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Design Thinking in educational publications: A document analysis of books issued by Turkish Public Institutions and implications for the Technology and Design course *

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Abstract

This research aims to investigate how the design thinking (DT) approach in education is defined and implemented in related books published by public institutions in Türkiye. The document analysis method, a qualitative research method, was used for data collection and analysis. Seven books published by the Republic of Türkiye Ministry of National Education (MONE) and the Scientific and Technological Research Council of Türkiye (TÜBİTAK) were selected as the data. Findings indicate that DT is perceived as a human-centered and interdisciplinary problem-solving process that requires a set of skills and mindsets and incorporates some values associated with 21st-century skills. In the books, the matter of how to develop a designer's mindset and skills in non-designers – teachers and students – is generally overlooked or under-emphasized. Therefore, the DT approach in education is not comprehended and practiced as a holistic approach that requires the interaction between relevant processes, mindsets, and tools. Considering the findings, incorporating the human-centered, experimental, and collaborative characteristics of the DT approach into the educational culture or teaching method can help teachers and students to adopt DT as a holistic approach rather than just a problem-solving process. The DT approach can also be employed as a tool to establish a context for technology teaching or integration. In line with this, some strategies are proposed to strengthen the integration of the DT approach within *Technology and Design* education. This research is considered significant in terms of providing teachers with a perspective on the DT approach and how it is integrated into *Technology and Design* education.

Keywords

Design thinking, Design thinking in Türkiye, Design thinking in K-12 education, Design thinking for educators, Design thinking in Technology and Design Education

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Introduction

Design thinking (DT), an interdisciplinary, iterative, and human-centered problem-solving approach, is utilized for multiple purposes in education, such as curriculum design, learning environment design, and improving students' skills (Öztürk, & Korkut, 2022).

The use of DT in K-12 education has recently gained popularity in Türkiye. In the 2023 education vision report of the Türkiye Ministry of National Education (MONE), the statement on the establishment of "Design Skill Workshops" (named "Tasarım Beceri Atölyeleri" in Turkish) in all educational institutions draws attention. These workshops aim to provide DT and STEM/STEAM education (Türkiye's Education Vision 2023 report, n.d.). Furthermore, under the framework of the National Technology Initiative in Türkiye, cooperation has been made to establish the "Experimental Technology Workshops" (named "Deneyap Teknoloji Atölyeleri" in Turkish) in 81 cities. The Design and Production course to be given in these workshops intends to educate the students within the framework of the DT approach (Deneyap, n.d.). Books were also published through MONE to disseminate the DT approach in national education and to support STEM and STEAM education (Karataş et al., 2021; Aksoy et al., 2020). Additionally, while the literature predominantly comprises various systematic literature reviews, bibliometric analyses, and extensive research and applications on articles related to the DT approach (Lin et al., 2025; Li, & Zhan, 2022), there is a dearth of publications providing comparative analyses or reviews of DT books.

This research investigates how the DT approach in education is defined and implemented in the books published by Turkish public institutions. The purpose of this paper is to compare and evaluate the books on DT published by public institutions in Türkiye to gain an understanding of the DT approach and how it is applied. This research addresses a notable deficiency in academic literature by carefully analyzing and contrasting various DT books. This paper is also considered significant in terms of providing a perspective on the DT approach and how it can be integrated into *Technology and Design* education.

Design Thinking Approach

Design thinking (DT) is a holistic approach that stresses the collaborative, human-centered, and experimental problem-solving process (Guha et al., 2017) and offers a wide range of tools and strategies to handle wicked problems (Peng, 2022). In education, the DT approach is used to redesign the school system, facilitate teachers' collaboration on curriculum creation, and solve school-related problems (Diefenthaler, 2017). Mindsets of the DT approach help students acquire 21st-century skills[1] (Goldman et al., 2017).

[1] 21st-century skills are:
Learning and Innovation Skills (4Cs): Critical Thinking & Problem Solving; Communication & Collaboration; Creativity & Innovation.
Information, Media and Technology Skills: Information Literacy; Media Literacy; ICT Literacy.
Life and Career Skills: Flexibility & Adaptability; Initiative & Self-Direction; Social & Cross-Cultural Skills; Productivity & Accountability; Leadership & Responsibility (The P21 Framework for 21st Century Learning, 2009).

The literature states that the DT approach is utilized as an iterative problem-solving process that includes multiple methods, principles, and tools for dealing with wicked problems (what designers do) (Peng, 2022; Kimbell, 2011) that entails a range of skills (what designers know; their skills) (Lin et al., 2025; Kimbell, 2011) and ways of thinking (how designers approach and comprehend the task; their mindsets) (Diefenthaler, 2017; Kimbell, 2011). Accordingly, the DT can be practiced in four different ways (Gerken, 2022):

- Tool (ways of creating an artifact): DT as an approach is used to generate artifacts due to its methods and techniques (using brainstorming as a single tool, for example).
- Process (ways of working): DT is an organized, non-linear problem-solving activity that identifies users' needs, frames the problem, and develops user-centered solutions. To manage complicated issues at this level, tools at the relevant stages and particular skills (collaboration, self-reflection, etc.) are utilized collectively during the problem-solving process.
- Mindset (ways of approaching the task): DT is used as a way of thinking, where experiencing the DT process with its tools cultivates mental representations and leads to adopting the DT mindset.
- Holistic approach (includes all the mentioned above): DT is a comprehensive, holistic approach that comprises all relevant processes, mindsets, and tools. These components are interconnected and affect each other in the problem-solving process.

This paper discusses the five stages of the Stanford University d.school's DT approach (Figure 1) due to its widespread use in the Turkish setting (Kaygan et al., 2025a; Aksoy et al., 2020). Accordingly, the *Empathize* stage entails developing empathy with users to uncover their wants and desires. The *Define* stage includes identifying the problem or challenge by synthesizing the acquired data. The *Ideate* stage requires brainstorming potential solutions to the defined design problem. *Prototype* and *Test* stages involve prototyping several concepts and arriving at a final design through iterative testing and user feedback ("Design Thinking Bootleg" n.d.).

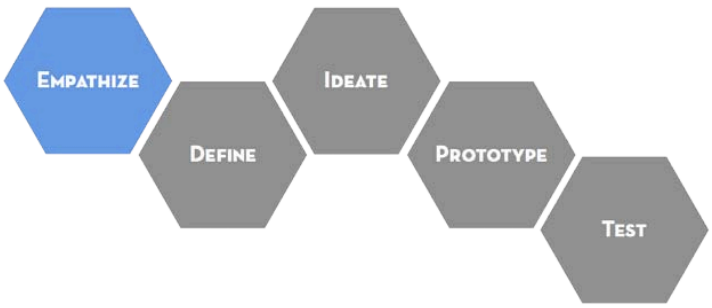

Figure 1: The Stanford d.school's DT Approach ("Design Thinking Bootleg" n.d.)

The literature identifies three DT approaches commonly used in the field of education (Öztürk, & Korkut, 2022) (Table 1): Stanford d.school's ("Design Thinking Bootleg" n.d.), HPI's

(HPI, n.d.), and IDEO's (IDEO, 2012) DT approaches. Table 1 presents stages with similar functions, but some with different names, in the same column. Accordingly, two HPI stages correspond to IDEO's *Discovery* and d.school's *Empathize* stages. The *Experimentation* stage of IDEO encompasses both the *Prototype* and *Test* stages. The *Evolution* stage is distinctive to IDEO, where the progress of the concept is documented based on stated success criteria, and additional steps are planned to produce the actual product with high precision.

The literature can describe DT mindsets as DT characteristics or attributes of design thinkers (Gerken, 2022). Human-centered and collaborative, for instance, are defined as both characteristics (Guha et al., 2017) and mindsets of the DT approach (IDEO, 2012). Although many mindsets are identified in the literature, Table 1 describes those highlighted in these three DT approaches. Accordingly, shared characteristics/mindsets of these DT approaches can be found around the following: human-centered/empathy[2], collaboration, and experimentation.

Table 1. A comparison of the stages of Stanford d.school, HPI, and IDEO design thinking approaches and a description of the mindsets they adopted

Note: The color red denotes shared mindsets discovered in all DT approaches

Source. Based on Öztürk and Korkut's "A comparison of d.school, HPI, and IDEO DT approaches" (2022), with the addition of DT mindsets.

DT Approach	Stages of Design Thinking						DT Mindsets	Description of Mindsets
Stanford d.school's DT approach ("Design Thinking Bootleg" n.d.)	Empathize		Define	Ideate	Prototype	Test	Focus on human values Radical collaboration Embrace experimentation Be mindful of process Craft clarity Bias towards action Show don't tell	-Focus on human values (Think & Act in a human-centered way/Human-centered): Focus on users' needs/desires through developing empathy. -Radical collaboration (Collaborate in diverse teams /Collaborative): Collaborate with people from diverse backgrounds/experiences to comprehend/solve the problem. -Embrace experimentation[3] (Learn through experimentation /Experimental): Prototype to learn through failures/mistakes and iterate to improve the concept. -Be Mindful of Process: Use the DT approach to guide you in the design process, where you are, what you aim to achieve, and what you need to do next. -Craft clarity: Express your idea clearly/simply so that others can easily comprehend the concepts. -Bias towards action: To turn your idea into reality, focus on
HPI's DT approach (HPI, n.d.)	Understand	Observe	Define the Point of View	Ideate	Prototype	Test	Think & Act in a human-centered way Collaborate in diverse teams Learn through experimentation Envision a radically new future (Optimistic) Explore the problem space Embrace uncertainty	

[2] The IDEO toolkits (IDEO, 2012; The Field Guide to Human-Centered Design, 2015) use the terms "human-centered" and "empathy" interchangeably.

[3] This mindset can be expressed as the combination of "Learn from failure" and "Iterate" mindsets (The Field Guide to Human-Centered Design, 2015).

IDEO's DT approach (IDEO, 2012)	Discovery	Interpretation	Ideation	Experimentation	Evolution	Human-centered Collaborative Experimental Optimistic	action rather than talking or thinking. -Show don't tell: Communicate your ideas through creating prototypes. -Envision a radically new future (Optimistic): Be resilient, have faith to solve problems, and imagine new things/ideas. -Explore the problem space: Adopt a holistic thinking approach to investigate the problem from multiple perspectives/experiences. -Embrace uncertainty: Embrace complexity and tolerate uncertainty/ambiguity when dealing with unforeseen challenges.

In this paper, it may be helpful to distinguish between "design thinking" and "design as a problem-solving process", that is, the design process. The phrase "design as a problem-solving process" can be defined as the process of iteratively and systematically solving problems to transform or solve an existing situation or problem into a desired one or tangible design (Sameti, Koslow, & Mashhady, 2022; Aspelund, 2017). The meaning of the word "product" can also vary from discipline to discipline; it can refer to tangible, digital, system, or service products. While the stages may vary depending on the type of product being developed (Ulrich, Eppinger, & Yang, 2019), "design as a problem-solving process" may include the following stages:

- *Defining the Problem:* Examining the current situation, environmental concerns, and user needs; and determining or refining the problem to be solved (Ulrich, Eppinger, & Yang, 2019; Aspelund, 2017).
- *Analysis:* Detailed examination of the causes/context of the problem, identification of user needs/constraints (Ulrich, Eppinger, & Yang, 2019).
- *Ideation:* Developing different concepts and design ideas through both written and visual means.
- *Developing and Implementing the Solution:* Iteratively prototyping, testing, and implementing to explore selected ideas/concepts in more detail (Ulrich, Eppinger, & Yang, 2019; Aspelund, 2017).
- *Evaluation and Improvement:* Evaluating the results of the implemented solution and improving it if necessary (Ulrich, Eppinger, & Yang, 2019).
- *Production:* Communicate and collaborate with internal/external suppliers on matters involving a wide range of disciplines (Ulrich, Eppinger, & Yang, 2019; Aspelund, 2017).

Accordingly, encompassing all relevant processes, mindsets, and tools, the DT approach stresses user-centeredness, empathy, iterative prototyping, and testing in the problem-solving process. The "design as a problem-solving process" usually concentrates on the creation of a functional and ergonomic product while also considering technical specifications, detailing, manufacturing procedures, and considerations.

Technology and Design Education in Türkiye

In 2018, changes were executed in the national curriculum of *technology and design* education in Türkiye (Turkish Technology and Design Education Curriculum, 2018). The aim of the *Technology and Design* course is described in the MONE textbook as developing individuals who understand the technology and design development process, can think analytically, understand the problem-solving processes applied by designers, can develop creative solutions with an interdisciplinary approach, know the concepts related to design and technology, are prone to teamwork, and are technology and design literate.

When the weekly schedules of K-12 educational institutions in Türkiye for the 2025-2026 academic year are examined, it is discovered at the secondary school level that the *Technology and Design* course is given for 2 hours per week in the 7th and 8th grades. The *Information Technologies and Software* course is taught for 2 hours per week in the 5th and 6th grades. *Robotics Coding* (in 5th and 6th grades) and *Artificial Intelligence Applications* courses (in 7th and 8th grades) are offered only as electives. None of these courses is taught in primary school. At the high school level, only *Information Technologies and Software* is given as compulsory or elective course, depending on the school type (Weekly Course Schedule, n.d.). The *Technology and Design* course is also recommended to be conducted in collaboration with other disciplines (Turkish Technology and Design Education Curriculum, 2018). This suggestion may be due to the difficulty of providing two hours of hands-on, interdisciplinary technology and design training per week.

The curriculum review reveals that the same learning areas are found in grades 7 and 8: “Fundamentals of Technology and Design,” “Design Process and Presentation,” “Built Environment and Product,” “Needs and Innovation” and “Design and Technological Solutions.” Within these learning areas, we encounter a program that strives to raise awareness of various design fields, such as architectural design, visual communication design, engineering design, computer-aided design, design-focused process, and product development. There is no topic, or unit called the Design Thinking (DT) Approach within the curriculum (ibid). The *Technology and Design* course curriculum in Türkiye intends to enhance understanding of various design and technology fields and teach concepts pertinent to them.

Since there are no institutions in Türkiye that train teachers for this course, teachers are selected and appointed from among graduates of different departments (such as Industrial Design department, Art education, etc.) (Fields in Teacher Appointments, n.d.). This situation raises questions about their competence and experience in the field of design and technology, and the equivalence and quality of the education provided in the classroom.

There are some problems that can be encountered in technology integration in schools: not every school and student has the same internet speed, workshops, and technological tools or is completely devoid of them; there are differences between the technological competencies of in-service teachers (due to their limited in-service training in technological approaches) and pre-service teachers (due to the limited number of technology-content courses in education faculties). Literature also states that technology integration should be

done with a purpose; The training provided should not focus solely on the use of technological tools and equipment (Akgündüz, Kurt, & Seferoğlu, 2023). Accordingly, technology can be integrated into education under three categories:

As a tool or facilitator (An electronic hardware/software device, Web 2.0/3.0/4.0 tools, etc.) (Ellis et al., 2020; Doğan, & Robin, 2015).
This category can include CAD/CAM tools, calculators, virtual environments, online communication, data collection, collaboration and artificial intelligence (AI) tools, Google Docs & Spreadsheets, portable technologies, and the tools used by practitioners of STEM disciplines (such as using microscopes, modeling with CAD software) (ibid).

To facilitate the problem-solving process (Ellis et al., 2020; Akgun, 2013; Bruce, & Levin, 1997).
In this category, the learner uses educational/instructional technology for inquiry (doing research, data collection/analysis), communicating (collaborating, documenting, presenting the findings), construction (prototyping things by using waste/simple materials, robotics, computer-aided design, digital fabrication tools, etc.), and expression (the presentation of the results by using editing programs, animation software, etc.) (Bruce, & Levin, 1997). This approach to technology use aims to integrate and embed technology directly into educational activities to facilitate the implementation of a problem-solving process in courses (Ellis et al., 2020; Bruce, & Levin, 1997). This category can include using technology (Lego Mindstorms sets, etc.) for coding to solve a required task/challenge (Ellis et al., 2020).

To teach technological contents or skills (Ellis et al., 2020; Akgun, 2013).
Integrated or embedded technology can be learned as a subject in education (Akgun, 2013). For example, by using particular tools and practices, students can design a specific device to measure the temperature and learn the intended content, instead of utilizing the thermometer itself (Ellis et al., 2020). Under this category, one can develop their skills via engaging educational technologies, such as gaining algorithmic thinking skills while working with the Arduino robot kit to create a software prototype.

Considering these categories, in the *Technology and Design* course textbook, technology appears to be used as a tool (using 2D/3D modeling programs, etc.) and to facilitate the problem-solving process (preparing PowerPoint presentations to present the result, etc.).

Methodology

This article aims to evaluate the books on DT in education published by state entities in Türkiye by comparing them with popular DT approaches used in education (IDEO, 2012; “Design Thinking Bootleg,” n.d.; HPI, n.d.). The document analysis method, a qualitative research method, was utilized for data collection and analysis. Document analysis is the analysis of materials carrying information about the research subject (such as videos, books, academic papers, or journals, etc.). It entails document collection, review, reading, analyzing, and interpretation (Bowen, 2009).

Because they were published by MONE and TÜBİTAK (The Scientific and Technological Research Council of Türkiye), the following seven books were chosen and used as data (Table 2). Four of these books are prepared solely according to the DT approach (Kaygan et al., 2025a, 2025b; Avcı et al., 2023; Aksoy et al., 2020) while the others refer to the DT approach in some chapters. Except for one book (Turan et al., 2021; Sarıkoç et al., 2021), the target audience of other books is secondary/high school students, as well as teachers/educators.

Table 2. Books on design thinking (DT) published by public institutions in Türkiye

Name of the book	Editors/Authors	Publishers	The number of pages investigated	Target group
Deneyap Türkiye: Tasarım ve Üretim-Ortaokul (2025a)[4] **Deneyap Türkiye: Tasarım ve Üretim-Lise (2025b)**	Pınar Kaygan, Sedef SÜNER Pla-Cerda, Nur Akkuş Çakır, Alper Karadoğaner, Gizem Hediye Eren, Engin Kapkın, Tolga Yılmaz (Authors)	TÜBİTAK Publications	313 (Total 313 pages)	Secondary school students / Educators High school students / Educators
Tasarım Odaklı Düşünme ile Proje Hazırlama: Öğretmen Rehber Kitabı (Örnek Proje Tasarımlarıyla) (2023)	Sarper Serkan Avcı, Kemal Şimşek, Lokman Güzelyurt, Atilla Çifci, Bülent Akça, Hülya Olgun (Authors)	MONE, General Directorate of Secondary Education	106 (Total 106 pages)	High school teachers
Eğitimde İnovasyon için Tasarım Odaklı Düşünme (2020)	Sibel Akbıyık, Volkan Hasan Kaya (Eds.)	Behiye Dinçer Aksoy Ece Balçık Emre Uykun Ercüment Erdemli Fatma Ayça Yıldırım Fatma Kaya Gökhan Biçer Kenan Gökdağ Kürşat Demir Merve Kızanlık Murat Öztürk Özgül Eynel Zeynep Sarıkoç (Authors)	MONE, General Directorate of Teacher Training and Development	384 (Total 384 pages)	Secondary school students / Teachers
Okul Öncesinden Ortaöğretime Farklı Disiplinlerde STEM Eğitimi Uygulamaları (2021)	İpek Saralar-Aras (Ed.)	Ali Turan, Mustafa Talha Soysal, Türkan Dümbüllü, Özlem Çelikkol (Authors) Zeynep Sarıkoç, Sevda Baydar, Selin Sarıça, Tuğçe Ekici, Kısmet Türkan Kurnaz, Işılay Güneş Torun (Authors)	MONE, General Directorate of Teacher Training and Development	Between 99-130 (Total of 462 pages) Between 355-370 (Total of 462 pages)	Not specified Not specified

[4] The DT approach, narrative, and process are applied nearly identically in both books within the context of the same project, despite being published as two separate volumes for High School and Secondary School. Accordingly, the article will proceed through Deneyap Türkiye: Tasarım ve Üretim-Ortaokul (2025a). Additionally, the "Student Workbook" was available for download in the 2021 version of the book, but not in the 2025 version.

Different Approaches in STEM Trainers' Training (2021)	Asaf Murat Karapınar, Rukiye Orman, İlkay Solmaz (Eds.)	Serçin Karataş, Ebru Kılıç Çakmak, Mutlu Tahsin Üstündağ (Authors)	MONE, General Directorate of Teacher Training and Development	Between 12-14 (Total 152 pages)	Teachers
Tasarım Beceri Atölyeleri Öğretmen El Kitabı (n.d.)	Not specified		MONE, General Directorate of Secondary Education	Between 15-16 (Total 347 pages)	High school teachers

In the analysis process of the data (Bowen, 2009), using the Microsoft Excel application, the author coded and evaluated the data. The data were processed using an initial framework in which categories were primarily determined by reviewing the literature. Accordingly, a comparison was carried out under the categories described in Tables 3 and 4 to comprehend the general view of the DT approach and each stage of the DT approach. The initial framework was updated many times throughout the coding process. The findings were interpreted using this framework.

Data were encoded using the coding format types of Corbin and Strauss (2008). In general comparison, data were coded according to predetermined concepts for the categories of *adopted DT approach, approach to implementing DT, characteristics of DT approach, DT mindsets*, and *Technology integration*. The categories of *view of DT from an educational perspective* and *expectations from the implementation of the DT approach* were coded according to the concepts extracted from the data.

In general comparison, Gerken's (2022) model, which is based on four different ways to implement DT, was utilized to investigate the second category -approach *to implementing DT*. The categories of *views of DT from an educational perspective* (Kaygan et al., 2025a, p. 3) and *expectations from the implementation of the DT approach* (Aksoy et al., 2020, p. 10) were explored by examining the definition, purpose, and benefits of the DT approach in the relevant books.

> "The general and specific objectives of the course are determined as follows: … *approaching the challenges with a human-centered perspective* (Way of thinking), … *collaborating effectively* (Skill), *understanding that the design and production process is iterative, learned by making mistakes* (Way of thinking)"[5]
>
> "Stanford University (d.school) characterizes the DT approach as a learning approach that focuses on *developing students' self-confidence*."[6]

[5] Dersin genel ve özel hedefleri aşağıdaki gibi belirlenmiştir: … zorluklara *insan merkezli bir bakış açısıyla yaklaşma*, … *etkin bir şekilde işbirliği yapma*, tasarım ve üretim sürecinin *tekrarlı, hata yapılarak öğrenilen bir süreç olduğunu benimseme*. (Text of the book in Turkish)

[6] Standford Üniversitesi, TOD yaklaşımını, *öğrencilerin öz güvenlerini geliştirmeye odaklanan* bir öğrenme yaklaşımı olarak nitelendirir. (Text of the book in Turkish)

A model that covers the fundamental 21st-century skills and values was developed for Türkiye (Türel et al., 2023). This model focuses on promoting social-emotional development and learning skills in a supportive educational environment. Accordingly, 11 core values associated with these skills were identified: justice, friendship, honesty, love, respect, patriotism, helpfulness, morality, conscience, manners, and thrift[7] (Türel et al., 2023). Under the category of *expectations from the implementation of the DT approach*, the books were also reviewed considering these values. The names of these values, their synonyms, and antonyms were used as keywords, and the findings were evaluated according to whether they were seen as a "value" in the context of the sentence in which they were found.

> "…To prevent material *waste (the antonym of the word 'thrift'),* and to provide equal opportunities for each student to use materials, instructors can follow the following strategies …:"[8]

> "While asking students to empathize, they are expected to display a *respectful* attitude without *judgment* …."[9]

Literature can describe DT mindsets as DT characteristics. To distinguish between DT's characteristics and mindsets, the way they are presented in the sentence was examined. If it was stated as a way of thinking, it was regarded as a mindset (p. 18). If it was presented as an attribute of the DT approach, it was considered as a characteristic (Aksoy et al., 2020, p. 5). Considering the literature, the following keywords were used to explore DT's mindsets and characteristics: iteration, prototyping, reflection, experimental, creativity, innovation, human-centered/empathy, collaboration, failure/mistake, and uncertainty/ambiguity.[10]

> *"An optimistic perspective* should always be maintained throughout the process for innovative and creative solutions."[11]

[7] Keywords in Turkish: Adalet, Dostluk, Dürüstlük, Sevgi, Saygı, Vatanseverlik, Vatanseverlik, Yardımseverlik, Ahlak, Vicdan, Görgü, Tasarruf

[8] …Malzeme *israfını (Tasarruf kelimesinin zıt anlamlısı)* önlemek ve her öğrenciye eşit miktarda kullanım imkânı sunabilmek için eğitmenler aşağıdaki stratejileri izleyebilirler…: (Text of the book in Turkish)

[9] Öğrencilerden empati kurmalarını isterken *yargılamadan ... saygılı* bir tavır sergilemeleri beklenir. (Text of the book in Turkish)

[10] Keywords in Turkish: Yineleme, prototip yapma, yansıtma, deneysel, yaratıcılık, yenilik, insan odaklı/empati, iş birlik, hata/yanlış, belirsiz

[11] Süreç boyunca yenilikçi ve yaratıcı çözümler için hep *iyimser bir bakış açısı* sergilenmelidir. (Text of the book in Turkish)

> "…The DT approach is powerful for … bringing diverse disciplines together to generate *human-centered* and *innovative* solutions to problems in a *collaborative* and *experimental* structure."[12]

In the category of *technology integration*, the sample activities in the books were reviewed, considering the previously mentioned three types of technology usage in education.

As a tool or facilitator.
Using the Figma Web 2.0 tool for logo design (Avcı et al., 2023); AutoCAD for 3D modelling (Aksoy et al., 2020); Making models using simple materials (Karataş et al., 2021); Making an award statuette using a laser cutter (Kaygan et al., 2025a).

To facilitate the problem-solving process.
Creating a project exhibition in the Metaverse (Avcı et al., 2023); Preparing a digital presentation (Kaygan et al., 2025a; Aksoy et al., 2020).

To teach technological content or skills.
Using the Arduino robot kit, getting information about electrical circuit elements and developing coding skills (Avcı et al., 2023; Aksoy et al., 2020); Learning planning (which model parts will be produced and how) and time management (time allocated for production) skills while making high-fidelity prototypes (Kaygan et al., 2025a).

The *stage*, *the purpose of the stage,* and the *method name* of the DT approach are clearly mentioned in the books of Avcı et al. (2023, pp. 8-105), Kaygan et al. (2025a, pp. 167-245), and Aksoy et al. (2020, pp. 22-37). These served as data for a comparison of each step of the DT approach with the Stanford d.school DT approach used in the books.

Validity and Reliability
The document analysis methodology employed in this study was founded on the preliminary coding performed in 2023 and subsequently re-evaluated and refined in 2025. This re-evaluation at various intervals illustrates that the data are not solely reliant on immediate interpretations but are assessed within context. The study's validity was enhanced through the implementation of the "time triangulation" approach (Kimchi, Polivka, & Stevenson, 1991). The coding method conducted by the same researcher across different years enhanced the study's reliability by reinforcing the "intra-coder reliability" (Hoonard, 2008). Accordingly, in contrast to the analysis conducted in 2023, the 2025 analysis incorporated the secondary school and high school books authored by Kaygan et al. (2025a, 2025b) - replacing the secondary school book by Kaygan et al. (2021)- as well as the book by Avcı et al. (2023). Consequently, a total of seven textbooks were analyzed, compared to five in the initial study. Furthermore, under the "Findings" section, the recent analysis introduced a new category titled *technology integration*. Within the category of *expectations from the*

[12]… Tasarım odaklı düşünme yaklaşımı, … farklı disiplinleri bir araya getirerek *iş birlikli* ve *deneysel* bir yapı içinde problemlere *insan odaklı* ve *yenilikçi* çözümler üretmek için güçlü bir modeldir. (Text of the book in Turkish)

implementation of the DT approach, eleven values associated with 21st-century skills were examined.

Findings

General Perspective on the Design Thinking Approach

According to the findings (Table 3), all books employ the DT approach used at Stanford d.school. Three books view it as a holistic approach to problem-solving that incorporates tools, processes, and mindset (Kaygan et al., 2025a; Avcı et al., 2023; Aksoy et al., 2020), while others solely consider it as a process for problem-solving. From an educational standpoint, it is thought to cover a set of skills, particularly 21st-century skills, in all books. Holistic thinking (Kaygan et al., 2025a; Avcı et al., 2023; Aksoy et al., 2020), hands-on, model-making, iterative, prototyping (Kaygan et al., 2025a; Avcı et al., 2023), and analytical thinking (Sarıkoç et al., 2021; Aksoy et al., 2020) are the other skills associated with the DT approach. It is also regarded as a way of thinking due to its particular mindsets (Kaygan et al., 2025a; Avcı et al., 2023; Sarıkoç et al., 2021; Aksoy et al., 2020), an engineering approach in STEM education (Turan et al., 2021), a competence (Karataş et al., 2021), and a teaching method (Tasarım Beceri Atölyeleri Öğretmen El Kitabı, n.d.). It is further highlighted as an active learning approach that includes hands-on, collaborative, and reflective practices (Kaygan et al., 2025a; Aksoy et al., 2020).

Some expectations are expressed regarding the implementation of the DT approach: its ability to increase students' engagement (Kaygan et al., 2025a; Avcı et al., 2023), motivation, interaction (Kaygan et al., 2025a); boost students' self-esteem (Aksoy et al., 2020), and its potential to improve their skills and acquisitions (Kaygan et al., 2025a; Avcı et al., 2023; Aksoy et al., 2020). DT is reported to provide them the ability to construct their own learning environments and school systems (Aksoy et al., 2020). Except for three books, in others, the DT approach is also expected to facilitate the product (physical, interior, software, building, and system) design process (Kaygan et al., 2025a; Avcı et al., 2023; Sarıkoç et al., 2021; Aksoy et al., 2020). Furthermore, it has been noticed in three books that some of the strategies suggested in the implementation of the DT approach can develop some values related to 21st-century skills in students; these are, respect, thrift (Kaygan et al., 2025a; Avcı et al., 2023; Aksoy et al., 2020); morality (Avcı et al., 2023; Aksoy et al., 2020); conscience, manners (Avcı et al., 2023); justice (Kaygan et al., 2025a); and honesty (Aksoy et al., 2020).

The DT approach is characterized by two qualities in all books: human-centered/user-centered and interdisciplinary. In two books, it is considered to provide a context for integrating STEM disciplines (Turan et al., 2021; Sarıkoç et al., 2021; Karataş et al., 2021). It is also associated with innovation (Kaygan et al., 2025a; Avcı et al., 2023; Sarıkoç et al., 2021; Karataş et al., 2021; Aksoy et al., 2020), collaboration (Kaygan et al., 2025a; Avcı et al., 2023; Sarıkoç et al., 2021; Aksoy et al., 2020), iteration (Kaygan et al., 2025a; Avcı et al., 2023; Aksoy et al., 2020), reflection (Kaygan et al., 2025a; Avcı et al., 2023), and experimental (Avcı et al., 2023; Aksoy et al., 2020).

The mindsets of the DT approach used in Stanford d.school are explicitly underlined in two books (Sarıkoç et al., 2021; Aksoy et al., 2020). While the mindset of human-centered/

empathy is prominent throughout the books, the mindsets of radical collaboration and embracing experimentation are the other mindsets most explored in the books (Kaygan et al., 2025a; Avcı et al., 2023; Sarıkoç et al., 2021; Karataş et al., 2021; Aksoy et al., 2020). Some of HPI's mindsets are also discovered in the books: explore the problem space (Avcı et al., 2023; Turan et al., 2021; Aksoy et al., 2020), envision a radically new future, and embrace uncertainty (Aksoy et al., 2020). However, there is no information on how to emphasize these mindsets when applying the DT approach to students.

Except for two books in which technology is used only as a tool or facilitator (A) (Karataş et al., 2021; Sarıkoç et al., 2021), in others (Kaygan et al., 2025a; Avcı et al., 2023; Aksoy et al., 2020), there is also technology usage in education to facilitate the problem-solving process (B) and to teach technological content and skills (C). According to the findings, prototyping and presentation activities in problem-solving processes involve the use of technology in categories A and B, while the integration of robotics into the learning process generally involves technology integration in category C.

The three books explicitly provide a relevant DT workbook/template/form. In the book by Kaygan et al. (2021), the student workbook can be downloaded to help students follow the DT approach. In Aksoy et al.'s book (2020), teachers are provided with some forms/rubrics to manage and evaluate the implementation of the DT approach. For students, monitoring forms and worksheets for all stages of the DT approach are also presented. In Avcı et al.'s book (2023), teachers are provided with forms to measure and evaluate each stage of the DT approach. While there are forms for students to assess themselves and their peers (Reflection, Self-Assessment & Peer Review Forms), many forms/tables are also designed for them for each stage of the DT approach.

Table 3. General view of the DT approach in books published by public institutions in Türkiye

Note: The color red refers to the common findings under each category discovered in the books

Name of the book	Adopted DT approach	Approach to implementing DT	View of DT from an educational perspective	Expectations from the implementation of the DT approach	Characteristics of the DT approach	DT Mindsets	Technology Integration	Workbook/Template/Form in the book
Deneyap Türkiye: Tasarım ve Üretim-Ortaokul (2025a; 2025b)	Stanford d.school' DT approach	• Holistic approach: Include tools, mindset, and process for problem-solving	• An active learning approach • A way of thinking • Set of skills (hands-on, model-making, iterative prototyping, holistic thinking, & 21st-century skills, such as problem-solving, teamwork, 4C skills)	• Increase students' engagement. • Increase students' motivation. • Increase students' interaction. • Improve students' particular skills & acquisitions. • Have students design a physical product. •Develop students' specific values,	• Human-centered/user-centered • Interdisciplinary • Collaboration • Innovation • Iteration • Reflection	• Human-centered /Empathy • Embrace experimenta-tion • Radical collaboration	A-As a tool or facilitator B-To facilitate the problem-solving process C-To teach technological contents or skills	Student workbook (Kaygan et al., 2021)

				such as respect, justice, & thrift.					
Tasarım Odaklı Düşünme ile Proje Hazırlama: Öğretmen Rehber Kitabı (2023)	Stanford d.school' DT approach	•Holistic approach: Include tools, mindset, and process for problem-solving	•A way of thinking •Set of skills (hands-on, model-making, iterative prototyping, holistic thinking, & 21st-century skills, such as problem-solving, teamwork, 4C, and Information, Media, and Technology Skills)	•Increase students' engagement. •Develop students' specific values, such as respect, morality, conscience, manners, & thrift. •Improve students' particular skills & acquisitions. •Have students design a physical product, systems (food safety systems), a software product (smart traffic light), & a building.	•Human-centered/user-centered •Interdisciplinary •Collaboration •Innovation •Iteration •Reflection •Experimental	• Human-centered /Empathy • Embrace experimenta-tion • Radical collaboration • Explore the problem space (Holistic thinking)	A-As a tool or facilitator B-To facilitate the problem-solving process C-To teach technological contents or skills	For teachers: •Measure-ment and Evaluation Forms specific to each stage of the DT approach	For students: •Reflection Form •Self-Assessment Form •Peer Review Form •Forms/ Tables specific to each stage of the DT approach
Eğitimde İnovasyon için Tasarım Odaklı Düşünme (2020)	Stanford d.school' DT approach	• Holistic approach: Include tools, mindset, and process for problem-solving	• An active learning approach • A way of thinking • Set of skills (holistic thinking, analytical thinking, inquiry, & 21st-century skills, such as problem-solving and teamwork)	• Improve students' self-esteem. • Improve students' particular skills & acquisitions. • Have students design a physical product, interior (the learning environment), systems (school rules, school management, lesson plans, or lunch menu), & a software product (automatic plant irrigation system). •Develop students' specific values, such as respect, honesty, thrift, & morality.	• Human-centered/user-centered • Interdisciplinary • Collaboration • Innovation • Iteration • Experimental	• Stanford d.school's Mindsets • Explore the problem space (Holistic thinking) • Envision a radically new future (Optimism) • Embrace uncertainty	A-As a tool or facilitator B-To facilitate the problem-solving process C-To teach technological contents or skills	For teachers: • Teachers' Process Observa-tion List • Product Evaluation Criteria • Social and Emotional Skills Observa-tion Form • Process Evaluation Rubric	For students: •Monitoring Form and Worksheet specific to each stage of the DT approach • Forms for o Process Analysis Matrix o Post-interview Problem Analysis o Empathy Map o 2X2 Matrix
Okul Öncesinden Ortaöğreti-me Farklı Disiplinler-de STEM Eğitimi Uygulama-ları (2021)	Stanford d.school' DT approach	• A process for problem-solving activity	• Set of skills (21st-century skills) • An engineering approach	Not specified	• Human-centered/user-centered • Interdisciplinary	• Human-centered/ Empathy • Explore the problem space (Holistic thinking)	Not specified		
		• A process for problem-solving activity	• A way of thinking • Set of skills (analytical thinking & 21st-century skills, such as problem-solving)	• Have students design a physical product.	• Human-centered/user-centered • Interdisciplinary • Collaboration • Innovation	• Stanford d.school's Mindsets	A-As a tool or facilitator		

Different Approaches in STEM Trainers' Training (2021)	Stanford d.school' DT approach	• A process for problem-solving activity	• A competence	Not specified	• Human-centered/user-centered • Interdisciplinary • Innovation	• Human-centered /Empathy • Embrace experimenta-tion	A-As a tool or facilitator
Tasarım Beceri Atölyeleri Öğretmen El Kitabı (n.d.)	Stanford d.school' DT approach	• A process for problem-solving activity	• A teaching method • Set of skills (21st-century skills)	Not specified	Not specified	• Human-centered /Empathy	Not specified

Stages of Design Thinking Approach

The results from Table 4 indicate that only Aksoy et al.'s book contains the same stages as the Stanford d.school's DT approach. The DT approach outlined in the book of Kaygan et al. (2025a) is the same as the d.school's DT approach up until the *Prototype* stage. Unlike other books, the *Prototype* stage in this book includes the production of low-fidelity prototypes and testing the concepts with students before user testing. The *Test* stage evaluates test results and plans the high-precision manufacturing production process for the selected design. The DT process has one more *Prototype* stage: producing and assessing a high/low-fidelity prototype, followed by presenting it to students/users by preparing posters/presentations. Although there is no comparable stage in the d.school's DT approach, the *Test* and the final *Prototype* stages are thought to be akin to the IDEO *Evolution* stage (2012), and the *Production* stage within "design as a problem-solving process". The DT approach followed in the book of Avcı et al. (2023) is almost the same as the d.school's DT approach. The *Testing and Assessment* stage has the same purpose as other *Test* stages; only the name of the stage is different. Distinctively, after this stage, there is another stage called *Presentation and Dissemination*. In this stage, students develop strategies for marketing the product to introduce, deliver, and disseminate the product/prototype to students/users. If the design is deemed appropriate, the necessary applications are made for obtaining a patent/utility model acquisition and for national/international project competitions.

No books integrate AI tools into the DT approach; instead, they continue to use conventional methods at each stage of the DT process. While all books present almost identical methods for each stage, Aksoy et al.'s book, similar to IDEO's classification (IDEO methods, n.d.), categorizes diverse methods into four difficulty levels from the point of the implementation process. Books present shared methods, such as interview, observation, and empathy map (also available in the d.school toolkit), as well as different methods, such as the 5W1H Method, hot potato, and reverse thinking, for each DT stage. Furthermore, in the *Ideate* stage, all books offer different brainstorming methods that are not available in the d.school's DT approach. In the *Prototype* stage, most of the methods are available in the d.school toolkit, except for the "Prototyping with digital tools (software prototype)" method. While one book (Aksoy et al., 2020) presents the relational map, journey map, and 2x2 matrix as methods under the group of create frameworks, as in one of the IDEO toolkits (The Field Guide to Human-Centered Design, 2015), they are offered as stand-alone methods in the d.school toolkit. Some methods discovered at certain stages of the DT approach in the books are presented at different stages of the d.school's DT approach. For instance, methods offered in the *Empathize* stage, such as empathy map, journey map, and 2x2 matrix, are

presented in the *Define* stage of the d.school toolkit. Alternative methods are also available to be used in each stage of the d.school's DT approach.

Table 4. Comparison of each stage of the DT approach presented in books published by public institutions in Türkiye with each other and with Stanford d.school's DT approach
Note: The color red refers to the shared methods presented under each DT stage discovered in the books

	Deneyap Türkiye: Tasarım ve Üretim-Ortaokul (Kaygan et al., 2025a; 2025b)	Tasarım Odaklı Düşünme ile Proje Hazırlama: Öğretmen Rehber Kitabı (Avcı et al., 2023)	Eğitimde İnovasyon için Tasarım Odaklı Düşünme (Aksoy et al., 2020)		Stanford d.school's DT approach ("Design Thinking Bootleg" n.d.)
Stage	Empathize	Empathize	Empathize		Empathize
Purpose of the Stage	Investigate the needs/expectations of the target group and the context where the designed product is used.	Develop an insightful perspective on the problem by engaging with users and focusing on their needs/thoughts/ emotions.	Investigate the needs/emotions/behaviors /expectations of the people affected by the problem.		Build empathy with users to discover their needs/desires.
Method Name	•Interview •Observation	• Interview • Observation • Empathy map • Role-playing • Mind-mapping	• Interview / Asking open-ended questions • Observation / Live or video observation • Why-How Laddering • Create frameworks (Journey map, 2x2 matrix, Relational map) • Dig deeper • Community mapping	• **Level 1:** Interview, Observe • **Level 2:** Interview, Observe, Dig deeper • **Level 3:** Why-How Laddering • **Level 4:** Community mapping	• Interview for Empathy • Observation **Methods to be used in the "Define" stage** • Empathy map • Why-How Laddering • Journey map • 2x2 matrix **Methods to be used in the "Ideate" stage** • Role-playing **Alternative methods to be used in the "Empathy" stage** • User Camera Study • What? | How? | Why? • Assume a beginner's mindset
Stage	Define	Define	Define		Define
Purpose of the Stage	Interpret results and identify insights from collected user information.	Gather, analyze, and synthesize data obtained from the beginning of the process to create a specific problem statement that can be acted upon.	Develop a point of view based on the user's needs/experiences to identify a problem statement.		Identify the problem/challenge by synthesizing the collected data.
Method Name	• Empathy map • Role-playing	• Point of view madlibs	• Empathy map • 2x2 matrix • Point of view madlibs • POV analogy • "How might we" (HMW) questions	• **Level 1:** Point of view madlibs • **Level 2:** Empathy map • **Level 3:** 2x2 matrix (Create frameworks) • **Level 4:** POV analogy	• Empathy map • 2x2 matrix • Point of view madlibs • POV analogy **Methods to be used in the "Ideate" stage** • Role-playing • "How might we" (HMW) questions **Alternative methods to be used in the "Define" stage** • Saturate and group • Why-How Laddering • Journey map
Stage	Ideate	Ideate	Ideate		Ideate
Purpose of the Stage	Generate diverse, creative ideas for the defined problem statement.	Develop different/ multiple ideas for users' real needs, based on the defined problem.	Develop multiple ideas for new/alternative solutions or improvements.		Generate multiple ideas for potential solutions to the identified design problem.
Method Name	Brainstorming methods: • Speak within yourself • Hot potato • Reverse brainstorming • Reverse thinking	Brainstorming methods: • Brainstorming with small papers (post-its) • Visual brainstorming • Mind-mapping • Idea filter (A method based on evaluating originality & feasibility	Brainstorming methods: • Brainstorming with small papers (post-its) • Visual brainstorming • Bodystorming • Get broad audience opinions	• **Level 1:** Brainstorming with small papers • **Level 2:** Brainstorming by following rules • **Level 3:** Visual brainstorming, bodystorming • **Level 4:** Get	• Bodystorming **Alternative methods to be used in the "Ideate" stage** • Brainstorming (individually or with a scribe) • "How might we" (HMW) questions • Role-playing

		to select the best idea) • 5W1H method • Storyboarding	using online surveys, forms, or forums	broad audience opinion using online surveys, forms, forums	
Stage	Prototype (Low-fidelity prototype production & Test)	Prototype	Prototype		Prototype
Purpose of the Stage	Create low-fidelity prototypes to implement and test ideas quickly with other student groups/users.	Concrete ideas quickly and economically.	Turn the best idea into a prototype.		Turn ideas into physical forms through prototypes.
Method Name	• Model-making o Prototyping with physical model making • Peer review • User testing	• Model-making o Prototyping with paper o Prototyping with physical model making • Prototyping with digital tools (software prototype) • Drawing	• Model-making o Prototyping with paper o Prototyping with physical model making • Prototyping a case/experience • Prototyping with digital tools • Identify a variable • Drawing	• **Level 1:** Prototyping with paper • **Level 2:** Prototyping with physical model making, Identify a variable • **Level 3:** Role-playing • **Level 4:** Prototyping a case/experience	• Model-making o Prototyping with paper o Prototyping with physical model making • Prototyping a case/experience (Role-playing or bodystorming activity) • Identify a variable • Drawing **Methods to be used in the "Test" stage** • User testing
Stage	Test (Assessment and Manufacturing Planning)	Testing and Assessment	Test		Test
Purpose of the Stage	Evaluate the test results, choose an appropriate product proposal, and plan the manufacturing process.	Test prototypes/solution proposals with users, get their feedback, evaluate them, and improve the prototypes.	Test the prototypes with other students' groups/users to get feedback and improve prototypes.		Reach a final design by iterative testing and receiving user feedback about the prototype.
Method Name		• User testing • Feedback capture grid • Empathy map (for second prototype) • Dig deeper	• Live prototyping (User testing) • Peer review • Feedback capture grid • Make a presentation • Test scenario • Online polls or surveys	• **Level 1:** Make a presentation • **Level 2:** Feedback capture grid • **Level 3:** Test scenario • **Level 4:** Live prototyping, Online polls or surveys	• User testing • Feedback capture grid **Methods to be used in the "Define" stage** • Empathy map
Stage	Prototype (Low/High-fidelity prototype production & Presentation)	Presentation and Dissemination			
Purpose of the Stage	Create low/high-precision prototypes, and prepare posters/ presentations for project presentations.	Develop strategies for marketing the product to introduce, deliver, and disseminate the product/prototype to users (logo design, creating media content for promotion, preparing presentations/websites/ online exhibitions, etc.), and, if appropriate, make the necessary applications for patent/utility model acquisition & national/international project competitions.			

Discussion and Conclusion

Discussion

The purpose of this paper is to compare and evaluate the books on DT in education published by public institutions in Türkiye to gain an understanding of the DT approach and how it is applied. This study is considered significant because the information gleaned from comparing the books, as well as the following recommendations for implementing the DT approach, can assist teachers in implementing the DT approach in K-12 education, particularly in the *Technology and Design* course.

According to the literature, the DT-based learning process is given in three different ways: a learning process based on an existing DT process, a learning process based on a single DT stage, and a learning process with a DT approach customized for different teaching purposes (such as for developing students' 21st-century skills, etc.) (Lin et al., 2025). This finding in the literature is consistent with the finding that the application of the DT approach in the reviewed books is based on the Stanford d.school DT process, an existing DT process. The reviewed books also benefit from some stages of IDEO's DT approach (Kaygan et al., 2025a), HPI's mindsets, and IDEO methods in the problem-solving process (Aksoy et al., 2020).

According to the findings, DT is perceived as an interdisciplinary and human-centered problem-solving process that necessitates a set of skills and mindsets. Although described as a holistic approach in some books, all books focus on the physical problem-solving process in which students design, build, test, and receive feedback. The issue of how to develop a designer's mindset and skills in non-designers – teachers and students – is generally under-emphasized in the books. For this reason, the DT approach in education isn't comprehended and practiced as a holistic approach that requires the interaction between mindsets, processes, and tools.

The iterative nature of the DT approach allows for revisiting previous stages or even the first stage of the problem-solving process if deemed necessary, if the proposed solution proves ineffective, or if no solution is found. Although the findings indicate that the DT approach is perceived as an iterative process, its iterative nature is only emphasized in the *Prototype* and *Test* stages, where prototypes are revised based on feedback from users/students. Even though the core of this method is to think and act like a designer in the problem-solving process, this way of implementation appears to be a simplified version of "design thinking" that consists of stages (Li, & Zhan, 2022). This finding aligns with literature criticizing non-design educators' application of the DT approach as a linear process or their simplification of complex design processes (von Mengersen, 2023).

The OECD points out that social/emotional skills or moral/ethical values (such as a sense of belonging to school/environment, healthy social relationships, etc.) should be the focal point of the education curriculum along with academic achievement (OECD, 2018). Research has revealed that some OECD social/emotional skills coincide with DT mindsets, including optimism, empathy, collaboration, creativity, embracing ambiguity, and experimentation (Aksoy et al., 2020). It has been noticed that some of the strategies proposed for the implementation of prototyping or teamwork encompass values that are intended to be

developed in Turkish students (such as time management, trust, respect for the other party, etc. (Kaygan et al., 2025a). Accordingly, the essence of the DT approach and its implementation in activities naturally involves the implicit instruction of specific skills and values. Implicit teaching strategies integrated into activities using the DT approach can effectively develop social/emotional skills and values, compared to direct instruction. Consequently, the DT approach can be used to support the development of social/emotional skills and integrate societal values with 21st-century skills, as aimed by both the Turkish MONE and the OECD.

Except for three books (Kaygan et al., 2025b; Avcı et al., 2023; Tasarım Beceri Atölyeleri Öğretmen El Kitabı, n.d.), the target audience of other books is secondary school students and teachers/educators. The examination of the books reveals no substantial difference in the presentation and execution of the DT process based on students' educational levels. Although being released as two distinct volumes for high school and secondary school by Kaygan et al. (2025a, 2025b), the DT approach, narrative, and process are implemented nearly similarly in both books within the same project framework. Literature underscores the need to differentiate design education in secondary and high school (Choi, & Hyun, 2025). Accordingly, the presentation and implementation of the DT approach can be differentiated by taking into account the grade levels of the students.

Strategies for Integrating the Design Thinking (DT) Approach into Technology and Design Education

In the *Technology and Design* textbook in Türkiye, the course aims to teach and raise awareness of processes and concepts related to different technology and design disciplines, and collaboration with other disciplines is recommended. In the book, technology is used as a tool and to facilitate the problem-solving process within the units. The DT approach is not included in a single topic or unit. It is additionally posited that attaining these objectives may be unfeasible with a practical course offered for two hours weekly only in the 7th and 8th grades at the K-12 level, taught by teachers from various disciplines in schools with limited resources.

In the books investigated, there is the use of technology at any stage of the problem-solving process within interdisciplinary activities, or as a tool in this process, or in teaching technological content/skill related to problem solving within the DT process. Although the purpose of the books doesn't explicitly state that the DT approach is used for technology teaching/integration, the activities in the books demonstrate that the DT approach can be used for this purpose. The literature supports this suggestion that the DT approach is stated to be employed as a tool to establish a context for the use of technological tools for teaching a subject (González & Mella, 2021).

In the 2033 Türkiye Education Policies Strategy Document, it is stated that some of the 21st-century skills are lacking in teachers and students in secondary school education in Türkiye (Akgündüz, & Yulet Yılmaz, 2023). According to Dikpınar (2024), Türkiye's exam-focused educational system cannot give students 21st-century skills. In Türkiye, there is an absence of undergraduate programs specifically designed to train *Technology and Design* teachers,

resulting in instructors from diverse academic backgrounds teaching this subject. Similarly, Technasium (secondary school) in the Netherlands includes Research and Design course whose teachers have graduated from diverse disciplines and do not have prior knowledge about design (De Haan-Topolscak, Ebskamp, & Vos-de Tombe, 2024). Dikpınar (2024) recommends teaching *Technology and Design* teachers the DT approach to both enhance students' and teachers' 21st-century skills and facilitate design-based activities. Therefore, in countries without access to teacher education in the fields of technology and design or related ones, teachers can receive training in the DT approach to help them learn about design-related concepts and easily incorporate such interdisciplinary courses.

Technology is a multidisciplinary subject that merges scientific knowledge from different disciplines with creativity. Technology also means designing and producing, and using manual skills (Hanson, & Lucas, 2020). Design in technology education is perceived as a process used to identify problems (with empathy), design creative solutions, and gather information from interdisciplinary sources (ibid). Addressing the complex, multifaceted challenges of the 21st-century, such as the climate crisis, and rapid technological advancements, requires multidisciplinary, collaborative research. In this context, collaboration among teachers from diverse disciplines in the *Technology and Design* course is crucial for offering students an interdisciplinary viewpoint in the problem-solving process. At that point, the DT approach in *Technology and Design* education can help establish interdisciplinary connections and address problems from a holistic perspective (Dikpınar, 2024).

Considering the findings and the literature review, some recommendation is made to be employed in *Technology and Design* education implemented not just in Türkiye, but also in similar countries where there are exam-focused education systems and/or no subject-specific teachers.

Technology and Design courses may be delivered in a hybrid format, provided that students and schools have reliable internet access.

The use of non-location-based teaching methods that include digital technologies, such as blended or hybrid learning (online and face-to-face instruction together) or flipped learning (using pre-recorded audio, video, or reading digital teaching materials to prepare students for class with the teacher), in technology education can allow students to access information at their own learning pace (Winn, 2023). Given problems in technology integration in schools and the skills students are expected to acquire within a two-hour weekly *Technology and Design* course, this course may be implemented in a hybrid way at schools. The theoretical part of the course can be delivered online, supported by pre-recorded informative videos, while the practical part can be delivered in a two-hour course, more effectively through in-class practices. With the DT approach integrated into the course content, an interdisciplinary course that reinforces and teaches technology and design processes through practice and thus helps the development of certain content and skills, accessible to everyone, can be delivered. This way of approach can also facilitate the contribution of instructors/experts from different disciplines to the course in an online environment.

Modifications can be introduced to the stages of the design thinking (DT) approach applied in the Technology and Design course.
According to the literature, there is no single design process; rather, design processes may be specific to different fields or problems. For this reason, teachers may need to adapt the DT model or tools applied according to the problem to be solved, the grade level of the students, or different teaching objectives (Lin et al., 2025; Li, & Zhan, 2022).

The rise of data science has transformed design research and practice through the use of large language models like ChatGPT and rendering generators like Midjourney in the context of research, data collection/analysis, design prototyping, and development. Accordingly, this course, provided in a hybrid learning environment, can be planned to utilize AI technologies and tools, which both the Turkish MONE and UNESCO encourage for use in education (Sevil, 2025; Miao, & Holmes, 2023). The AI-assisted DT approach can accelerate the problem-solving processes in conducting user research, data collection, analysis, idea generation, visualization and testing, and facilitate the delivery of this course in both online and hybrid formats. This approach can also help students adapt to the changing working and design processes associated with AI technology, starting in secondary school.

Within the scope of findings and literature review, some differentiations in the stages of the DT approach can be made for the *Technology and Design* course. At first, theoretical or hands-on training can be given to students about tools used in the problem-solving process (such as AI tools, prototyping tools, or methods) before starting to apply the DT process. Then, the DT process can be taught and reinforced through practice within the problem-solving process. Secondly, the methods applied at each DT stage can be modified by taking into account the difficulty level of the methods, the experience of students and teachers using the DT approach, and the educational objectives. Thirdly, a stand-alone activity that concentrates on one stage or one tool can be implemented due to the benefits it provides to students and the convenience it provides in time management and application. Lastly, the DT approach integrated in this course can include the following stages: Empathize, Define, Ideate, Prototype, Test, Evolution, Presentation and Dissemination.

Empathize and Define Stages.
In these stages, two different approaches can be included in the problem-solving process: creating a new need in addition to finding a need and iterating the data collection and processing.

In recent years of rapid technological change, new products, technologies, and services are being invented to address needs people hadn't previously considered, or even knew, or realized they needed. Instead of designing products and services based on identified needs, as in the past, new products and services are being designed to create new needs or to address hidden needs. For example, 20 years ago, no one would have imagined that everyone would need a smartphone small enough to carry in their pocket, capable of communicating anywhere, with a camera, internet access, or e-mail (Barak, 2020). Accordingly, in the DT process to be taught in design and technology courses, an *Empathize* stage can be designed that addresses the issue of how to create new needs as well as the

need identification using the DT approach. This approach allows students to explore the ways to imagine/invent new digital products by creating new needs/uses.

Every user interaction with the product/system is a source of data that will enhance AI's learning, leading to more personalized and efficient design solutions. Therefore, the data-driven design process involves a cyclical, ongoing process of collecting data, analyzing it, making design decisions, and collecting more data after each new interaction (Cain, & Pino, 2023). At that point, generating a new product in the context of machine learning and artificial intelligence needs iterative data collection/capturing and interpreting/analyzing the data. Along with the iterative prototyping and testing stages, a continuous iteration in the *Empathize* and *Define* stages of the DT approach can be employed to prepare students for a data-driven future.

Ideate Stage.
At this stage, in addition to applying traditional brainstorming methods by pairing with other students, students can also apply brainstorming methods and produce multiple ideas together by working in partnership with AI to generate ideas. Furthermore, within the scope of this stage, the meaning of the word "product" should be explained to students to make them understand the types of products and their variations in different disciplines (such as tangible, digital, interior, exterior, building, software, system, or service products). In that way, they can see their options while developing ideas in the problem-solving process.

Prototype Stage.
This stage includes the production of low-fidelity prototypes and testing the concepts with students before user testing. In this stage, along with the d.school prototyping methods, prototyping with digital tools (software prototype) can be included as an option to develop digital/mobile/web products or systems. With the help of AI tools, students can easily build software designs even without having coding experience. Software/digital prototyping can also facilitate technology integration in education under three categories: for example, creating software with Raspberry Pi (technology as a tool) to solve a traffic signaling problem (technology to facilitate the problem-solving process) and developing algorithmic thinking skills (technology to teach technological contents or skills) (Avcı et al., 2023).

Test and Evolution Stages.
In the *Test* stage, the results of the tests conducted with students are evaluated, and low-fidelity or, if possible, high-fidelity prototypes of the selected concepts are produced and iteratively tested with real users. The *Evolution* stage includes evaluating the test results, improving them if necessary, and then planning the production process for the selected design. For this purpose, specialists from diverse disciplines, including engineering, manufacturing, or marketing, can be invited to the class to get feedback from them and to learn the real manufacturing planning process.

Presentation and Dissemination Stage.
In this stage, students are encouraged to prepare presentations, logos, media content, or websites for introducing and marketing their products to users/students and for applying for

patent/utility model acquisition and for participating in national/international project competitions. This way of approach can increase students' motivation in the problem-solving process.

Certain stages and tools of the Design Thinking (DT) approach can be emphasized in this course, as they offer pedagogical benefits for students and support effective time management and implementation.
In a data-driven design approach, certain mindsets and strategies are crucial for designers to interact with and manage data. Accordingly, the designer has a facilitating and integrating role between technology, design, and other disciplines; therefore, *collaboration with human and non-human (datasets, AI tools) stakeholders* is essential. Due to the constant changes and evolution of data, it's also crucial to embrace the complexities and uncertainties inherent in the design process. Therefore, *navigating uncertainty* (also called embracing ambiguity (Hanson, & Lucas, 2020)) remains a crucial mindset for designers (Cain, & Pino, 2023).

The literature also points to the importance of certain mindsets considered important in technology education and development, which also exist within DT mindsets: these are, critiquing (includes getting feedback and taking risks in the problem-solving process), imagining (includes creativity, embracing ambiguity, and reflective thinking in the problem-solving process), making (consists of the design process from sketching to prototyping, and learning from failure), and human-centered designing (empathizing with people to understand them and collaborating with diverse disciplines) (Hanson, & Lucas, 2020).

Given the findings, some recommendations are made for implementing the DT as a holistic approach in education. Instead of implementing 5 or 6 stages of the DT approach, teachers can design a stand-alone activity that concentrates on one stage (*Empathize* or *Test* stages) or one tool (implementing a *brainstorming* activity). Teachers can make incremental progress toward gaining students' acceptance of the DT process and mindsets (Zielezinski, 2017).

The literature suggests that individual DT stages can be flexibly integrated into any part of a course to emphasize DT's non-linear, flexible process (Lin et al., 2025). The DT skills that need to be developed most in both teachers and students emerge in the *Empathize, Prototype,* and *Test* stages (Watkins et al., 2020; Zielezinski, 2017). Empathy-focused DT instruction is considered to foster understanding of user needs and finding human-centered solutions (Lin et al., 2025). These activities can also help students engage in iterative prototyping and user testing and develop empathy, experimentation, and collaboration skills (Goldman et al., 2017; Zielezinski, 2017).

Encouraging students to reflect on each implemented DT stage and method can improve long-term retention of students' learning. Teachers' specific feedback and reflection at various points throughout the learning process can also lead students to self-assess their approach to problem-solving and experiment with different approaches to completing their tasks. Activities centered on the iterative prototyping process can be carried out for this

purpose. DT training, focusing on prototyping activities, can be easily integrated into existing learning processes, enables concrete creative ideas, and teaches students to receive and evaluate feedback, as well as to learn from failures through iterative practices in prototyping and testing processes (Lin et al., 2025). This way of approach also encourages students to adopt experimental, risk-taking, and collaborative mindsets (Watkins et al., 2020; Zielezinski, 2017). Practicing a design-based activity can help students tolerate challenging problem-solving processes and adopt a mentality of embracing ambiguity (Watkins et al., 2020).

Conclusion

While many studies examine DT in general education settings, this article's analysis of government-published materials offers insight into how a national education system approaches and disseminates modern pedagogical concepts. This article also makes a significant contribution by providing concrete suggestions for directly applying DT to *Technology and Design* education.

To improve the incorporation of DT into *Technology and Design* education, several strategies can be employed, considering the educational level of students. First, *Technology and Design* courses can be offered in a hybrid format, provided schools and students have dependable internet access. This approach offers greater flexibility in learning environments and enables the effective use of both physical and digital resources. Second, modifications can be made to the stages of the DT approach implemented in the course. These adaptations will better align the structure of the DT process with course objectives, learning outcomes, and classroom conditions. Finally, specific stages and tools of the DT approach can be highlighted in this course because they provide pedagogical benefits for students and support effective time management and implementation.

Analyzing DT books has the potential to inform educational practice and curriculum development. In future research, researchers can undertake systematic comparisons of basic DT books to find shared themes, methodological discrepancies, and theoretical evolution. Future reviews can also incorporate an examination of both books and research articles to provide a more comprehensive understanding of the evolution of DT.

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