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Analyzing 5th Grade Science Textbook Activities in Light of the Turkish Century Education Model: A STEM and Design Thinking Perspective

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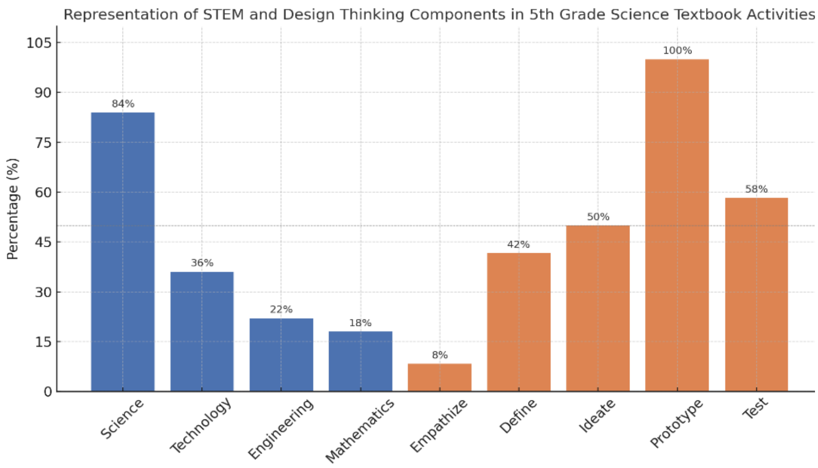
Graphical Abstract



Abstract

This study examined how the activities in the 5th grade Science textbook, updated within the Turkish Century Education Model (TCEM), were structured in terms of STEM education and the Design Thinking (DT) approach. Using document analysis, the 2024 Science textbook published by the Ministry of National Education was analyzed. Fifty activities were evaluated based on the four STEM components (science, technology, engineering, mathematics) and five DT stages (empathy, define, ideate, prototype, test).
Findings showed that the activities were mostly science-focused, while technology, engineering, and mathematics were less represented. About half of the activities involved some DT stages, yet creative production phases such as ideation, prototyping, and testing were limited. Only 40% of the activities included both STEM and DT components.
The qualitative analysis indicated that most activities emphasized observation and information gathering rather than creative thinking or problem-solving. This suggests that the TCEM's vision of raising productive and versatile individuals is only partially reflected in the textbook. It is recommended that textbook activities be redesigned to more fully integrate STEM and DT approaches, providing students with interdisciplinary, student-centered, and production-oriented learning experiences which support 21st-century skills.
Key words: STEM Education, Design Thinking, Science Textbook.

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Intoduction

The dynamic structure of the twenty-first century expects individuals not only to access information but also to make sense of this information, transform it into creative solutions and become productive individuals (Saavedra & Opfer, 2012; Trilling & Fadel, 2009). This change necessitates the restructuring of education systems. Today, the main purpose of learning processes is to move away from rote learning and to equip students with multifaceted skills such as critical thinking, problem solving, communication, collaboration and creativity (OECD, 2018). The importance of interdisciplinary integrated approaches in gaining these skills is increasing.

In this context, STEM (Science, Technology, Engineering, Mathematics) education and Design Thinking (DT) approach have become central to contemporary education. STEM education supports students' integrated learning of science, technology, engineering and mathematics disciplines through tasks associated with real-life problems (Yıldırım, 2016). STEM aims at not only scientific knowledge but also the operationalization of this knowledge through technology and engineering. In addition, the design thinking process integrated into STEM is a creative and innovative learning cycle which enables students to empathically define a problem, develop original solutions, and embody the solution by creating prototypes (Razzouk & Shute, 2012; Sarıkoç & Ersoy; 2022).

Design-based thinking (DT) has gained prominence as a transformative pedagogical approach in STEM education, offering a human-centered, iterative problem-solving framework which that fosters creativity, empathy, collaboration, and innovation (Brown, 2009). Rooted in constructivist and experiential learning theories, DT bridges engineering designs with real-world problem contexts, aligning well with 21st-century learning goals. Its core cycle—empathize, define, ideate, prototype, and test—guides students through authentic learning experiences which that promote deeper engagement and interdisciplinary thinking. Numerous studies underscore DT's educational value: Goldman et al. (2014) illustrated its effectiveness in the "Dive In!" curriculum, where students addressed water-related community issues through iterative design, Mahil (2016) demonstrated its scalability, and Frear and Fillip (2019) highlighted positive student outcomes from immersive DT workshops. The DT approach has the power to unleash the creative potential of the individual, especially in student-centered learning environments. The role of DT in education should be considered not only as a method but also as a pedagogical stance towards building a productive, creative and collaborative learning culture (Plattner et al., 2011; Öztürk, 2021).

In this context, it is seen that STEM and STEM-based education practices have become widespread at various levels and have been the subject of research in Turkey in recent years. The studies such as Güneş Varol (2020), Kavacık (2019), and Şen (2018) show that design-based STEM activities make significant contributions to students' academic achievement, inquiry skills, and interest in STEM professions. Similarly, studies conducted by Sarıkoç and Ersoy (2022) emphasize that the DT approach enables more effective and meaningful learning experiences when integrated with STEM.

The most prominent reflection of this holistic approach at the institutional level was the Turkish Century Education Model (TCEM) introduced by the Ministry of National Education in 2023. The TCEM aims to restructure not only curricula but also educational philosophy, learning experiences, measurement and evaluation approaches, and material design processes (MoNE, 2023). The model aims to transforming the individual into a "virtuous, competent and productive" individual by taking into account his/her mental, social, cultural and moral development. In this framework, the TCEM proposes that learning processes should be built with structures which support creative thinking, problem solving and multidisciplinary work.

Within the scope of TCEM, updated curricula and textbooks have been put into practice at the 1st, 5th and 9th grade levels as of the 2024-2025 academic year. Science, in particular, is one of the areas where the most tangible reflections of the transformation targeted by TCEM can be seen due to its scientific knowledge and practical nature. This course offers many learning environments where students can actively participate in STEM and DT processes (Demirezen, 2024). The type, purpose, content, and pedagogical structure of the activities in the textbooks are important sources of data to understand the extent to which students can be involved in these processes.

Although recent studies have emphasized the importance of STEM and Design Thinking (DT) in education and explored their classroom implementations (Sarıkoç & Ersoy, 2022), there remains a significant gap in evaluating how these approaches are reflected in official curricular materials, particularly in the context of recent national reforms. The Turkish Century Education Model (TCEM), introduced in 2023, marks a major shift in educational philosophy, emphasizing creativity, production, and interdisciplinary learning. However, resources revealing the extent to which these principles are operationalized within the structure of newly developed textbooks are limited. This study addresses this gap by systematically analyzing the activities in the 5th grade Science textbook—one of the first educational materials designed in line with TCEM. To the best of our knowledge, this research represents one of the first attempts to evaluate the implementation of TCEM through textbook content analysis from a STEM and Design Thinking perspective. In doing so, it offers original insights into how policy-level transformations are (or are not) concretely translated into classroom learning experiences.

The main purpose of this study is to analyze the activities in the 5th grade Science textbook, which was updated within the scope of the Turkish Century Education Model in the context of STEM education and Design Thinking (DT) approach. The study aims to reveal to what extent the activities offer integrated interdisciplinary learning opportunities, whether they support students' 21st century skills (creativity, collaboration, problem solving, computational thinking, etc.), and whether they reflect the pedagogical transformation envisaged by the TCEM at the textbook level.

In particular, considering the four basic components of STEM (science, technology, engineering, mathematics) and the five stages of DT (empathizing, defining the problem, generating ideas, prototyping, and testing), whether the activities are structured within this framework will be evaluated through content analysis. The question "Does the textbook focus only on knowledge transfer or does it offer a student-centered and production-based learning environment?" is regarded as the main starting point.

In line with the main objective of the research, answers to the following questions will be sought:

1. How often and in what way do the activities in the 5th grade Science textbook, which was updated within the scope of TCEM, include STEM components (science, technology, engineering, mathematics)?
2. Which stages of the Design Thinking approach (empathy, identification, idea generation, prototyping, testing) are included in the activities?
3. What is the proportion of activities which include STEM and DT components together and what are the characteristics of these activities?

4. How is TCC's vision of transforming learning experiences reflected in textbook activities?

Methods

This research was conducted with document analysis method, one of the qualitative research designs. Document analysis is a data collection and analysis process based on the systematic examination of written materials (Yıldırım & Şimşek, 2018). In the study, the activities in the 5th grade Science textbook, which was updated within the scope of the Turkish Century Education Model, were analyzed in line with STEM education and Design Thinking (DT) approaches. This method was regarded to be appropriate for evaluating how the pedagogical and structural approaches of the TCEM are reflected in teaching materials.

Data Source

The main data source of the study is the 5th grade Science textbook prepared and published by the Ministry of National Education in 2024 in line with the TCEM and put into practice as of the 2024-2025 academic year. All units and activities in the book were analyzed; not only the information texts but also the activity instructions and experiment suggestions directed to the students were included in the scope of the analysis.

Data Collection Process

All activities in the textbook were evaluated in terms of DT stages (empathy, identification, idea generation, prototyping, testing) and STEM components (science, technology, engineering, mathematics).

Data Analysis

The collected data were analyzed using descriptive and content analysis methods. In the content analysis process, themes aligned with the research questions—namely the components of STEM (science, technology, engineering, mathematics) and the stages of the Design Thinking (DT) approach (empathizing, defining the problem, idea generation, prototyping, and testing)—were determined in advance. Each activity in the 5th grade Science textbook was then systematically coded based on these themes. For example, the activity titled “Designing a Thermal Insulation Experimental Set” was coded as involving all four STEM components (S, T, E, M) and four DT stages (defining, idea generation, prototyping, testing), as it required students to develop a hypothesis, design a solution using insulation materials, build a prototype, and test its effectiveness. These codes were entered into a structured Excel matrix, including fields for activity title, description, STEM/DT representation, and relevant 21st century skills (e.g., problem-solving, creativity).

To ensure the reliability of the coding process, two researchers with doctoral degrees in science education—who were not involved in the study—coded the data independently. The intercoder reliability was then calculated by comparing the two sets of codes using percentage agreement, resulting in a consensus rate of 0.88, which is considered high and indicates strong consistency between coders (Miles et al., 2014).

Ethical Considerations

Since the study involved document analysis of an openly accessible and publicly available 5th grade Science textbook published by the Ministry of National Education, no ethical approval was required. However, all procedures adhered to research ethics principles regarding responsible use, citation of sources, and accurate representation of official documents. The study did not involve human participants or sensitive data.

Limitations

This study is limited to the analysis of a single grade level (5th grade) and a single subject (Science), which may restrict the generalizability of the findings to other levels or disciplines within the TCEM framework. Additionally, although a coding guideline was developed and intercoder reliability was calculated, the interpretation of the presence and depth of STEM and Design Thinking components may still reflect some degree of subjectivity due to the qualitative nature of the study.

Findings

In this section, the activities in the 5th grade Science textbook prepared within the scope of the Turkish Century Education Model were analyzed in terms of STEM components and Design Thinking (DT) stages. The 50 activities in the Excel spreadsheet were evaluated by content analysis method and the following findings were obtained.

A visual summary of the presence of STEM and Design Thinking components across activities is provided in the heatmap below. Each row represents a textbook activity, and each column represents a specific component. The intensity of the color indicates whether the component is included (darker shades) or absent (lighter shades).

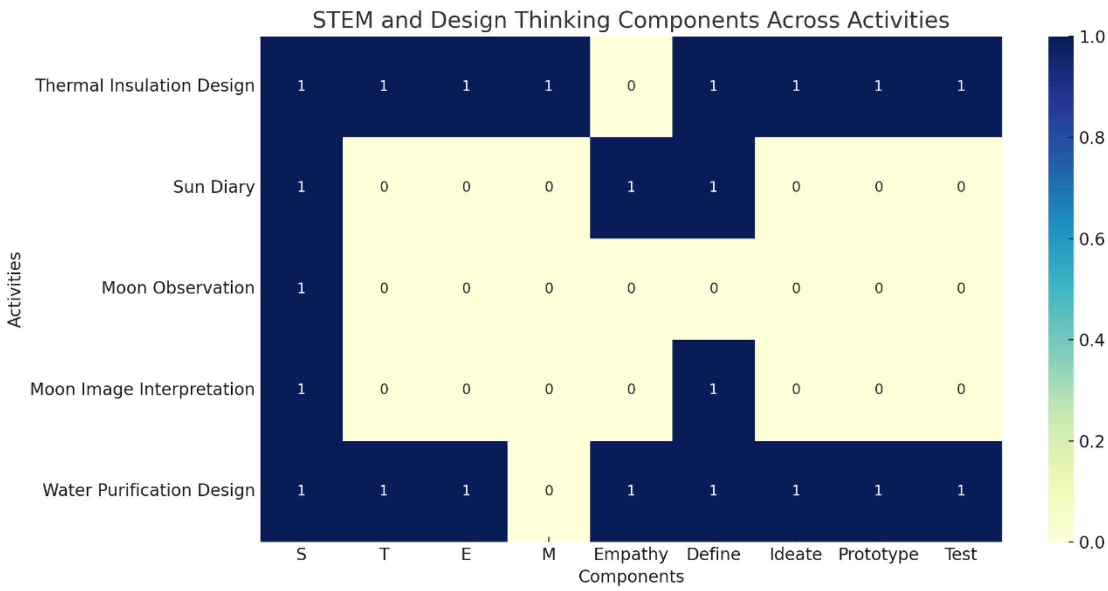

Figure 1. Heatmap showing the distribution of STEM and DT components across textbook activities

The inclusion of STEM components in the total activities in the book is presented in the table.

Table 1. Distribution of STEM Components

STEM Component	**Number of Events**	**Rate (%)**
Science	42	%84
Technology	18	%36
Engineering	11	%22
Mathematics	9	%18

Only three activities were found that included all STEM components. One of these activities, "Designing a Thermal Insulation Experimental Set", asks students to both develop a hypothesis about heat transfer and design a prototype by choosing an insulation material. In this process, students are expected to calculate heat loss, consider engineering principles and test the design. The low number of such integrated activities indicates that the "application and production" aspect of STEM is not adequately represented in the book.

These data show that the activities in the book are largely science-oriented; however, engineering and mathematics disciplines are represented at a limited level. Although STEM is considered as an integrated structure, in practice it is seen to be more science-oriented. TCEM suggests that learning processes should not only be based on accessing information, but also on production-oriented, collaborative and solution-oriented learning (MoNE, 2023). However, as seen in the table, science-intensive activities mostly remain at the level of making observations and drawing conclusions, and the active productive role of the student remains limited. This finding suggests that the textbook is still close to the "traditional science education + STEM label" formula; it is not integrated with all components of STEM and design-oriented processes. However, the expectation today is that students should not only observe the phase of the Moon, but also model, question, develop solutions and reflect on it.

The activities were evaluated separately within the framework of the five stages of the DT approach. The results are presented in the table below.

Table 2. Representation of Design Thinking Stages in Activities

TOD Phase	Number of Events Including	Rate (%)
Empathize	1	%8,33
Defining the problem	5	%41,66
Idea generation	6	%49,98
Prototyping	12	%100
Testing	7	%58,31
Total containing DT	12	%100

The Design Thinking (DT) approach is a five-stage process which that aims at developing students' creative problem solving skills: empathizing, defining the problem, generating ideas, prototyping and testing (Öztürk, 2020). Each of these stages supports students' active participation in the learning process and their creative potential. However, as a result of the analysis, it is seen that the level of representation of the activities in these stages is uneven.

When Table 2 is analyzed, it is seen that all of the 12 activities in the book include the prototyping phase (100%). This shows that students had the opportunity to transform their ideas into concrete products. However, the testing phase, which should accompany the production process, is included in only 7 activities and is represented by 58.31%. This indicates that student products were not sufficiently included in the process of receiving feedback and improvement.

On the other hand, the idea generation stage was included in 6 activities (49.98%) and the problem identification stage in 5 activities (41.66%). These two stages are the basic building blocks of creative thinking and solution-oriented approach. However, the rates show that these stages are included in less than half of the activities in the book. The empathizing stage is included in only one activity and is represented at a very low rate of 8.33%. This shows that students are not sufficiently involved in the processes of understanding user needs and developing human-centered solutions.

Overall, only half of the activities in the book include at least one of the Design Thinking stages. While the most intensive stages are the practical sections such as "prototyping" and "testing", critical cognitive stages such as empathizing and defining the problem, which constitute the beginning of the process, are represented at a limited level. This shows that the activities only provide students with the opportunity to develop products; however, they do not fully support DT and STEM processes. It is important that all stages are represented in a balanced way in order for the DT approach to be applied holistically.

The heatmap below visualizes how frequently each STEM component overlaps with the Design Thinking stages. Prototyping and science components show the highest levels of co-occurrence, whereas empathy and mathematics rarely intersect. This visualization offers insight into the depth and integration of interdisciplinary elements within the analyzed activities.

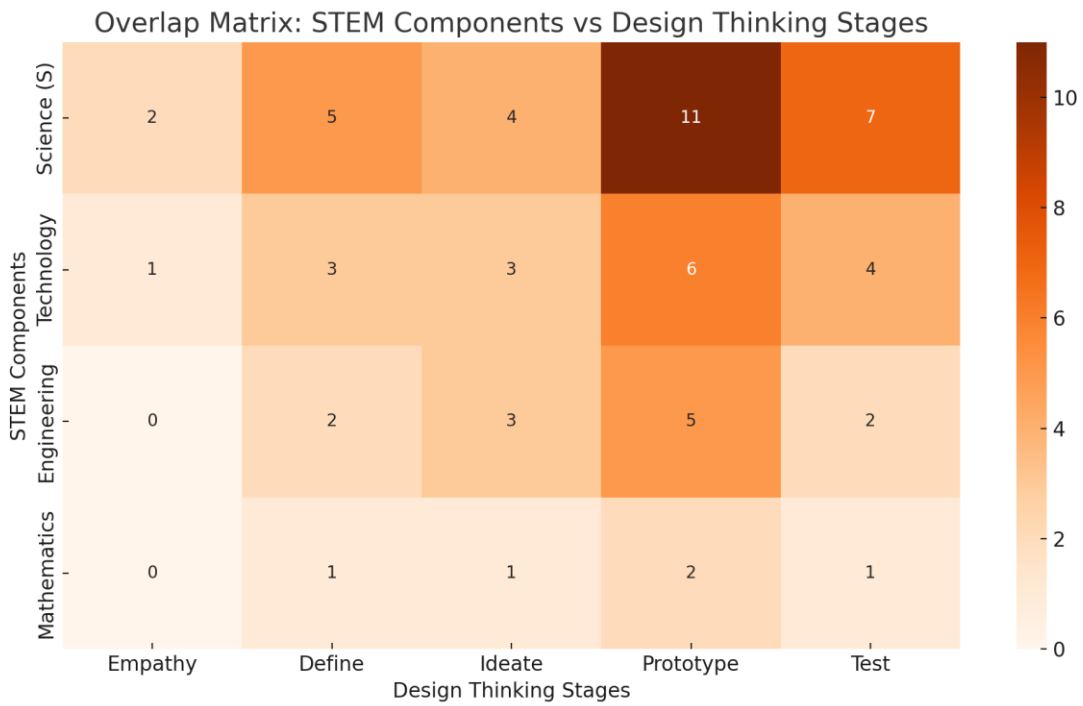

Figure 2. Heatmap showing the distribution of STEM and DT components across textbook activities

As seen in the visual below, the presence of STEM and Design Thinking components across all activities varies significantly. While science and prototyping stages are dominant, empathy and mathematical modeling are relatively rare.

Some activities in the 5th grade Science textbook prepared within the scope of the Turkish Century Education Model (TCEM) were analyzed qualitatively. The selected examples were analyzed multi-dimensionality in terms of the structure of the activity, its content, the skills it includes, and its relationship with STEM and Design Thinking (DT) approaches.

In the first activity, "Sun Diary", students are expected to observe the position of the sun throughout the day and record their observations in a diary format. This activity supports observation and data recording skills in accordance with the discipline of science, and partially serves the learning philosophy of TCEM based on establishing a relationship with nature. However, the student is not a knowledge producer here, but only an information collector. Although the empathy and identification stages of DT are partially represented, production-oriented stages such as generating ideas, prototyping or testing are not integrated into the activity. If students had been asked to design a model of solar motion based on these observations, the learning process could have been more functional in terms of both the DT approach and the engineering component of STEM.

In the similarly analyzed "Moon Observation" activity, students observe the phases of the Moon for a week and record the changes. This activity also has a strong science foundation. Students develop systematic data collection and observation skills; however, they are not involved in an active production process. In terms of DT, this activity does not reflect any stage. However, if this activity had been presented to students with tasks such as writing a creative story about the phases of the Moon, producing an animation, or designing a three-dimensional model, it could have provided a much more appropriate experience in terms of both creativity and productivity in line with the student profile objectives of the TCEM.

The third activity, "Analyzing Moon Images", presents students with images of different phases of the Moon and asks them to interpret these images. This activity is structured to develop skills such as visual reading, analysis and comparison. While it contains a limited connection with science in terms of STEM, it can be said that it indirectly touches the identification stage of DT. However, there is no production process or creative solution development step. If this activity had been supported with tasks such as designing infographics or preparing digital presentations after analyzing the visuals, a much richer learning environment could have been provided.

The analysis of these three examples shows that the activities in the book are generally structured at the level of making observations, recording data and drawing conclusions. This structure, in which students are positioned as observers and repeaters rather than constructors of knowledge, is in partial harmony with the vision of TCEM. However, the lack of components of DT which make students producers such as generating ideas, prototyping and testing limits the depth of the activities. In terms of STEM, although the science component is strongly represented, engineering and technology disciplines are not sufficiently integrated.

In conclusion, it can be said that in order for the activities to be fully in line with the goal of "virtuous, competent and productive individuals" envisaged by the TCEM, they should be reconstructed with structures which include problem solving, creative thinking, production and reflection processes, rather than being based solely on acquiring knowledge.

Conclusions and Discussions

Within the scope of this study, the activities in the 5th grade Science textbook prepared in line with the Turkish Century Education Model (TCEM) were analyzed in terms of STEM education and Design Thinking (DT) approach. The findings show that the goal of raising productive, competent and versatile individuals, which is included in the vision of the TCEM, is partially reflected in the textbook activities; DT and STEM are not fully integrated.

The vast majority of the activities in the book are science-oriented. Engineering, technology and mathematics, the other components of STEM, are represented at a very limited level. This situation contradicts the interdisciplinary nature of STEM and limits the participation of learners in the processes of production, application and solution development (Corlu et al., 2014). STEM requires not only science-based learning, but also the operationalization of this knowledge through technology, embodiment through engineering, and modeling through mathematical thinking. However, this holistic structure is not fully established in the current textbook structure (Kavacık, 2019; Yücel & Karamustafaoğlu, 2020). Learning scenarios in which STEM and DT are structured in an integrated way provide students with opportunities not only to acquire knowledge but also to make sense of this knowledge and transform it into practice. When the process which starts with the empathy and idea generation steps of DT is reinforced with the engineering and mathematics components of STEM, students can become individuals with both technical knowledge and creative problem solving skills. Such learning environments enable students to assume the role of active producers rather than mere observers (Becker & Mentzer, 2015; Öztürk, 2020). At this point, the necessity of adding daily life problems is seen as important (İncikabı & Tjoe, 2013).

The findings also show that about half of the activities included certain stages of DT, but production-oriented stages such as generating ideas, prototyping and testing were very limited. Creative problem solving and user-oriented design development processes, which are one of the strengths of DT, were not observed in the book activities. However, design thinking provides a strong basis for students to be not only observers but also creative producers (Razzouk & Shute, 2012; Avcu & Er, 2020; Chang et al., 2023). In this context, it can be said that DT should be integrated more consciously and systematically into the book content.

Many activities included only STEM or only DT components. Considering the holistic learning experiences recommended by the TCEM, this disconnected structure may limit students' ability to develop systematic solutions to real-life problems. Chang et al. (2023) showed that the integrated implementation of DT and STEM had positive effects on student creativity, computational thinking, and motivation. In this context, textbooks should be enriched with meaningful and design-based learning scenarios, not just representative STEM examples (Şen, 2018; Sarıkoç & Ersoy, 2022). This need becomes even more apparent when considering international best practices. Several countries have successfully integrated STEM education with design thinking to promote creativity, problem-solving, and student-centered learning. For example, Singapore's Applied Learning Programme incorporates design thinking into STEM activities to foster experiential and innovation-driven learning (Zhan & Niu, 2023). In Finland, the LUMA Centre initiatives offer interdisciplinary, project-based STEM environments that embed empathy and iterative prototyping (Tawbush et al., 2020). Likewise, Germany's Siemens Stiftung project highlights how global cooperation and design-based education enhance student engagement with real-world challenges (Siemens Stiftung, n.d.). Compared to these cases, the Turkish 5th grade science textbook demonstrates relatively limited integration of early-stage design thinking components—particularly empathizing and ideation—despite the strong visionary emphasis of the TCEM. This contrast suggests a need to further align Turkish instructional materials with internationally recognized models of integrated STEM and Design Thinking education. In particular, it supports the conclusion that the fact that our teachers have pedagogical knowledge only in their own fields of specialization is insufficient to train the qualified human resources which our country needs (Çorlu et al., 2014).

Considering the "virtuous, competent and productive individual" goal of the TCEM, it is seen that the activities in the book are mostly based on traditional teaching methods such as observing, collecting information and drawing conclusions; however, cognitive high-level processes such as productivity, creativity and generating solutions are not sufficiently structured. Contemporary approaches such as STEM and DT enable students to experience a learning process based on both academic success and social contribution (Demirezen, 2024; Güneş Varol, 2020). From this point of view, the transformation brought about by TCEM should be realized holistically not only at the curriculum level but also at the level of textbook and activity design.

As a result of this study, the following recommendations can be put forward:

- Textbook activities should include not only science-based knowledge transfer, but also multidimensional and real-life learning scenarios that include all components of STEM.
- The DT approach should not be limited to cognitive processes such as identification and idea generation; it should also be integrated into activity designs to include practical phases such as prototyping and testing.
- Students should be presented with open-ended, design-based tasks that build skills such as creative thinking, production, modeling and reflection.
- The number of activities which that support interdisciplinary learning, in which STEM and DT are structured together, should be increased and these processes should be planned to serve the individual profile targeted by TCEM.

These suggestions can contribute to the more concrete and effective realization of the transformation targeted by TCEM in teaching materials. Future studies can comparatively reveal the reflections of TCEM at the implementation level through similar analyses in different grade levels and courses.

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Conflict of Interest Statement

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Summary of Contribution Rate Declaration of Researchers

The authors declare that they have contributed equally to the conception, design, data analysis, and writing of this article.

References

Avcu, Y. E., & Er, K. O. (2020). Design Thinking Applications in Teaching Programming to Gifted Students. *Journal of Educational Technology and Online Learning*, 3(1), 1-30. https://doi.org/10.31681/jetol.671621

Becker, K., & Mentzer, N. (2015, September). Engineering design thinking: High school students' performance and knowledge. In 2015 International conference on interactive collaborative learning (ICL) (pp. 5-12). IEEE.

Brown, T. (2009). *Change by design: How design thinking transforms organizations and inspires innovation.* Harper Business.

Chang, C.Y., Du, Z., Kuo, H. C., & Chang, C.C. (2023). Investigating the Impact of Design Thinking-Based STEAM PBL on Students' Creativity and Computational Thinking. *IEEE Transactions on Education*, 66(6), 673-681.

Corlu, M. S., Capraro, R. M., & Capraro, M. M. (2014). Introducing STEM education: Implications for educating our teachers for the age of innovation. *Education & Science/Egitim ve Bilim*, 39(171).

Demirezen, S. (2024). *The effect of design-based STEM activities provided with distance education on the development of 21 st century skills* (Doctoral dissertation, Gazi University, Institute of Educational Sciences). Ankara.

Frear, L., & Fillip, C. (2019). Delvıng into desıgn: Using design thinking in Stem curriculum envıronments. In ICERI2019 Proceedings (pp. 9226-9226). IATED.

Goldman, S., Carroll, M., Zielezinski, M. B., Loh, A., Ng, E. S., & Bachas-Daunert, S. (2014, June). Dive in! An integrated design thinking/STEM curriculum. *In 2014 ASEE Annual Conference & Exposition* (pp. 24-440).

Güneş Varol, D. (2020**).** *Determining the effect of design based STEM education activities on academic success of middle school 7th grade students, attitudes towards STEM and stem profession* (Master's thesis, Fırat University, Institute of Educational Sciences). Elazığ.

İncikabı, L., & Tjoe, H. (2013). A Comparative Analysis of Ratio and Proportion Problems inTurkish and the U.S. Middle School Mathematics Textbooks. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, 14(1), 1-15.

Kavacık, İ. (2019). *The effect of science, technology, engineering and mathematics (STEM) applications; On students' learning approaches, inquiry learning skills perceptions and attitudes towards STEM* (Master's thesis, Mersin University, Graduate School of Educational Sciences). Mersin.

Mahil, S. (2016). Fostering STEM+ education: improve design thinking skills, 2016 IEEE Glob. Eng. Educ. Conf. (2016) 125–129.

Miles, M. B. & Huberman, A. M. (1994). Qualitative Data Analysis: An Expanded Sourcebook. Sage.

MONE. (2023). *Turkey Century Education Model Presentation Book*. Ankara: Ministry of National Education Publications.

OECD. (2018). *The Future of Education and Skills: Education 2030*. OECD Publishing

Öztürk, A. (2020). Co-developing STEM activities through design thinking approach for fifth graders. Unpublished Doctoral dissertation), Middle East Technical University, Ankara.

Öztürk, A. (2021). Meeting the Challenges of STEM Education in K-12 Education through Design *Thinking. Design and Technology Education, 26*(1), 70-88.

Plattner, H., Meinel, C., & Leifer, L. (Eds.). (2012). *Design thinking research*. Berlin: Springer.

Razzouk, R., & Shute, V. (2012). What is design thinking and why is it important?. Review of educational research, 82(3), 330-348.

Saavedra, A. R., & Opfer, V. D. (2012). Learning 21st-century skills requires 21st-century teaching. *Phi Delta Kappan*, 94(2), 8–13.

Sarıkoç, Z., & Ersoy, H. (2022). Tasarım Odaklı Düşünme Yaklaşımıyla STEM Uygulamaları: SPAM eTwinning Projesi Örneği. *Fen Matematik Girişimcilik Ve Teknoloji Eğitimi Dergisi*, 5(2), 98-122.

Siemens Stiftung. (n.d.). *Design Thinking in STEM: Education project combining STEM education with design-based education*. Retrieved from https://sdgs.un.org/partnerships/design-thinking-stem-education-project-combining-stem-education-design-based-education

Şen, C. (2018). Skills used by gifted and talented students in integrated STEM activities based on engineering design. Doctoral Dissertation, Ankara University, Institute of Educational Sciences.

Tawbush, R. L., Stanley, S. D., Campbell, T. G., & Webb, M. A. (2020). International comparison of K-12 STEM teaching practices. *Journal of Research in Innovative Teaching & Learning*, 13(1), 115-128.

Trilling, B., & Fadel, C. (2009). 21st century skills: Learning for life in our times. John Wiley & Sons.

Yildirim, B. (2016). An Analyses and Meta-Synthesis of Research on STEM Education. *Journal of Education and Practice*, 7(34), 23-33.

Yıldırım, A., & Şimşek, H. (2018). *Qualitative research methods in social sciences* (11th edition). Seçkin Publishing.

Yücel, M., & Karamustafaoğlu, S. (2020). Ortaokul 5. ve 6. sınıf fen bilimleri ders kitapları hakkında öğretmen görüşleri. *Amasya Üniversitesi Eğitim Fakültesi Dergisi*, 9(1), 93-120.

Zhan, Z., & Niu, S. (2023). Subject integration and theme evolution of STEM education in K-12 and higher education research. *Humanities and Social Sciences Communications*, 10(1), 1-13.