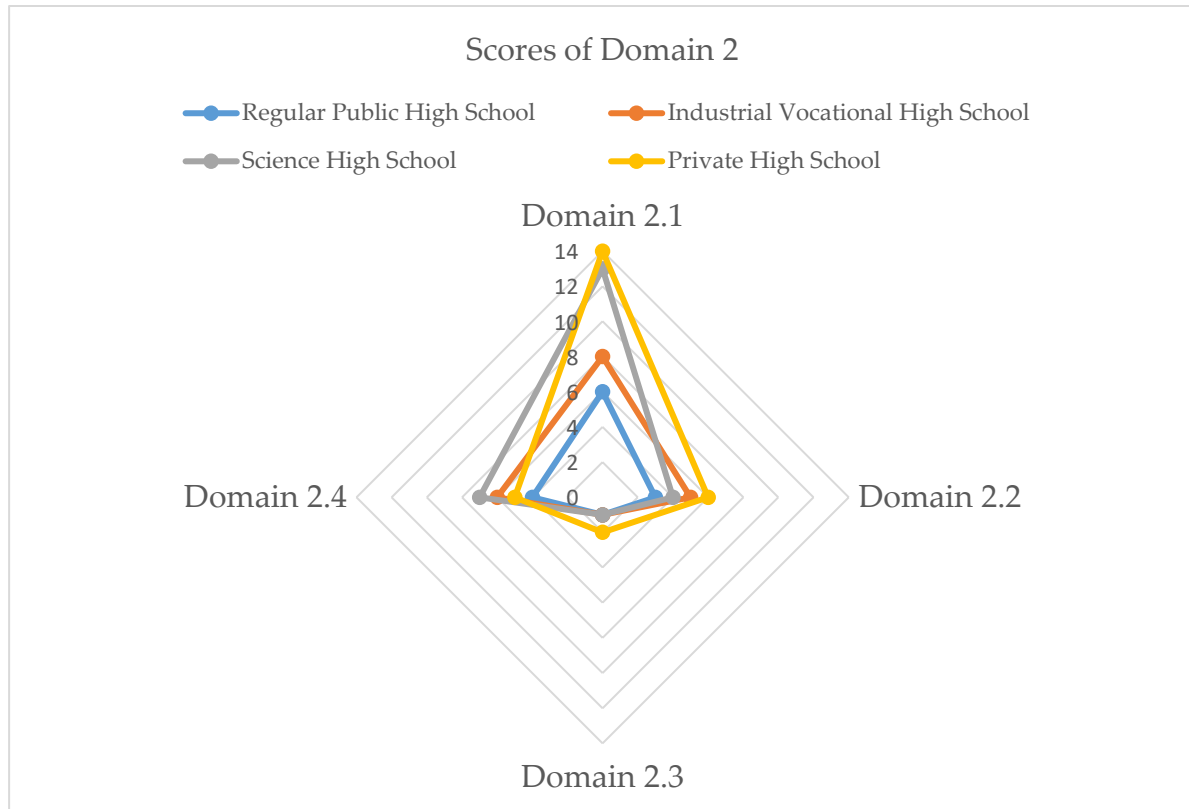
In contrast, the private high school and the science high school provide a more favorable environment for STEM integration. These institutions offer a greater number of STEM-oriented programs, dedicated STEM classes, and laboratories that facilitate interdisciplinary courses. Furthermore, both schools employ a larger number of staff members who help foster a supportive atmosphere for STEM education, although this remains insufficient to fully realize the potential of STEM initiatives. Overall, the findings indicate a clear disparity in STEM readiness and culture among these schools, with the science and private high schools leading in terms of available resources and institutional support.

Although the schools may not currently have a STEM-centered culture, some are willing to take the first steps. While certain clubs at the science high school and the private high school focus on STEM, this is not a school-wide initiative. Given that the IB Programme includes STEM projects, attending a private school appears to be advantageous. One positive takeaway from the findings is that participants from all schools now understand that incorporating technology into the curriculum does not equate to STEM. At this point, cultivating a STEM-centric culture requires increased awareness. Teachers who use technology in their lessons and conduct science experiments in their courses believe they are practicing STEM, but in reality, they are not. Another crucial element in developing a STEM-centric culture is establishing the right conditions and gaining the support of administrators and teachers, although some schools may find this challenging. For example, teachers in regular public high schools are not motivated to participate in STEM activities. This may be due to the exam-oriented Turkish education system or to individual factors, but this is a topic for another study. It appears that schools still need time and motivation to cultivate a genuine STEM culture.

**Domain 1.3-1.4 (STEM Program Evaluation-Budget/Management of Resources):** Based on the data obtained from the STEM Program Evaluation and STEM Budget domains, the evaluation process of STEM education in the schools was found to lack any evidence. Furthermore, it was reported that no budget had been allocated for STEM education. As a result, all schools scored 1 out of 4 in these domains. The participants' responses indicate that STEM education is not currently being implemented in schools; hence, the concept of a STEM budget is virtually non-existent. These schools are struggling to meet even their most urgent financial needs, let alone allocate funds for STEM education. Consequently, the STEM evaluation process is also not being considered. Schools must first cover their

daily expenses, such as project costs and laboratory supplies, before they can think about investing in STEM education. Almost all of the schools that were contacted reported lacking an adequate budget. In times of necessity, they manage to secure funds through donations and parental contributions.

**Results of Domain 2 (Curriculum, Instruction, and Assessment)**



**Figure 2.** Scores of Domain 2

**Domain 2.1 (Academic Rigor and Instructional Quality):** Drawing on the insights obtained from the Academic Rigor and Instructional Quality domains, this section identifies four subdomains. The science high school and the private high school frequently incorporate student-centered courses and inquiry-based methods into their teaching, whereas such practices are rare in other institutions. Moreover, the regular public high school lacks STEM applications, and the teaching strategies employed there are not suitable for STEM instruction. Currently, none of the schools fully implement STEM methodologies, and neither of them has a STEM curriculum that is completely aligned with the instructional strategies in use.

Inquiry-based learning, the integration of STEM into classroom instruction, and the use of STEM applications often rely heavily on the individual initiative of educators within the school system. This dependency is particularly evident in private high schools, where teachers tend to be more cautious. The reason lies in the structure of the IB Programme, which formally requires inquiry-based methods and student-centered pedagogies, thereby placing additional demands on teaching practices. Teachers at the science high school expressed a willingness to integrate STEM into their lessons; however, the university entrance examination poses a significant barrier, as 10th-grade students often prioritize exam preparation over exploring additional subjects. Conversely, teachers at the regular public high school showed little interest in implementing STEM education. Overall, the teaching methods employed are not conducive to STEM learning, primarily because Türkiye's national curriculum does not explicitly promote activities directly related to STEM. Additionally, teachers voiced concerns about the low academic levels of students and the limited time available for instruction.

The interviews revealed that some teachers were unfamiliar with the inquiry method, highlighting a more urgent need for teacher education than for STEM education in the country. As Vermunt (2014) points out, the processes of student learning and teacher learning are interconnected; the quality of teacher learning directly influences the quality of student learning. Therefore, it is essential to recognize that teacher learning, enabling educators to acquire new skills, is an ongoing process (Solheim et al., 2018).

**Domain 2.2 (STEM-centric Curriculum):** This domain examines the extent of STEM integration within courses, the existence of a STEM content curriculum, and the opportunities available for applying STEM concepts. While the regular public high school never integrated STEM subjects, the other schools rarely did. Furthermore, no school had a dedicated STEM curriculum. STEM was only partially incorporated into the private high school curriculum. Although the participating schools generally did not provide STEM applications for their students, they noted that the vocational high school and the private high school occasionally did. However, participants from the vocational high school reported that their students regularly went on field trips to manufacturing facilities and factories utilizing new technologies. Although the participants thought these trips allowed students to observe real-world applications of STEM fields, the curriculum did not include specific objectives linking the field trips to STEM education.

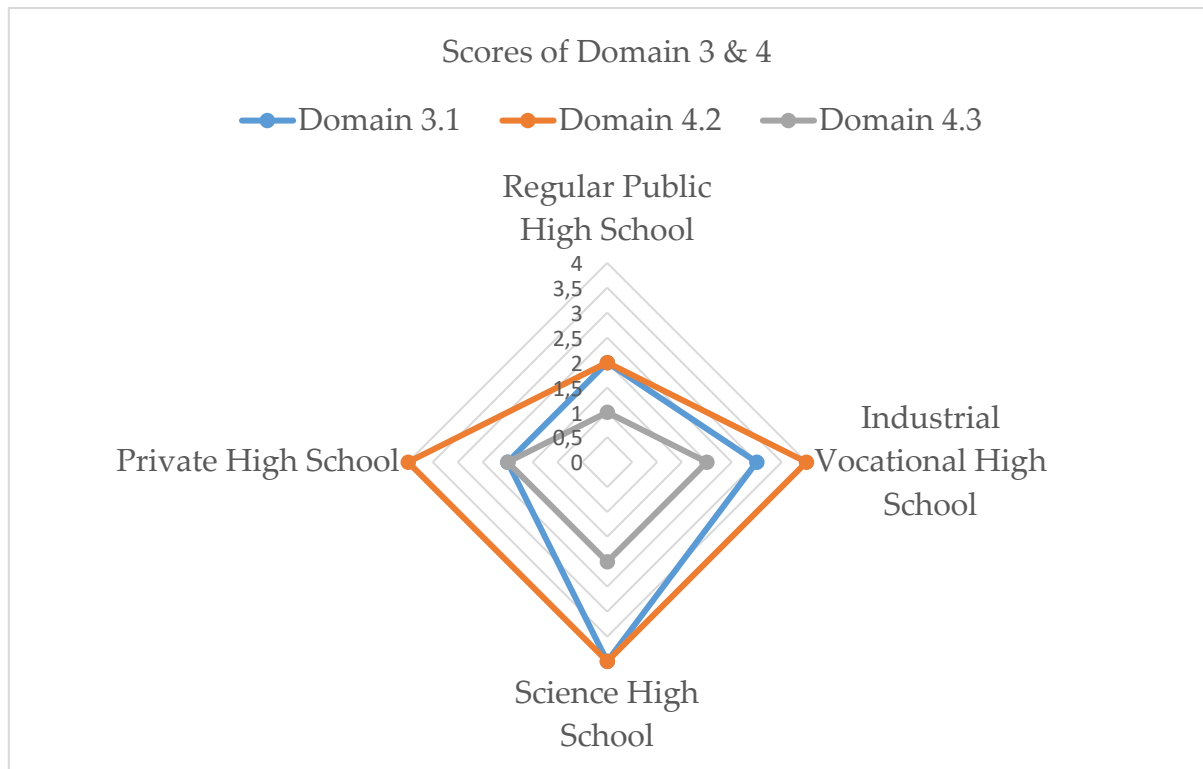
**Domain 2.3 (Authentic Assessment):** Based on the information gathered from the participants, authentic assessment was not used in any institution other than the private high school. As a result, the private high school received a score of 2 out of 4, whereas the other schools scored 1 out of 4. Authentic assessment enables students to apply their foundational knowledge and skills to real-world contexts, distinguishing it from traditional assessment methods (Mueller, 2008). Unfortunately, it must be acknowledged that the schools continue to employ outdated evaluation techniques such as multiple-choice exams, fill-in-the-blank items, true-false questions, and matching exercises. Once again, the IB Programme is the only one with policies that support the use of authentic assessment, albeit ineffectively.

**Domain 2.4 (Staff capacity):** An analysis of the staff capacity in this domain revealed that not all schools had teachers with the necessary experience or pedagogical understanding of STEM subjects. Furthermore, while some schools engaged in collaboration occasionally, neither the private high school nor the regular public high school collaborated on STEM-related issues. Additionally, the science high school provided teachers with the most frequent unplanned STEM support, whereas the regular public high school offered none at all.

Based on participant data, it was reported that teachers do not feel they possess sufficient academic knowledge of STEM education. Teachers at vocational high schools are open to teaching STEM subjects. Additionally, they stated that while administrators can provide some support in this area, it is insufficient on its own, and schools' physical environments must be adapted to accommodate STEM. However, there are no formal expectations or requirements for educators or administrators to develop their STEM competencies, and there is no organized dissemination of STEM knowledge within classrooms. Participants rely on their own motivation and individual efforts to sustain this process.

### **Results of Domain 3 (Strategic Partnerships)**

Based on the information gathered from the participants, the schools lacked strategic STEM partnerships with universities or companies, with the exception of the vocational high school and the science high school. Additionally, there was minimal collaboration with families on STEM initiatives and limited partnerships with other schools. Participants from the regular public high school indicated that parents' main concern is their children's performance on exams rather than their long-term futures, resulting in no educational push for STEM at the school due to a lack of family demand. Nonetheless, partnerships in education with families, universities, and colleges are essential for the advancement of STEM education.



**Figure 3.** Scores of Domain 3&4

#### *Results of Domain 4 (College and Career Readiness)*

The findings of the Planning Student Outreach and Access to STEM College and the Career Opportunities domains indicate that there were no resources available at the regular public high school and that only three schools offered opportunities for students to learn about STEM careers. In addition to the lack of opportunities, very few students were aware of STEM-related careers, and not a single student at the regular public high school knew about them. Lastly, although such initiatives were infrequent in other schools, students at the regular public high school were unable to receive support for future planning in STEM-related areas. Since the primary goal of the nation's education system is to prepare students for university entrance examinations, families and students tend to focus solely on academic achievement. Therefore, it is not surprising that career planning for STEM is either absent or severely limited within schools.

In the concluding section of the analysis, key statements were extracted from participants' responses. Subsequently, meaning units were developed from these significant statements, and these units were organized into broader themes. The themes identified in this study include the need for greater knowledge and awareness of STEM, the necessity of a STEM-integrated curriculum, the impact of university entrance exam anxiety as a barrier to STEM education, and the need for adequate budgets and resources to support STEM initiatives.

#### *Theme 1: The need for knowledge and awareness of STEM*

Based on the interview findings, it is evident that a significant number of participants have limited knowledge of STEM, with some possessing incomplete or inaccurate information. As a result, overall STEM awareness among participants remains considerably low. While some recognize STEM as a term, others perceive it as a process, a resource, or a novel concept. Therefore, it is crucial to establish a clear and consistent definition of STEM to ensure that educational institutions are adequately prepared to deliver STEM-oriented instruction.

Here are some quotes that reflect different perspectives on the definition of STEM:

*"I heard of STEM, but I haven't heard of STEM education." (T)*

*"STEM is something that many organizations do." (T)*

*"STEM is a learning method in the fields of science, technology, engineering and mathematics." (A)*

*"STEM means being interested in mathematics, physics, chemistry, biology and technology." (T)*

*"STEM is a system where all sciences are integrated." (T)*

*Theme 2: The need for STEM-integrated curriculum*

During the interviews, a recurring theme was the importance of incorporating STEM into the curriculum. By including STEM applications, teachers would have sufficient time to implement them effectively. Furthermore, integrating STEM into the curriculum would create a need for assessments and the establishment of evaluation units within schools. This would encourage students and parents to take STEM seriously, leading to increased interest in the subject.

Here are some quotes that highlight the need for a STEM-integrated curriculum:

*"As teachers, we have to follow a specific curriculum. So, the Ministry of National Education must prepare and plan a STEM curriculum to be integrated into teaching." (T)*

*"I don't think our education system is suitable for doing something directly related to STEM." (T)*

*"Here, there isn't enough time to encourage students to engage in STEM applications." (T)*

*"In order for unit and lesson plans to include STEM, a curriculum should be prepared for it." (A)*

*"The current curriculum is not suitable for STEM because it promotes an approach that encourages students to memorize." (T)*

*Theme 3: University exam anxiety is an obstacle for STEM*

A significant challenge hindering STEM education is the university entrance examination, according to the participants. Students in the 11th and 12th grades are particularly preoccupied with this exam, leaving little time for other activities. Furthermore, there appears to be minimal pressure from parents and students to prioritize STEM education. Nevertheless, the participants recognize STEM as a fresh and exciting field—a sentiment that resonates with nearly all individuals surveyed.

Some quotes about this theme are provided below:

*"After the 10th grade, our students prepare only for the university entrance exam. They are not interested in STEM because there are no STEM-related questions in the exam." (T)*

*"In order to be successful in STEM education, the examination system must be changed. Teachers and students should be motivated, and STEM-related goals should be made clear." (A)*

*"All students' lives revolve around exams. They just want to go to college." (T)*

*"Since the goal of the student is to be successful in the university entrance exam, the courses are taught as an information load." (T)*

*"The only thing parents want is for their children to have high grades and pass the university entrance exam." (A)*

#### Theme 4: The need for budget and materials for STEM

Another recurring theme that emerged from the interviews was the necessity of having a budget specifically allocated for STEM education. The participants emphasized that while schools may have adequate physical facilities, the feasibility of STEM programs depends on the availability of necessary resources, which can only be ensured through a dedicated STEM budget.

Some quotes from participants about this theme are presented below:

*“The school does not have the appropriate resources for STEM. There are no resources available for the students’ academic level.” (T)*

*“There are no materials we can use for mathematics at school.” (T)*

*“We lack equipment. We can find funds not from the school but from some foundations when it is necessary for projects. Teachers sometimes pay out of pocket to buy resources.” (A)*

*“There is no budget for direct STEM education. There is a budget for projects and experiments, but it is not sufficient for students’ needs.” (A)*

#### Summary of the Scores

The readiness level of the regular public high school is categorized as “emerging” with a total score of 30 points, although it is closer to the lower boundary of the “early” category. In contrast, the vocational high school also falls under the “emerging” category with a total score of 44 points, positioning it near the threshold of the “integrated” level. Both the science high school and the private high school are classified at the “integrated” level, with scores that are nearly identical. The overall scores of each school are illustrated in Figure 4 and Figure 5.

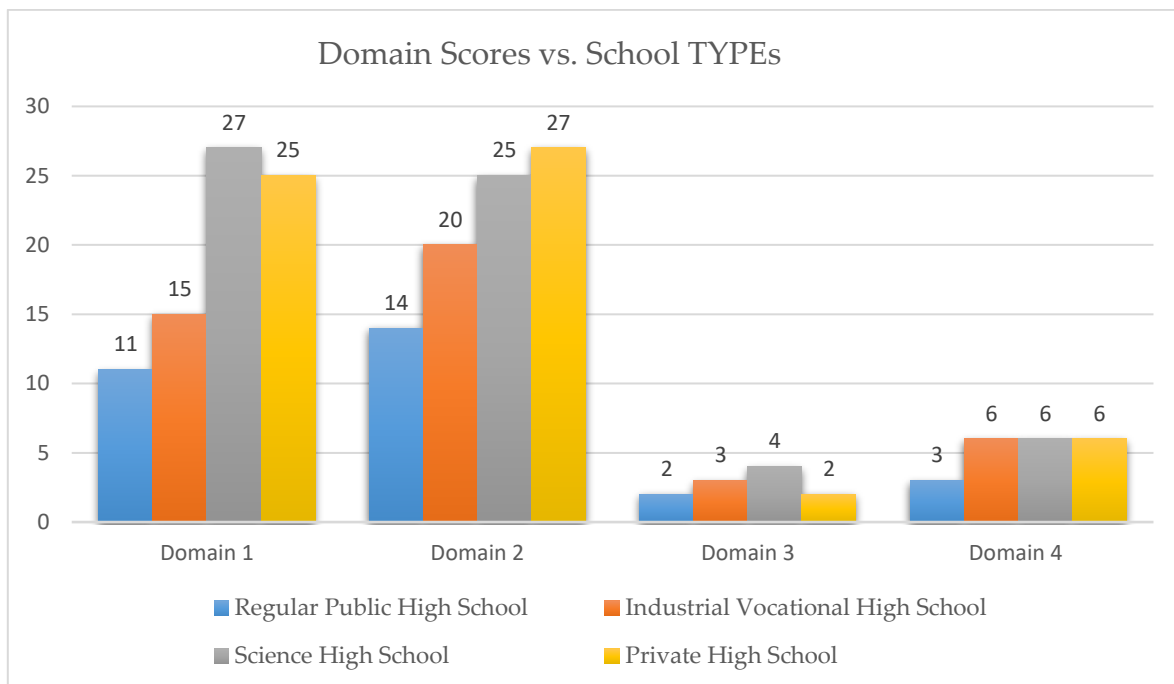


Figure 4. Domain Scores According to School Types

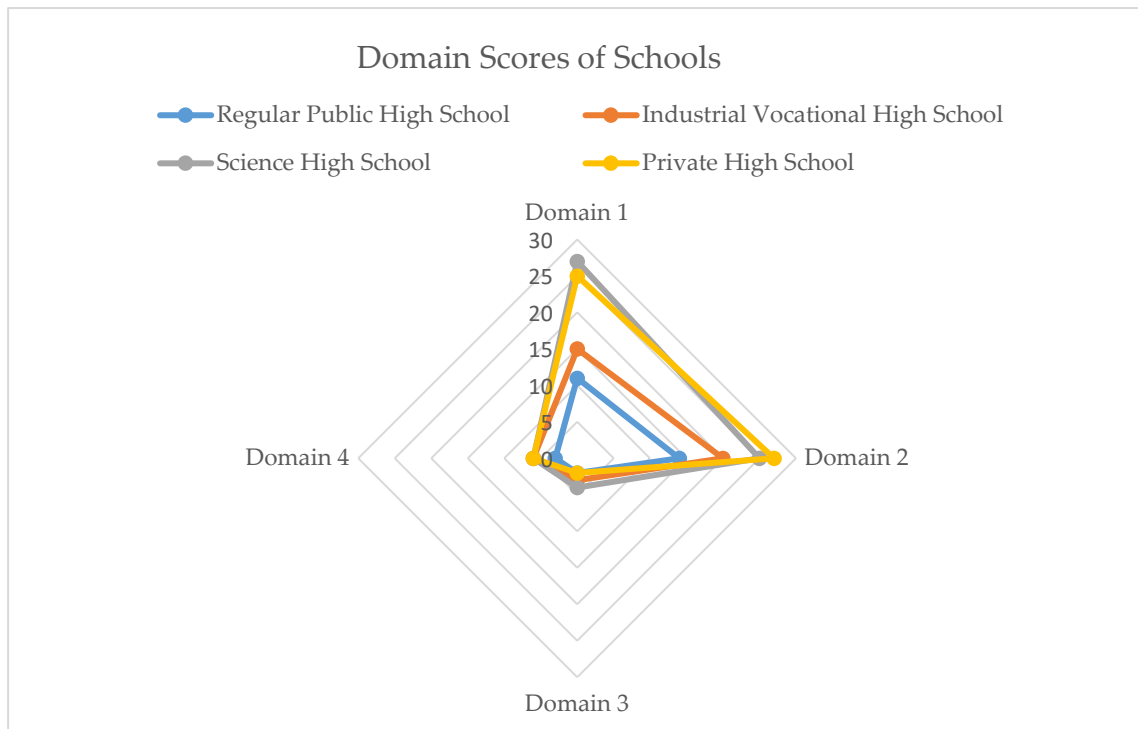


Figure 5. Summary of Results

### Discussion

The present study examined STEM education readiness across four types of high schools in Ankara, revealing significant institutional disparities in cultural, instructional, and structural capacities. Although some schools demonstrated promising characteristics, none reached the fully integrated level, and all exhibited context-specific challenges reflecting both systemic barriers and localized constraints. These findings indicate that readiness for STEM education is not a uniform construct but a multidimensional condition shaped by institutional culture, teacher capacity, and policy context. Therefore, efforts to enhance STEM readiness must address both the broader structural inequalities among school types and the specific needs that arise within each local context.

At the regular public high school and vocational high school, although the physical infrastructure, including classrooms and laboratories, was found to be broadly adequate, the school's overall readiness for STEM integration was significantly hindered by material constraints, low student and parent interest, a rigid exam-focused academic culture, and a notable lack of teacher motivation. These findings support the work of Marginson et al. (2013), who emphasize that successful STEM implementation requires not only adequate facilities but also strong institutional leadership, pedagogical vision, and stakeholder engagement. Additionally, the exam-oriented nature of the Turkish education system reflects broader challenges faced by many high-performing yet high-pressure academic contexts. Le et al. (2021) assert that assessment-driven cultures diminish opportunities for creative, hands-on learning and create disincentives for both teachers and students to engage in STEM. This pattern is compounded when stakeholders do not perceive STEM as relevant or valuable, as observed by Baharin et al. (2018), who link low community awareness of STEM's long-term utility to decreased motivation and participation. These insights underscore the importance of addressing both the cultural mindset and instructional conditions alongside physical readiness.

The private high school, benefiting from the structure of the International Baccalaureate (IB) Programme, appeared better prepared for STEM implementation. Teachers demonstrated familiarity with interdisciplinary methods, and the curriculum already included STEM-aligned objectives. However, challenges such as the limited number of IB-enrolled students and faculty, as well as the persistent pressure of the university entrance examination, hindered full institutional alignment. Stella (2020) similarly observed that even in pedagogically progressive environments, high-stakes testing contexts create misalignments between curriculum goals and actual classroom priorities. Consequently, students and teachers may deprioritize inquiry-based learning in favor of exam preparation, thereby weakening the effectiveness of otherwise well-designed STEM curricula.

The science high school, although not formally affiliated with an international curriculum such as the IB Programme, achieved the highest STEM readiness score, indicating a strong institutional vision and structural capacity. However, exam pressure remained the most frequently cited obstacle among participants. This aligns with Ghaleb's (2024) analysis of high-performing secondary schools, which found that the dominance of university entrance examinations often narrows the curriculum, discourages interdisciplinary learning, and fosters heightened anxiety that is counterproductive to authentic STEM engagement. While teacher motivation was comparatively higher in this school, the lack of systemic support to balance exam preparation with exploratory learning emerged as a limiting factor.

Across all four schools, the average readiness score of 49 out of 100 places them at the "emerging" level according to the rubric used. Although the science and private high schools demonstrate promising institutional characteristics, systemic issues such as the national exam system, fragmented teacher training, underdeveloped partnerships, and minimal stakeholder engagement continue to hinder the full-scale integration of STEM. These findings align with the conclusions of Schweingruber et al. (2014) and English (2016), who argue that STEM readiness should be understood not merely as a function of resources but as a dynamic construct shaped by cultural beliefs, professional development systems, and alignment with broader educational policies.

These findings also align with the study's theoretical framework, which conceptualizes readiness as a multidimensional construct shaped by institutional culture, teacher capacity, and systemic policies. Prior research in Türkiye has highlighted similar challenges: Asiroglu and Akran (2018) reported that while teachers felt moderately competent in integrating STEM, they lacked readiness in areas such as engineering practices, technology-supported instruction, and innovative assessment. Likewise, Dönmez and Gülen (2023) emphasized that although science curricula have been frequently updated, teacher training programs have not kept pace, resulting in a persistent gap between curricular expectations and classroom realities. From a policy perspective, these results underscore the need for systemic investment in professional development, stronger coordination between MoNE and CoHE, and reforms aimed at reducing the dominance of high-stakes testing. A limitation of the present study is its focus on four schools in Ankara, which constrains the generalizability of the findings. Nevertheless, the multiple-case design provides valuable insights into the systemic and institutional factors shaping STEM readiness across diverse school types.

## Conclusion

This study aimed to assess the readiness of four different types of high schools in Ankara to implement STEM education. The research was guided by the STEM Framework developed by the New York City Department of Education (NYCDOE, 2015), which emphasizes a holistic and interdisciplinary approach to science, technology, engineering, and mathematics. In line with global trends, Türkiye has become increasingly aware of the need to equip students with skills that foster innovation, problem-solving, and technological adaptability. Developing these competencies at the secondary school level is essential for preparing students to meet the demands of a rapidly changing world and for ensuring the country's long-term economic competitiveness.

Findings from the study revealed significant differences in readiness levels among the four school types. The regular public and vocational high schools demonstrated lower levels of preparedness, primarily due to inadequate resources, limited stakeholder awareness, low academic motivation, and the dominant influence of exam-oriented education. Teachers at these schools also reported limited engagement with STEM practices, often citing time constraints and the perceived difficulty of integrating STEM into the national curriculum. In contrast, the private and science high schools exhibited relatively higher levels of readiness, supported by more structured programs such as the International Baccalaureate (IB) Programme and stronger institutional visions. However, even in these schools, challenges such as exam pressure and the absence of a dedicated STEM curriculum remained significant barriers to full integration.

A key conclusion of the study is that readiness for STEM education cannot be achieved through infrastructure alone. It requires a combination of pedagogical, cultural, and systemic factors working together. Teacher capacity and training, clear curriculum alignment, administrative support, and collaboration among school stakeholders all play critical roles. Moreover, the widespread exam-oriented culture continues to hinder creativity, inquiry, and project-based learning opportunities that are central to effective STEM education. For meaningful progress to occur, there must be a shift in both mindset and practice across the education system.

To advance STEM integration, schools should no longer treat it as a supplementary program or an occasional enrichment activity. Instead, it should be viewed as a central component of the curriculum that supports interdisciplinary learning across subject areas. This transition requires concrete steps, including curriculum reform, investments in teacher professional development, improved resource allocation, and increased engagement with families and local communities. Efforts should also focus on raising awareness among all stakeholders about the long-term value of STEM for students' futures and the nation's development. A unified and collaborative approach will increase the likelihood of successful implementation.

In summary, although the current average readiness level of Ankara's high schools is classified as "emerging," there is strong potential for improvement if systemic barriers are addressed. The insights gained from this research provide a valuable foundation for future planning, policy-making, and school-level reform efforts. With coordinated action and a commitment to long-term development, high schools in Türkiye can make meaningful progress in STEM education. In doing so, they will not only better prepare students for 21st-century careers but also strengthen the country's innovation capacity and global competitiveness.

### Suggestions

The research aimed to assess the readiness of high schools for STEM education, with the potential to broaden future studies to include preschool, primary, secondary, and higher education institutions. The evaluation in this study was based on interviews with teachers and administrators, and future research could expand to include students and parents. Additionally, the findings from this study can serve as a valuable reference for future STEM reports, and the revised STEM framework may be applied in subsequent investigations.

This research has provided a comprehensive overview of high schools' readiness levels; however, future studies could examine additional factors such as teachers' age, gender, and families' socioeconomic status that may influence preparedness. Moreover, the findings suggest that high schools in Ankara are not yet adequately equipped for STEM education. Teachers' feedback highlights the need for curriculum developers to design an integrated STEM curriculum for high schools that includes specific objectives such as algorithm creation, machine construction, or model design.

To evaluate the effectiveness of STEM initiatives, higher authorities could conduct systematic assessments of schools implementing these programs. Additionally, to help schools obtain affordable and accessible instructional materials, such resources could be developed and made available for purchase. Finally, seminars and workshops could be organized to inform families about the importance of STEM education and to foster greater community interest and engagement.

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