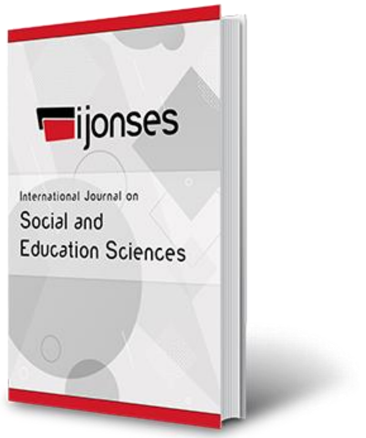

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Abstract

This study aims to develop a scale to measure the design thinking process and to evaluate the reliability and validity of this scale. It fills this gap by introducing a 36-item scale specifically designed to measure design thinking abilities across the five key stages of the design thinking process: empathize, define, ideate, prototype, and test, to provide an accurate assessment of individual abilities across these stages. Aligned with the well-established design thinking process, the scale comprises five sub-dimensions, each focused on a specific stage. It employs a 5-point Likert-type response format, ensuring nuanced feedback. Rigorous psychometric evaluations confirmed the scale's trustworthiness. Internal consistency within each sub-dimension was exceptional, with Cronbach's alpha coefficients exceeding .80 across all stages. Remarkably, the overall scale achieved an outstanding .95 Cronbach's alpha, signifying unparalleled cohesiveness and reliability. Validity was further established through rigorous statistical analyses. Exploratory component analysis (EFA) accounted for 60% of the variance, confirming the structure and demonstrating strong item-to-factor loadings (ranging from .31 to .74). Confirmatory factor analysis (CFA) provided additional validation, with all fit indices exceeding established benchmarks, solidifying the scale's accuracy and applicability. Beyond these impressive psychometric qualities, the study offers several key advantages. The concise 36-item format ensures efficient administration and analysis, while the five distinct sub-dimensions allow for targeted evaluation of specific strengths and weaknesses within each stage. This detailed feedback holds immense value for researchers, educators, and professionals seeking to cultivate design thinking capabilities in diverse settings. By providing a validated and reliable tool for design thinking assessment, this study empowers a comprehensive understanding of individual strengths and weaknesses across the five critical stages. This, in turn, enables targeted interventions and fosters the development of effective design-thinking skills in various contexts.

Introduction

Design thinking is a human-centred approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success (Brown, 2009). It is a creative problem-solving process that can address a wide range of challenges, from improving the user experience of a product to developing new business models.

However, effectively assessing Design Thinking skills is a challenge that prevents the full potential of this approach from being realised. Existing assessment methods are often subjective, time and cost-hungry, and limited in generalisability to different contexts (Hmelo-Silver et al., 2017). Recognizing the valuable contributions of existing Design Thinking (DT) skill assessments (Taheri et al., 2016; Chesson, 2017; Greene et al., 2019; Atabek, 2020; Sürmelioğlu & Erdem, 2021), this research aims to develop a new scale specifically tailored for university students. This new scale will strive to address potential gaps in existing assessments by ensuring alignment with established frameworks like the Stanford d. school model (EMPATHISE, define, ideate, prototype, test) (IDEO, 2015), while also considering the unique needs and learning environment of university students. By providing a comprehensive and contextually relevant assessment tool, this research aims to enhance the evaluation of DT skills among university students, ultimately contributing to their learning and development in this critical area. Design thinking differs from traditional problem-solving in several ways. First, design thinking is user-centred, while traditional problem-solving is often focused on the needs of the business or organization. Second, design thinking is iterative, with a focus on prototyping and testing solutions. (Kelley & Kelley, 2013). Third, design thinking is collaborative, involving a team of people with different skills and perspectives. (Liedtka, 2018).

Design thinking provides various benefits, including amplified creativity and innovation (Brown, 2008), refined problem-solving capabilities (Martin & Osterwalder, 2015), elevated user experience, enhanced collaboration and teamwork (Liedtka, 2015), along heightened agility and adaptability. While Design Thinking may be commonly associated with business and product development, its impact extends far beyond. It holds immense potential to revolutionize education by fostering crucial skills in young learners. These skills, including creativity, critical thinking, teamwork, communication, and problem-solving, align perfectly with the demands of 21st-century education, where active participation and adaptability are vital.

This synergy between Design Thinking and education manifests in several ways:

- Partnership with STEM/STEAM education: Both approaches emphasize deep learning, inquiry-based learning, and collaborative problem-solving, creating a natural partnership to cultivate these valuable skills (Yalcin & Erden, 2023).
- Alignment with the constructivist approach: The constructivist approach prevalent in the Turkish education system, with its focus on active learning and collaboration, provides fertile ground for integrating Design Thinking (Boland, 2018; Taspinar, 2022).
- Promoting student participation and real-world application: By incorporating Design Thinking, we can encourage student engagement, teamwork, and the application of knowledge to real-world challenges, fostering a lifelong learning mindset.

In essence, Design Thinking offers a powerful bridge between theory and practice, equipping young learners with the skills to thrive in a dynamic and demanding world. Its integration into education holds immense promise for the future of learning and development. Indeed, the Turkish Ministry of National Education's 2023 Education Vision document and "Design Skill Workshops" initiative demonstrate a strong commitment to design thinking. This personalized approach allows schools to tailor their programs, ensuring alignment with local needs and student interests. (MoNE, 2023).

This study aims to develop a reliable and valid scale specifically designed to assess DT skills among university students. By focusing on key skills like empathy, problem-solving, and collaboration, the scale will address the limitations of existing tools and provide valuable insights into students' strengths and weaknesses. Ultimately, this research will contribute to improving the effectiveness of DT education and its impact on preparing students for success in a complex and integrated world.

Method

Participants

This study aims to develop a scale that assesses the design thinking skills of university students. The study involved 600 university students from diverse faculties across state and foundation universities in Turkey, including Yeditepe, Istanbul Technical, Medipol, Istanbul, Mehmet Akif Ersoy, Dicle, Cukurova, Harran, Mersin, Ankara, Gazi, and Duzce, throughout the spring term of the academic years 2022 and 2023. The method of convenience sampling was utilized for participant selection, allowing researchers to choose easily accessible environments (Ekiz, 2013, p. 12; Yildirim & Simsek, 2016, p. 189; Buyukozturk, 2022, p. 150). Through a demographic survey, various aspects of the respondents were investigated, resulting in a substantial amount of data.

The results indicate a relatively even gender distribution, with 53.1% (N = 318) female participants and 46.9% (N = 282) male participants. Similarly, the distribution across academic years shows a balanced pattern, with the largest percentage of students in the fourth year (27.6%, N = 166), followed closely by the third year (26.5%, N = 159), the second year (22.7%, N = 136), and the first year (23.2%, N = 139). Regarding enrolment in specific faculties, 4% of participants (N = 24) are spread across various fields, including Naval Architecture and Marine Engineering, Medicine, Textile Technologies and Design, Education, Agriculture, Veterinary Medicine, Economics and Administrative Sciences, Mechanical Engineering, Health Sciences, Arts and Sciences, Business Administration, Dentistry, Fine Arts and Design, Law, Mining Engineering, Maritime Studies, Aeronautics and Astronautics, Political Sciences, Pharmacy, Communication, and Aquatic Sciences.

Additionally, 2.66% (N = 16) are enrolled in Electrical and Electronics Engineering, while 5.33% (N = 32) are pursuing studies in Architecture and Civil Engineering. Further analysis reveals that 48.7% (N = 292) of students have their current department as their first preference, while 28.3% (N = 169) have it as their 2nd to 5th preference, 11.7% (N = 70) as their 6th to 10th preference, and 11.03% (N = 66) as their 10th preference or beyond. Finally, in terms of GPA levels, 2.5% (N = 15) of students scored less than 1, 6.8% (N = 41) scored between 1 and 2, 43.2% (N = 259) scored between 2 and 3, and 47.5% (N = 285) scored between 3 and 4.

Research Instrument

This study developed a 36-item scale to assess individual ‘’design thinking’’ abilities (see Appendix for the survey items). Aligned with the ‘’design thinking model,’’ the scale features five sub-dimensions: EMPATHISE (7 items), define (6 items), ideate (11 items), prototype (8 items), and test (4 items). Every item has a 5-point Likert-type rating scale, ranging from "Strongly Disagree" (1) to "Strongly Agree" (5). The validity and reliability of the scale were rigorously evaluated. Cronbach's alpha coefficients revealed high internal coherence in each sub-dimension: EMPATHISE (.86), define (.88), ideate (.87), prototype (.81), and test (.78). Surprisingly, the aggregate Cronbach's alpha for the whole scale achieved an outstanding.95, showing extraordinary cohesiveness and reliability. The scale's validity was confirmed further using exploratory component analysis (EFA), which accounted for 60% of the overall variance, with items neatly loading into five unique factors matching the desired sub-dimensions. Factor loadings ranged from .31 to .74, demonstrating strong relationships between items and their respective factors. Confirmatory factor analysis (CFA) provided additional validation. Fit indices were excellent across all metrics: $x^2/SD = 3.23$, RMSEA = .07, GFI = .85, NFI = .95, CFI = .97, and RMR = .057. These numbers imply a strong fit between the predicted results and the actual data, presenting further proof of the scale's accuracy and applicability in evaluating design thinking. To summarize, this study accomplished the creation of a 36-item scale for measuring individual design thinking talents spanning its critical stages. This tool holds significant potential for researchers, educators, and professionals seeking to evaluate and cultivate ‘’design thinking capabilities’’ in various contexts.

Scale Development

The focus of our research was to develop a trustworthy and legitimate scale for assessing abilities in design thinking in undergraduates. Following (DeVellis, 2016, 2017; DeVellis & Thorpe, 2021) seven-stage scale development framework, the process unfolded meticulously:

1. Defining the Target: Design thinking was chosen as the construct, and an initial theoretical model was formulated. An extensive literature review revealed a scarcity of design thinking measures, (Taheri et al., 2016; Chesson, 2017; Greene et al., 2019; Atabek, 2020; Sürmelioglu & Erdem, 2021), highlighting the need for this research.
2. Generating Item Pool: Leveraging the five-stage model by ‘’Stanford University's Hasso-Plattner Design Institute (empathy, define, ideate, prototype, test),’’ a preliminary item pool of 70 statements was created, capturing various facets of design thinking.
3. Selecting Measurement Format: The Likert-type scale, a widely used format for assessing attitudes and beliefs, was chosen due to its ease of use and data analysis capabilities.
4. Expert Review: To ensure content validity, the draft scale with 60 items underwent review by field and language experts. Their feedback led to refinements in wording and structure, reducing the item pool to 40.
5. Validation Items: The proposed Design Thinking Scale (DTS) included 40 items across five sub-dimensions, with some items measuring overlapping constructs.
6. Item Evaluation: The draft scale was administered to 600 university students, a sufficient sample size according to Comrey & Lee (1992). The scale's structure and item performance were assessed using EFA and CFA. EFA facilitated the identification of overlapping items (1, 28, 29, 36), leading to their removal and finalizing the scale at 36 items.

7. Optimizing Scale Length: Prioritizing internal consistency and conceptual coherence, items with low factor loadings and average correlations were excluded. This refinement process led to the final 'Design Thinking Scale (DTS)' consisting of 36 items, distributed across five sub-dimensions: "EMPATHISE," "Define," "Ideate," "Prototype," and "Test." Following refinement, the updated scale was circulated via email to a larger sample of students (n=600) from 12 Turkish universities using Google Forms. Depending on individual reading speed, the average response time ranged from 5 to 6 minutes.

These multiple-step strategies depend on well-established principles. guidelines and rigorous data analysis resulted in a reliable and valid design thinking scale for university students. This scale contributes to the field by addressing the gap in design thinking measurement and provides investigators and instructors with an invaluable instrument for assessing and strengthening design thinking abilities among learners.

Data Analysis

This study sought to develop the Design Thinking Scale and assess its psychometric properties. Descriptive statistics were computed using SPSS-24 software, while confirmatory factor analysis and structural correlations were performed using LISREL 8.80. To evaluate the scale's validity and reliability, both exploratory and confirmatory factor analyses were conducted with data from the study group. Initially, the factor structure of the scales was examined through exploratory factor analysis (EFA) according to the research question's specifications. Subsequently, the validity and reliability of the scores were assessed via confirmatory factor analysis. The results of the CFA demonstrated the validity and reliability of the scales. Exploratory Factor Analysis (EFA) is a method utilized to uncover the underlying factor structure within observed data, while Confirmatory Factor Analysis (CFA) is employed to evaluate a predetermined factor structure. EFA offers greater flexibility, allowing for data-driven exploration, whereas CFA is focused on testing models and confirming hypotheses (Thompson, 2004; Hair, et al., 2021).

Results and Discussion

This section presents the results of preliminary analyses, which consist of holistic analyses of descriptive statistics for normal distribution, CFA and DFA in terms of validity, and reliability.

Preliminary Analyses

As shown in Table 1, individual scores from the DTS were compiled for each student, and the overall scores were averaged. The empathize sub-dimension displayed a range of scores, from a minimum of 7 to a maximum of 35. Similar ranges were observed for the other sub-dimensions: define (6-30), ideate (11-55), prototype (8-40), and test (4-20). The overall scores on the DTS ranged from 36 to 180. An analysis of the scores revealed that students achieved average performance in all sub-dimensions: empathize (29.13 ± 4.32), define (24.10 ± 4.22), ideate (44.71 ± 7.21), prototype (31.85 ± 5.62), and test (15.84 ± 3.00). The overall score (145.65 ± 21.71) also reflected an average performance.

Table 1. Descriptive Statistics of DTS for Normal Distribution

Subdimension	N	Minimum	Maximum	Median	Mean	Sum ($\bar{X}$)	S. D	Skewness	Kurtosis
Empathize	600	7	35	29	29.13	21849	4.32151	-0.951	2.034
Define	600	6	30	24	24.1	18079	4.22604	-0.646	0.862
Ideate	600	11	55	45	44.71	33535	7.21012	-0.911	1.588
Prototype	600	8	40	32	31.85	23892	5.62424	-0.659	0.836
Test	600	4	20	16	15.84	11886	3.00571	-0.659	0.83
DTS Overall	600	36	180	146	145.65	109241	21.71172	-1.285	2.342

***p < .001.

According to Liedtke (2013), students with high design thinking proficiency are more likely to leverage it for enhanced creativity and problem-solving skills. The ideate dimension, with the highest mean (44.71 ± 7.21), assesses the capacity to generate and refine original ideas. It's important to note that the means for define (24.10 ± 4.22) and empathize (29.13 ± 4.32) are also relatively high. These dimensions assess a person's ability to understand and define user needs (empathize) and translate those needs into actionable steps (define).

Additionally, there are comparatively high means for the define and empathize dimensions. Prototype and test exhibit lower averages, which measure the capacity to comprehend and define user needs and assess a person's ability to design and evaluate prototypes. Therefore, compared to prototype and test, ideate, empathize, and define may be easier to quantify, could encompass more widely applicable abilities, or may assess more challenging and sophisticated skills.

The analysis of the research scale suggests that parametric tests may be appropriate if the skewness and kurtosis values fall within certain ranges. According to Hair et al. (2021), skewness and kurtosis values between +1.0 and -1.0 indicate suitability for parametric tests. Similarly, Tabachnick and Fidell (2013) suggest that values between +1.5 and -1.5 are acceptable for parametric tests. George & Mallery (2010) propose a slightly wider range, with values between +2 and -2 being considered acceptable for parametric tests.

In this context, for the Design Thinking Scale's overall dimension and its sub-dimensions, parametric analyses could be conducted if the skewness and kurtosis values meet the criteria specified by these authors. The histograms and Normal Q-Q Plot values for the scales are sequentially presented in Figure 1 and 2.

Psychometric Properties of DTS

A comprehensive scale development study established the DTS as a valid and reliable assessment tool. To ensure the scale's dependability, the study rigorously re-evaluated the DTS's validity and reliability assessments, utilizing both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), alongside computing Cronbach's alpha reliability coefficients.

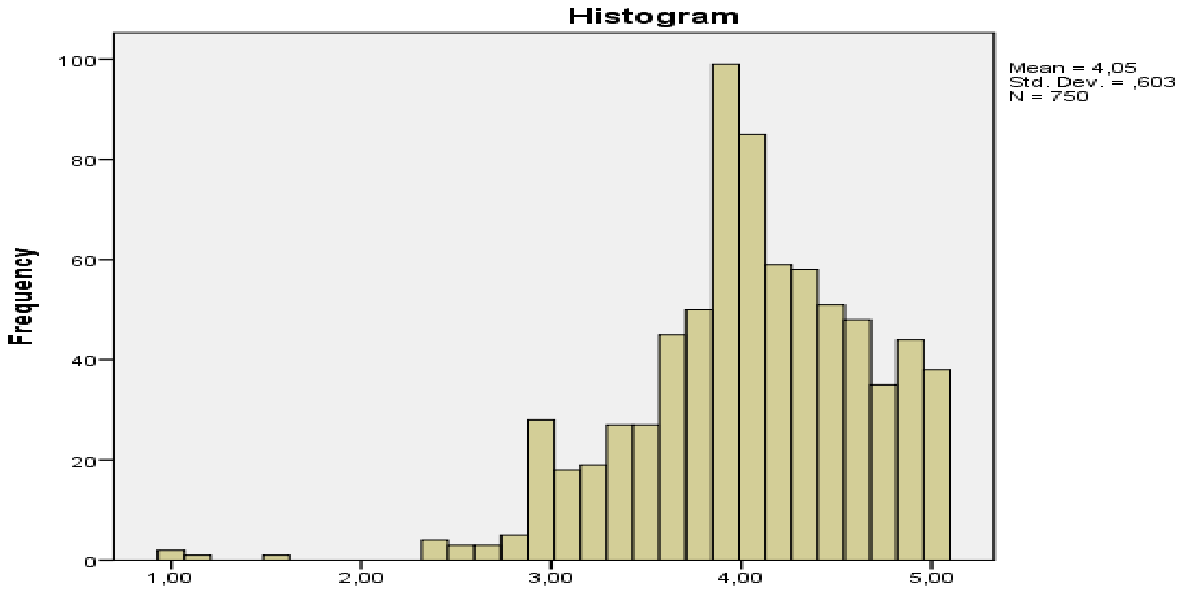

Figure 1 DTS Overall Dimension

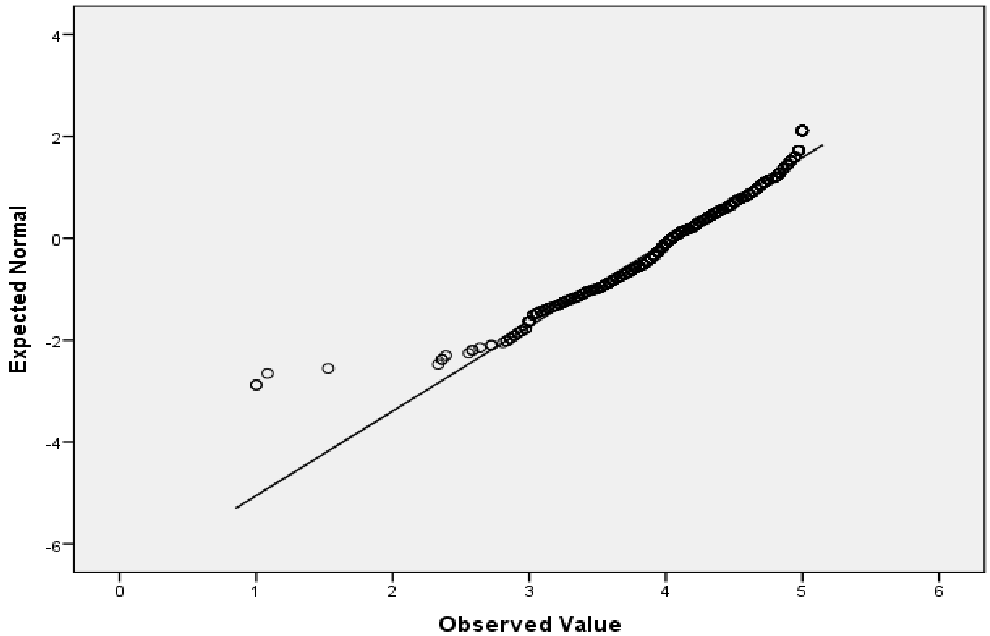

Figure 2 Normal Q-Q Plot of DTS Overall Dimension

Initially, the Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's Sphericity test were performed on the data collected from the pre-application of the Design Thinking Skill Scale to assess the eligibility of the study data for EFA. The KMO score, calculated to be 0.95, indicated that the model is well-suited for factor analysis. Additionally, Bartlett's Sphericity test yielded significant findings ($\chi^2 = 13258.66$, $p < .05$), confirming that the scale data are appropriate for EFA.

The exploratory factor analysis was conducted using Principal Component Analysis and the Direct Obimin approach. The determination of the number of factors was based on the line graph, factor eigenvalue values, and cumulative variance. This meticulous process ensures that the Design Thinking Skills Scale not only meets the standards for validity and reliability but also adheres to the principles of robust factor analysis.

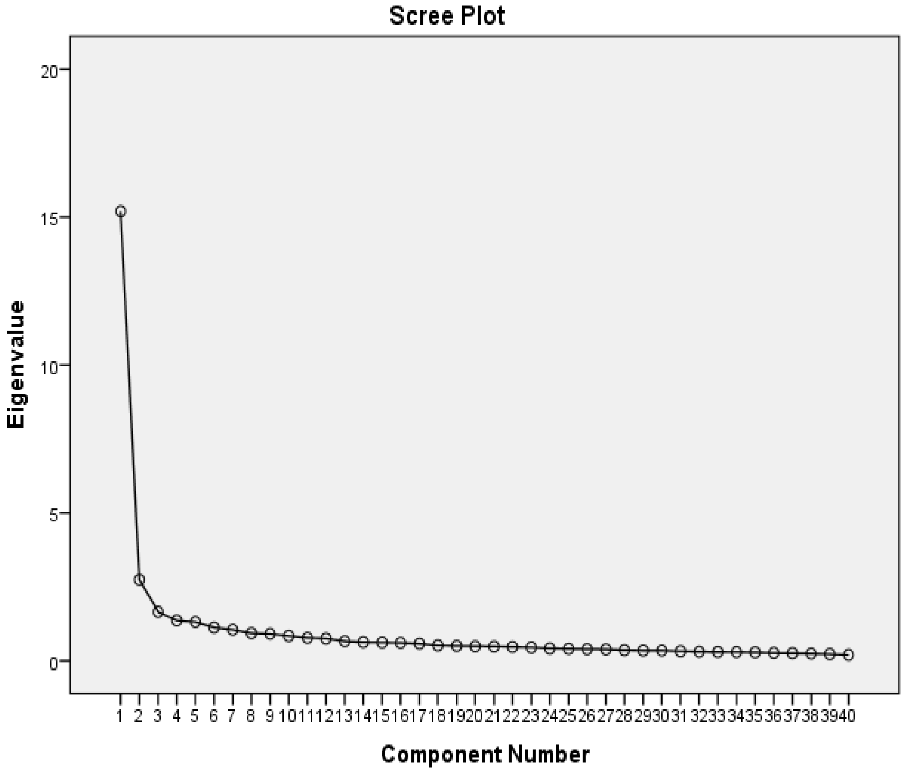

Figure 3. Scree Plot of the DTS

The results of the factor analysis indicated the presence of five factors, each with an eigenvalue greater than one. This study validates the five-factor framework of the DTS. Together, these five factors explain 60% of the overall variation, surpassing the requirement set by Yaslioglu (2017) that the explained variance should exceed 50%. This confirmation underscores the robustness of the EFA findings.

Table 2. Exploratory Factor Analysis (EFA) and Reliability Results of the DTS

Sub-dimensions	Number of items	KMO	Bartlett's $\chi2$	Variance explained%	Factor load		Cronbach's Alpha
					Lowest	Highest	
DTS Overall	36				.317	.748	.95
Empathize	9				.522	.675	.88
Define	9	95.4	11346.46 p:.000	60	.476	.644	.87
Ideate	6				.317	.748	.81
Prototype	4				.483	.551	.78
Test	8				.483	.696	.87

$^{***}p < .001$.

Table 2 displays the factor loadings for the DTS, demonstrating significant magnitudes across the five factors.

The factor loadings for the "Empathize" dimension range from 52 to 67, for "Define" they range from 47 to 64, for "Ideate" they range from 31 to 74, for "Prototype" they range from 48 to 55, and for "Test" they range from 48 to 69. Overall, the scale's factor loadings span from 31 to 74.

According to Cokluk et al. (2016, p. 194), an item factor loading value of .60 and higher suggests a high magnitude, while a value between .30 and .59 indicates a medium magnitude. The Cronbach's Alpha coefficients for the Design Thinking Scale factors are .88 for "Empathize," .87 for "Define," .81 for "Ideate," .78 for "Prototype," and .87 for "Test."

The exploratory factor analysis efficiently categorizes the items into five factors, accounting for 60% of the total variance. This highlights the scale's construct validity and reliability. Before the large-group application, overlapping items (1, 28, 29, and 36) were eliminated, resulting in a final scale of 36 items and 5 sub-dimensions. Table 3 presents the findings of Confirmatory Factor Analysis (CFA), which was employed to validate the factor structure identified by EFA. The fit indices indicate that the Design Thinking Skills Scale is a good fit, reinforcing its structural integrity.

Table 3. Confirmatory Factor Analysis (CFA) Results for the DTS

CMIN(X^2)	SD	$\chi 2$/SD	RMSEA	GFI	CFI	NFI	RMR
1889.55	584	3.23	0.071	0.85	0.97	0.95	0.057

The Confirmatory Factor Analysis (CFA) results for (DTS)' indicate a degree of freedom (DF) of 584 and a chi-square (χ^2) value of 1889.55. Following Sumer (2000) recommendations, a chi-square/degree of freedom value of three or fewer suggests a perfect fit in terms of fit indices. The χ^2/DF value for the scale was calculated as 3.23, indicating a good match as the model fit falls within the acceptable range.

Additionally, RMSEA (Root Mean Square Error of Approximation) and RMR (Root Mean Square Residual) values of ".08" or less, and GFI (Goodness of Fit Index), CFI (Comparative Fit Index), and NFI (Normed Fit Index) values of ".90" or greater, often indicate a strong fit (Hooper et al., 2008; Brown, 2006; Sumer, 2000). Based on the fit indices derived from the CFA results, the scale demonstrates a good fit in this particular investigation, indicating that the model aligns well with the observed data.

Figure 4 illustrates the coefficients and path map for item-factor correlations generated using CFA, offering a comprehensive overview of the associations among items and factors on the DTS. Figure 4 illustrates the structural and correlation coefficients that elucidate the relationships between each item on the scale and its corresponding dimension. Upon examining the goodness-of-fit values of the scale, it was observed that the scale exhibits a satisfactory fit, as evidenced by its acceptable Comparative Fit Index (CFI) and Root Mean Square Residual (RMR) values despite slightly elevated chi-square/degree of freedom (χ^2/DF) value. While specific fit indices may reveal limitations, the detailed structural insights provided by Figure 4 reaffirm the overall appropriateness of the Design Thinking Skills Scale in aligning with the proposed factor structure.

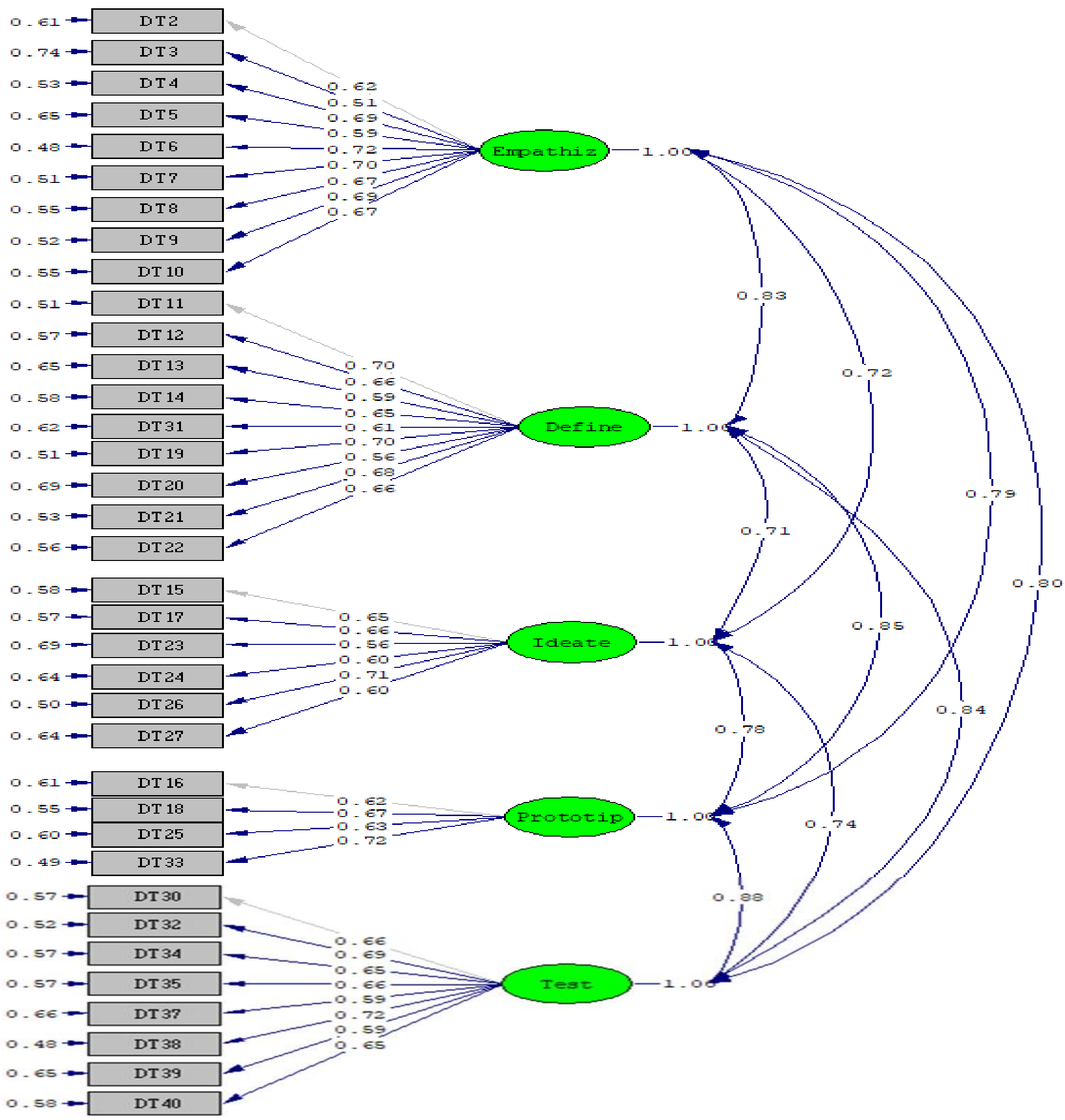

Figure 4. CFA Results for the Path Diagram of the DTS: Path Analysis

Conclusions and Suggestions

This study investigated the validity and reliability of a scale measuring students' design thinking skills (DTS). The findings of this study indicate that the performance of university students in design thinking skills in general is high. Supporting the result obtained from the design thinking scale data, previous studies in different disciplines have shown that teaching design thinking principles to students has positive effects in areas such as problem-solving, communication, empathy, STEM skills, creativity and entrepreneurship. For example, Taheri et al. (2016), who designed a curriculum for engineering students, found that it was effective in improving students' problem-solving skills. Similarly, Chesson (2017), who taught design thinking principles to university students, showed that design thinking was effective in improving students' clinical skills.

In addition, Greene et al. (2019), who taught design thinking principles to engineering students, and Atabek (2020), who developed a scale for pre-service teachers, reached similar results. All of these studies support that curriculum are an effective strategy for developing the design thinking skills of university students. Therefore, we can say that the findings support that university students generally have high performance in design thinking skills.

Factor analysis results confirmed the five-factor structure of the DTS (empathize, define, idea**te**, prototyp**e**, test). These findings indicate that the DTS comprehensively measures the important stages of the design thinking process. The five-factor structure of the DTS is consistent with the findings of previous design thinking research. The scale showed high reliability and construct validity by both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Supporting the study results, Dosi, Rosati, and Vignoli (2018) aimed to develop and validate a "design thinking mindset" scale.

The findings revealed that the scale showed high reliability and construct validity through both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Similarly, the EFA and CFA results of Surmelioglu, and Erdem, (2021) study, which aimed to develop a valid and reliable scale for determining the design thinking constructs of teachers in the technology-based instructional design process, showed that the scale had high reliability and construct validity. Recently, Cai, & Yang, (2024) developed and validated the "Design Thinking Teaching Scale" (DTTS). To summarize, it shows that the instruments developed for the measurement of design thinking skills are becoming increasingly reliable and valid. However, it is important to consider the characteristics and limitations of different scales. Referring to more than one source and approach when measuring design thinking skills will provide a more comprehensive and accurate assessment. Although it is a positive result that students performed above average, the study was conducted with a relatively small number of students. It may be useful to repeat the study with larger and different groups for generalizability.

Future research should employ both quantitative and qualitative methodologies to thoroughly investigate the development of students' design thinking skills. Exploring the validity and reliability of the Design Thinking Scale (DTS) across diverse cultural contexts would offer valuable insights. Despite generally good fit results from factor analysis, the slightly high χ^2/DF value suggests the need for re-evaluation of the model's fit using a larger dataset. It is recommended to conduct future studies with larger and more diverse student cohorts. Employing a combination of quantitative and qualitative approaches to examine the development of students' design thinking skills is advisable. Additionally, exploring the validity and reliability of the DTS across different cultural contexts could provide further insights.

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Appendix. Design Thinking Scale

DESIGN THINKING SCALE	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1. I usually try to understand the perspective of others.	(1)	(2)	(3)	(4)	(5)
2. I am aware of my own emotions.	(1)	(2)	(3)	(4)	(5)
3. I can easily understand the needs of others in any situation.	(1)	(2)	(3)	(4)	(5)
4. I observe my surroundings.	(1)	(2)	(3)	(4)	(5)
5. I consider user needs when designing.	(1)	(2)	(3)	(4)	(5)
6. I prefer communicating directly with users to ensure my design meets their expectations.	(1)	(2)	(3)	(4)	(5)
7. I listen to other people's ideas.	(1)	(2)	(3)	(4)	(5)
8. I can effectively communicate my design/product.	(1)	(2)	(3)	(4)	(5)
9. I can express my ideas concretely.	(1)	(2)	(3)	(4)	(5)
10. I handle all aspects of a job/task I work on.	(1)	(2)	(3)	(4)	(5)
11. I identify the steps involved in solving complex problems I encounter.	(1)	(2)	(3)	(4)	(5)
12. I enjoy redefining or restructuring problems I need to work on.	(1)	(2)	(3)	(4)	(5)
13. I listen to users' experiences regarding the design I made.	(1)	(2)	(3)	(4)	(5)
14. My imagination has improved.	(1)	(2)	(3)	(4)	(5)
15. I enjoy generating original ideas.	(1)	(2)	(3)	(4)	(5)
16. My friends tell me that I have creative ideas.	(1)	(2)	(3)	(4)	(5)
17. I like to think about possibilities.	(1)	(2)	(3)	(4)	(5)
18. When I encounter a problem, I think of multiple solutions.	(1)	(2)	(3)	(4)	(5)
19. I collaborate with my friends to generate ideas.	(1)	(2)	(3)	(4)	(5)
20. I value the ideas of my friends I work with.	(1)	(2)	(3)	(4)	(5)
21. I always want feedback from relevant people on my work.	(1)	(2)	(3)	(4)	(5)
22. I use my intuition to make design decisions.	(1)	(2)	(3)	(4)	(5)

23. The best part of problem-solving is coming up with ideas.	(1)	(2)	(3)	(4)	(5)
24. I see creativity as a mental activity.	(1)	(2)	(3)	(4)	(5)
25. I enjoy designing.	(1)	(2)	(3)	(4)	(5)
26. I easily apply the steps of the design process.	(1)	(2)	(3)	(4)	(5)
27. I refer to good examples of existing work in my work.	(1)	(2)	(3)	(4)	(5)
28. I constantly use technology to create/produce/create a product.	(1)	(2)	(3)	(4)	(5)
29. I pay attention to the product being innovative and original.	(1)	(2)	(3)	(4)	(5)
30. I can visualize the model in my mind.	(1)	(2)	(3)	(4)	(5)
31. I use trial and error method when creating models.	(1)	(2)	(3)	(4)	(5)
32. Models help to understand how the solution will be realized.	(1)	(2)	(3)	(4)	(5)
33. I attach importance to pilot applications.	(1)	(2)	(3)	(4)	(5)
34. I review whether any design I create is feasible.	(1)	(2)	(3)	(4)	(5)
35. I always compare my final design with the first project examples.	(1)	(2)	(3)	(4)	(5)
36. I finalize the design by considering the implementation results.	(1)	(2)	(3)	(4)	(5)