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Eyüp Yurt
Bursa Uludağ University, Turkiye

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Abstract

This study aimed to develop and validate the Creative Problem-Solving Skills Test (CPSS-T), grounded in Torrance's creativity theory, to assess these skills in university students. The CPSS-T consists of five open-ended question types, each designed to measure different aspects of creative problem-solving: Alternative Use, Hypothetical Scenario, Problem-Solving, Visual Interpretation, and Future Design. Content validity was ensured through expert feedback from six specialists in educational psychology and creativity. The test was administered to a sample of 1007 university students to conduct its validity and reliability analyses. Confirmatory factor analysis (CFA) indicated adequate model fit, supporting the construct validity of the test in alignment with Torrance's theoretical framework. The CPSS-T also demonstrated strong convergent and discriminant validity. Reliability analysis revealed high internal consistency, with Cronbach's alpha and Omega values as follows: Alternative Use ($\alpha = 0.87$, $\omega = 0.87$), Hypothetical Scenario ($\alpha = 0.85$, $\omega = 0.85$), Problem-Solving ($\alpha = 0.90$, $\omega = 0.91$), Visual Interpretation ($\alpha = 0.74$, $\omega = 0.74$), Future Design ($\alpha = 0.67$, $\omega = 0.67$), and the overall test ($\alpha = 0.93$, $\omega = 0.85$). Item-total correlations ranged from 0.511 to 0.812, indicating a strong alignment of the items with the overall test construct. Additionally, the CPSS-T showed significant differences between the upper and lower groups for all items, demonstrating robust discriminatory power at the item level. Criterion-related validity was assessed using the Scientific Creativity Test, revealing significant positive correlations ($r = 0.62$, $p < 0.01$), further establishing the CPSS-T as a reliable and valid tool for measuring creative problem-solving skills in university students. These findings suggest that the CPSS-T, supported by Torrance's creativity theory, is a psychometrically sound instrument that educators can use to evaluate and foster creative problem-solving skills in students.

Introduction

Creative problem-solving represents a complex cognitive process that has garnered significant attention in psychological and educational research over the past several decades. The theoretical underpinnings of creative problem-solving emerge from the intersection of creativity research and cognitive psychology, providing a robust framework for understanding how individuals generate innovative solutions to complex challenges (Runco & Jaeger, 2012). In today's rapidly evolving societal landscape, the importance of creative problem-solving has become increasingly pronounced, particularly in higher education, where students must develop competencies essential for addressing future professional and societal challenges (Miller & Dumford, 2016; Taguma & Barrera, 2019). Creative problem-solving is also recognized as one of the essential 21st-century skills, alongside critical thinking, communication, and collaboration, necessary for thriving in a dynamic and interconnected world (Binkley et al., 2012; Griffin et al., 2012).

The significance of creative problem-solving in university education is multifaceted. First, it enhances students' academic performance by enabling them to approach learning tasks from different perspectives and develop original solutions (Akpur, 2020; Hu et al., 2017; Yang & Zhao, 2021). Second, it prepares them for professional life by equipping them with creative problem-solving skills that are increasingly valued by employers (Di Battista et al., 2023). Third, it supports their personal development and adaptability in an era of rapid technological and social change (Zhanqiang, 2023). Given the demands of the 21st century, fostering creative problem-solving abilities helps students build resilience and flexibility, critical attributes for navigating future complexities (Trilling & Fadel, 2009; OECD, 2019).

Despite the recognized importance of creative problem-solving in higher education, there remains a notable gap in the availability of comprehensive assessment tools designed to measure these skills among university students. While several established creativity tests exist in the literature, such as the Torrance Tests of Creative Thinking (TTCT) and the Alternative Uses Task, these instruments have significant limitations. The TTCT, despite its widespread use, has been criticized for cultural bias (Kim, 2011; Plucker, 2023), subjective evaluation processes (Baer, 2011), and limited relevance to real-life problem-solving situations (Kaufman & Beghetto, 2009; Plucker et al., 2023). Additionally, existing creativity measures predominantly focus on divergent thinking abilities, often neglecting the essential role of convergent thinking in creative problem-solving (Cropley, 2000; Runco & Acar, 2012; Plucker, 2023). While specialized instruments like the Scientific Creativity Test (Hu & Adey, 2002) offer structured theoretical frameworks, their domain-specific nature and focus on middle school students limit their applicability for assessing general creative problem-solving abilities in university populations. Therefore, this study aims to develop and validate a new instrument, the Creative Problem-Solving Skills Test (CPSS-T), designed to assess university students' creative problem-solving abilities through a theoretically grounded and methodologically robust approach. The test incorporates divergent and convergent thinking components, aligning with contemporary theoretical frameworks while addressing the practical needs and cultural considerations in educational assessment in higher education settings.

Theoretical Foundations

The dynamic interplay between creative thinking and systematic problem-solving approaches characterizes the theoretical foundation of creative problem-solving. This interaction manifests in identifying problems, generating alternative solutions, and selecting the most effective approaches while maintaining originality and practicality (Treffinger et al., 2023). The process encompasses cognitive elements, such as analytical and imaginative thinking modes, and affective elements, including motivation, persistence, and openness to experience.

Creative problem-solving can be conceptualized as a dynamic interaction between creative thinking and problem-solving skills. While creative thinking enables individuals to generate original, innovative, and diverse ideas, problem-solving skills involve analyzing, evaluating, and transforming these ideas into feasible solutions. These two processes mutually reinforce each other, forming the foundation of creative problem-solving. Creative thinking introduces new perspectives and alternative approaches to the problem-solving process, whereas problem-solving skills systematically apply these approaches to achieve effective outcomes (Mumford et al., 2012; Cropley, 2006). Therefore, creative problem-solving should not be considered independently of creativity or problem-solving skills but rather as the integration and synergy of these two competencies. In this regard, creative problem-solving ability can be defined as the capacity to generate original ideas and systematically transform them into practical solutions by integrating creative thinking and problem-solving skills dynamically and interactively.

E. Paul Torrance's theoretical framework has provided one of the most influential foundations for understanding creative thinking and problem-solving processes. Torrance's (1972) model delineates creativity into four fundamental dimensions that continue to inform contemporary research and assessment practices. These dimensions - originality, fluency, flexibility, and elaboration - provide a comprehensive framework for evaluating creative potential and problem-solving capabilities (Almeshal & Aloud, 2019; Permata et al., 2022).

Contemporary research has substantiated the empirical validity of these dimensions in assessing creative cognitive processes (Khalid et al., 2020). Torrance's contribution extends beyond theoretical constructs; his work has established empirically validated methods for assessing both cognitive and affective aspects of creative thinking abilities. In educational contexts, cultivating creativity demonstrates a robust correlation with enhanced problem-solving capabilities among learners, particularly in developing systematic approaches to novel challenges (Hobri et al., 2020).

The "Just Suppose" test, another significant contribution from Torrance, evaluates speculative thinking and imagination while incorporating systematic problem-solving elements. Such scenarios reveal individuals' systems thinking and social impact analysis skills (Runco, 2014). This approach has been particularly influential in developing modern creativity assessment tools emphasizing practical application and real-world relevance, bridging the gap between pure creative thinking and structured problem-solving methodologies.

While Torrance focused on measuring creative potential through various dimensions, J.P. Guilford's (1967) theoretical contributions complemented this understanding by distinguishing between convergent and divergent thinking modalities. This dichotomy represents complementary cognitive processes essential for effective problem-solving. Divergent thinking, characterized by generating multiple unique solutions to open-ended problems, operates in dynamic interaction with convergent thinking, facilitating the synthesis and evaluation of information toward optimal solution identification (Lin, 2017).

Research has shown that effective creative problem-solving involves using both divergent and convergent thinking flexibly and dynamically. Divergent thinking allows individuals to generate ideas and explore possibilities, engaging the cognitive elements identified in Torrance's framework. In contrast, convergent thinking helps them critically assess and refine these ideas to identify the most effective solutions, incorporating the systematic approach highlighted in problem-solving theories (Brophy, 1998; Jaarsveld & Lachmann, 2017). Cognitive flexibility—the ability to switch between these two modes of thinking—is crucial for successful problem-solving because it enables individuals to move seamlessly from idea generation to evaluation. According to the dual pathway to creativity model, cognitive flexibility and persistence are key factors influencing the creative process. Cognitive flexibility allows for exploring novel ideas, while persistence, an essential affective element, ensures that individuals stay engaged and committed to solving complex problems. Together, these attributes play a critical role in generating innovative solutions and assessing their potential effectiveness (Oh, 2017).

The Core Components of Creativity

Creativity is often understood through a set of core components encompassing various aspects of creative thinking, including fluency, flexibility, originality, and elaboration. As initially identified by Torrance (1972) and further developed by subsequent researchers, the core components of creativity provide a comprehensive framework for understanding and assessing creative problem-solving abilities. These components represent distinct yet interrelated aspects of creative thinking that collectively contribute to effective problem-solving outcomes.

Fluency, the first component, refers to the ability to generate numerous ideas within a given timeframe. This quantitative aspect of creativity reflects an individual's capacity to produce relevant responses to a given problem (Kaufman & Sternberg, 2010). Research has shown that higher levels of ideational fluency often correlate with an increased likelihood of generating innovative solutions, as a larger pool of ideas provides more opportunities for unique combinations and insights.

Flexibility represents the capacity to generate diverse categories of responses and approach problems from multiple perspectives. This component reflects cognitive adaptability and the ability to break free from mental sets or fixed thinking patterns. Studies have demonstrated that flexibility in thinking contributes significantly to problem-solving success, particularly in complex or novel situations requiring innovative approaches (Čančer & Mulej, 2013).

Originality, the most commonly associated component with creativity, refers to the ability to produce unique, unusual, or novel ideas. This component is often evaluated based on the statistical rarity of responses within a given population (Runco, 2004). The assessment of originality requires careful consideration of cultural and contextual factors, as what constitutes an original response may vary across different settings and populations.

Elaboration, the final core component, involves developing and enriching initial ideas with details and complexity. This component reflects the depth of thinking and the capacity to expand upon basic concepts to create more sophisticated solutions. Research has shown that elaboration skills contribute significantly to the practical implementation of creative ideas and the development of comprehensive problem-solving approaches (Amabile, 1996).

The assessment of creative problem-solving abilities has historically relied on various standardized instruments, each with strengths and limitations. The Torrance Tests of Creative Thinking (TTCT) is one of this domain's most widely used and thoroughly researched instruments. The TTCT employs verbal and figural tasks to assess the four core components of creativity, providing a comprehensive evaluation of creative thinking abilities (Kim, 2006).
Another significant tool is the Alternative Uses Task, initially developed by Guilford (1967) and subsequently adapted by various researchers. This assessment requires participants to generate multiple unique uses for everyday objects, measuring divergent thinking capabilities by evaluating fluency, flexibility, and originality (Amran et al., 2019). Also, the Scientific Creativity Test developed by Hu and Adey (2002) represents a more specialized assessment tool, focusing specifically on creative thinking within scientific contexts. While this instrument offers psychometric solid properties and a structured theoretical framework, its domain-specific nature limits its applicability for assessing general creative problem-solving abilities.

Despite their widespread use, existing creativity assessment tools face several significant limitations that necessitate the development of more comprehensive and culturally sensitive instruments. The TTCT, while well-established, has been criticized for cultural bias (Kim, 2011), subjective evaluation processes (Baer, 2011), and limited relevance to real-life problem-solving situations (Kaufman & Beghetto, 2009). Current assessment tools often focus primarily on divergent thinking abilities, potentially neglecting the critical role of convergent thinking in creative problem-solving. This limitation fails to capture the complex interplay between different cognitive processes in real-world problem-solving situations.

The Present Study

This study aims to develop a test that effectively measures university students' creative problem-solving skills validly and reliably. The Creative Problem-Solving Skills Test (CPSS-T) development addresses several critical gaps in existing assessment tools while incorporating a contemporary understanding of creative problem-solving processes. The rationale for developing this new instrument stems from the need for a more comprehensive, culturally sensitive, and practically relevant assessment tool to evaluate creative problem-solving abilities in educational and professional contexts effectively. For example, Plucker et al. (2023) highlight that the multifaceted, sociocultural, and developmental nature of creativity necessitates that assessments be adapted to different life stages and problem-solving contexts.

The CPSS-T's contribution lies in its integrated approach to assessment, incorporating both divergent and convergent thinking processes while maintaining a strong theoretical grounding in established creativity frameworks. The test structure, comprising five distinct components (Alternative Uses Test, Hypothetical

Scenario, Problem-Solving Scenario, Visual Interpretation, and Future Design), provides a multifaceted evaluation of creative problem-solving abilities. Each component of the CPSS-T has been carefully designed to assess specific aspects of creative problem-solving while maintaining practical relevance to real-world situations. Including visual interpretation and future design, components reflect contemporary needs for creative problem-solving in increasingly complex and technologically advanced contexts (Finke et al., 1992). The test's evaluation criteria operationalize Torrance's four core components while incorporating modern approaches to creativity assessment. The emphasis on practical application and real-world problem-solving scenarios addresses limitations identified in existing instruments, providing a more comprehensive and relevant assessment tool for contemporary educational and professional settings.

Method

Research Design

The research design followed a systematic four-phase approach to develop and validate the test (DeVellis, 2012). Initially, the theoretical foundation was established based on Torrance’s and Guilford’s theories, guiding the identification of core constructs—fluency, flexibility, originality, and elaboration. Subsequently, an item pool was generated by designing test components, including alternative uses, hypothetical scenarios, problem-solving tasks, visual interpretation, and future design. In the second phase, six subject matter experts evaluated the items based on specified criteria (e.g., originality, flexibility, fluency, and elaboration) to ensure content validity. In the third phase, the test was implemented with a sample of 1,007 students, followed by a pilot analysis of 854 participants. Finally, the data analysis phase assessed construct validity through confirmatory factor analysis (CFA) and reliability through internal consistency and item-total correlations, complemented by criterion validity testing with 153 participants using the Scientific Creativity Test as a benchmark.

Test Structure, Development and Validation Process

The Creative Problem-Solving Skills Test (CPSS-T) developed in this study is based on Torrance's (1972) theory of creativity and Guilford's (1967) theory of convergent and divergent thinking, structured to meet contemporary problem-solving needs. Torrance identified four core components of creativity: fluency, flexibility, originality, and elaboration. These components form the building blocks of the creative problem-solving process (Kaufman & Sternberg, 2010). Fluency refers to the ability to generate numerous ideas within a given time; flexibility reflects the ability to think across different categories and develop various approaches; originality is the capacity to produce new and unique ideas; and elaboration refers to the skill of developing and enriching ideas. The development process of CPSS-T and its key components are presented in Figure 1, showing the progression from theoretical framework to pilot implementation. According to Guilford's theory, creative thinking is best evaluated through open-ended tasks that require divergent thinking. This approach necessitates measuring skills such as generating multiple solutions to problems, thinking in diverse contexts, providing unconventional solutions, and developing in-depth ideas (Runco & Acar, 2012). Based on this theoretical foundation, the test includes five distinct components: Alternative Uses Test, Hypothetical Scenario, Problem-Solving Scenario, Visual Interpretation component, and Future Design.

The first component, the Alternative Uses Test, inspired by Guilford's (1967) work, requires participants to consider as many alternative uses as possible for an ordinary pen (Appendix A and B). This task assesses divergent thinking and enables the measurement of fluency, flexibility, and originality. Cropley (2006) emphasizes that thinking of unusual uses for everyday objects is a significant indicator of creative problem-solving ability. The second component, the Hypothetical Scenario, adapted from Torrance's "Just Suppose" test, asks participants to consider, "If people could communicate through telepathy, how would society change?" This component evaluates speculative thinking and imagination, revealing individuals' systems thinking and social impact analysis skills (Runco, 2014).

The Problem-Solving Scenario, based on a real-world problem-solving approach (Isaksen et al., 2011), asks participants to propose creative solutions for extending the battery life of a smartphone produced by a specific company. This component provides a holistic evaluation encompassing all assessment criteria (fluency, flexibility, originality, elaboration). As emphasized in Amabile's (1996) theory of creativity, generating solutions for real-world problems is one of the most critical indicators of creativity.

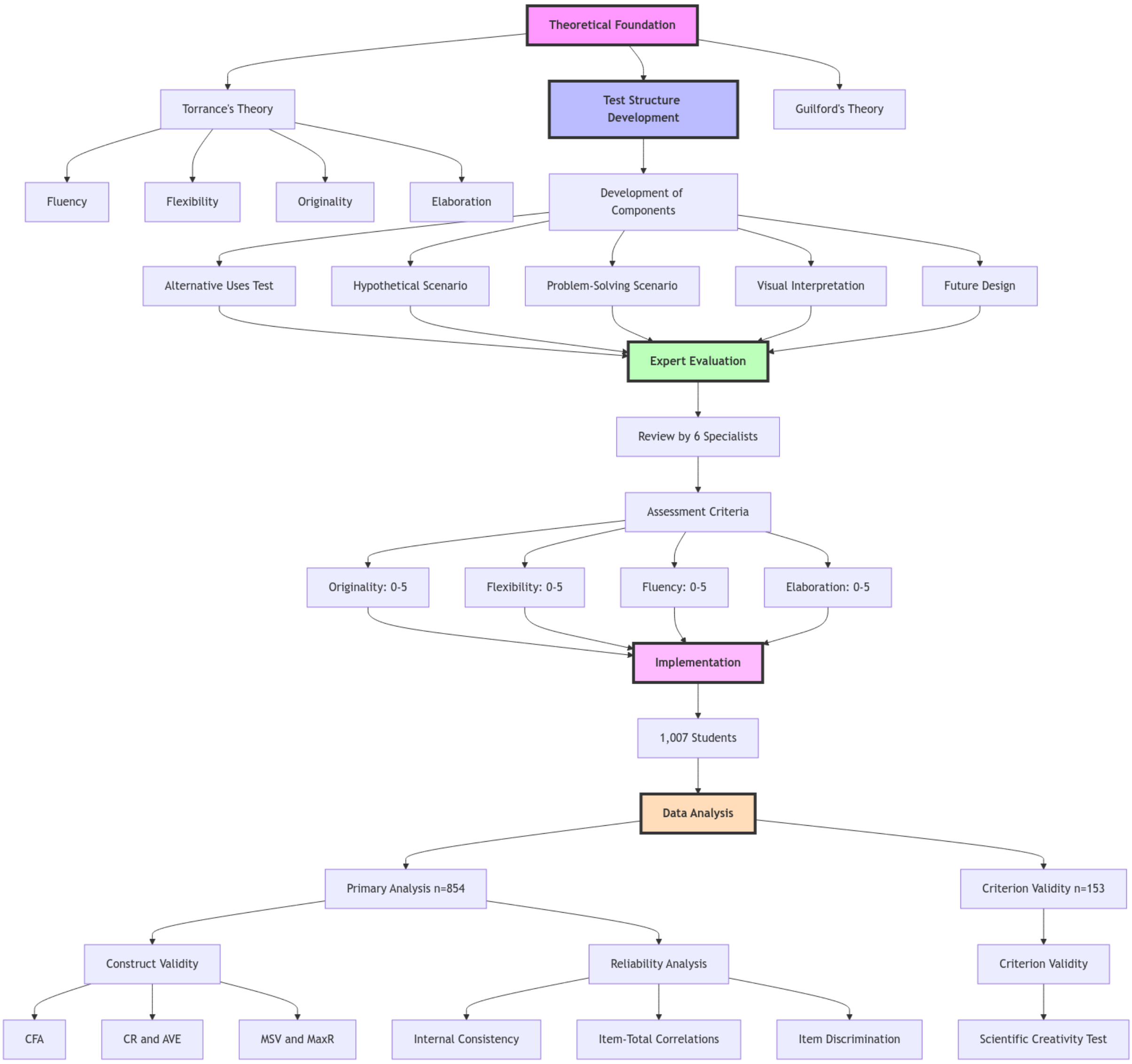

Figure 1. Development and Validation Process of the CPSS-T

The Visual Interpretation component, inspired by Torrance's visual-verbal transformation tests, requires participants to create a short story or scenario based on given visual elements. This task measures visual creativity and storytelling ability, focusing on originality and elaboration dimensions. Finke et al. (1992) highlight the importance of visual stimuli in triggering creative thinking. The final component, Future Design, adapted from Torrance and Torrance's (1978) Future Problem-Solving Program, involves designing a new mode of transportation for the year 2050, describing its features through a drawing, and evaluating visionary thinking and design skills.

Table 1. Summary Table of CPSS-T Components and Evaluation Criteria

Component	**Theoretical Foundation**	**Assessment Focus**	**Evaluation Criteria**	**Key Theoretical Support**
Alternative Uses Test	Guilford (1967)	Divergent thinking, everyday object utility	Fluency, Flexibility, Originality	Cropley (2006)
Hypothetical Scenario	Torrance's "Just Suppose"	Speculative thinking, social implications	Fluency, Flexibility, Originality	Runco (2014)
Problem-Solving Scenario	Real-world approach	Practical creativity, solution generation	All four components	Isaksen et al. (2011), Amabile (1996)
Visual Interpretation	Torrance's visual-verbal tests	Visual creativity, narrative development	Originality, Elaboration	Finke et al. (1992)
Future Design	Future Problem-Solving Program	Visionary thinking, innovative design	Originality, Elaboration	Torrance & Torrance (1978)

The assessment criteria operationalize Torrance's four core components systematically. Originality assessment is based on the statistical rarity principle that Runco (2004) proposed and is evaluated across all questions. Appendix C and D present some rare and common answers to test items. Flexibility relies on categorical diversity, while fluency is assessed according to the productivity principle. Elaboration is based on Torrance's elaboration principle. The content validity of the test was established through expert feedback from six specialists in educational psychology and creativity, who assessed the alignment of the test items with the theoretical foundations of Torrance and Guilford, the level of measurement of contemporary problem-solving skills, and the clarity of the items. Some items were revised based on the experts' feedback to enhance clarity and comprehensibility.

Consequently, the developed test is designed to comprehensively evaluate the multidimensional structure of creative problem-solving ability. The test format and assessment criteria are aligned with widely accepted theoretical frameworks in the literature and reflect modern creativity assessment approaches. This test can be valid and reliable for assessing creative problem-solving ability in educational and professional settings. Table 1 summarizes the CPSS-T components and their respective evaluation criteria, offering a comprehensive overview of the tasks and assessment dimensions.

Evaluation of the Creative Problem-Solving Test

The Creative Problem-Solving Skills Test (CPSS-T) is scored based on four distinct criteria: Originality, Flexibility, Fluency, and Elaboration. Each criterion is rated on a scale of 0 to 5 points. The Originality criterion measures the uniqueness of participants' ideas. A score of 5 is awarded for highly original and unique ideas (in the top 5% frequency); a score of 3 for moderately creative ideas (between the 5-10% frequency); a score of 1 for common or ordinary ideas (between the 10-30% frequency); and a score of 0 for lack of original ideas. The Flexibility criterion evaluates participants' ability to produce ideas across different categories. A score of 5 is awarded for highly diverse ideas across multiple categories, a score of 3 for moderately diverse ideas, 1 for ideas restricted to a single theme or category, and 0 for no diversity in ideas.

The Fluency criterion assesses the speed and quantity of idea generation. A score of 5 is given for generating a high number of ideas (10 or more); a score of 3 for a moderate number (5-9); a score of 1 for a few ideas (1-4); and a score of 0 for an inability to produce ideas. Finally, the Elaboration criterion measures the clarity and comprehensiveness of the generated ideas. A score of 5 is given for thoroughly detailed ideas, a score of 3 for moderately detailed ideas, a score of 1 for minimal detail, and a score of 0 for a lack of detail. Table 2 outlines the scoring criteria and the minimum-maximum scores for each question in the test.

Table 2. Scoring Criteria for the Creative Problem-Solving Test

Question No and Content	Originality (0-5)	Flexibility (0-5)	Fluency (0-5)	Elaboration (0-5)	Min-Max Score
1. Alternative Uses (Pen)	✓	✓	✓	✗	0-15
2. Hypothetical Scenario (Telepathy)	✓	✓	✓	✗	0-15
3. Problem-Solving (Battery Life)	✓	✓	✓	✓	0-20
4. Visual Interpretation	✓	✗	✗	✓	0-10
5. Future Design (Transportation)	✓	✗	✗	✓	0-10
Total	5 questions	3 questions	3 questions	3 questions	0-70

The total score obtained on the Creative Problem-Solving Test ranges from 0 to 70. This score is then converted to a 0 to 5 scale using the formula [(Score × 5) ÷ 70], allowing for a standardized interpretation of participants' abilities. This comprehensive evaluation process provides a detailed, multidimensional assessment of participants' creative problem-solving skills, highlighting strengths and areas for improvement.

- 4.1 - 5.0: Superior creative thinking ability
- 3.1 - 4.0: Good level of creative thinking ability
- 2.1 - 3.0: Moderate level of creative thinking ability
- 1.1 - 2.0: Creative thinking ability in need of improvement
- 0.0 - 1.0: Inadequate creative thinking ability

Participants and Data Collection Process

The study included 1,007 university students who voluntarily participated in the research. Of the participants, 54.8% (n = 552) were female, and 45.2% (n = 455) were male. The sample was drawn from students enrolled in undergraduate programs across multiple universities in Turkey, ensuring diverse representation in institutional and academic backgrounds. The distribution of participants across academic levels was as follows: 35.4% (n = 356) were first-year students, 21.4% (n = 216) were second-year students, 26.8% (n = 270) were third-year students, and 16.4% (n = 165) were fourth-year students. Participants' ages ranged from 18 to 35 years, with a mean age of 24.58 (SD = 6.59).

The study was conducted after obtaining approval from the Bursa Uludağ University Ethics Committee (approval number: 2024-09-53). Participants were selected using a convenience sampling method, with efforts made to include students from various universities and fields of study to enhance the generalizability of the findings. Data collection was facilitated through collaboration with academic staff at participating institutions, who supported the recruitment process by disseminating information about the study to their students.

Before the assessments, information sessions were held to explain the study's purpose, procedures, and voluntary nature, allowing interested students to participate. A detailed document outlining the study's objectives and procedures was distributed to participants, and written informed consent was obtained. The document emphasized that participation was entirely voluntary and that refusal to participate would not affect students' academic standing.

A structured data collection schedule was prepared to optimize accessibility and minimize disruptions to academic activities. Assessments were conducted in person during class hours within a designated timeframe under the supervision of the researchers. Participants were provided with clear instructions before the assessment began to ensure consistency in administration. This comprehensive approach to participant recruitment and data collection was designed to maintain methodological rigor while respecting the participants' time and autonomy.

Data Analysis

Validity and reliability analyses were conducted on two separate samples to examine the psychometric properties of the scale: 854 students for the primary analyses and 153 students for the criterion validity study. Confirmatory factor analysis (CFA) was performed to test the construct validity of the scale, assessing whether the factor structure of the measurement tool represented the theoretically proposed structure and the level of inter-factor relationships (Brown, 2015; Kline, 2011). Additionally, convergent and discriminant validity was examined by calculating Composite Reliability (CR), Average Variance Extracted (AVE), Maximum Shared Variance (MSV), and Maximum Reliability (MaxR(H)) values as further evidence of construct validity (Hair et al., 2014). For reliability, Cronbach's alpha and Omega alpha coefficients were calculated to evaluate internal consistency. Item-total correlations were computed to assess each item's relation to the overall scale and its adequacy in measuring the targeted attribute (DeVellis, 2012). An independent samples t-test was conducted between the top and bottom

27% groups, based on their scores on the scale items, to determine the discriminatory power of the items (Kelley, 1939). This analysis demonstrates the ability of items to differentiate between individuals with and without the targeted trait.

The Scientific Creativity Test, developed by Hu and Adey (2002) and adapted into Turkish by Deniş Çeliker and Balım (2012), was utilized for criterion validity. Criterion validity assesses the relationship between the developed measurement tool and another validated instrument measuring a similar construct, providing essential evidence of the scale's effectiveness in capturing the intended construct (Cronbach & Meehl, 1955). In this context, the Scientific Creativity Test and the Creative Problem-Solving Test were administered to the same group, and the correlation between their scores was examined.

Results

Descriptive Results

Upon examining the descriptive statistics for the Creative Problem-Solving Test scores presented in Table 3, it is observed that scores for the Alternative Uses question range from 1 to 13, with a mean of 7.97 (SD = 1.97). Scores for the Hypothetical Scenario question range between 2 and 12, with a mean score of 7.97 (SD = 1.98). The Problem-Solving question scores vary from 2 to 18, yielding a mean of 11.44 (SD = 2.96). Scores for the Visual Interpretation question range from 1 to 9, with an average score of 6.36 (SD = 1.21). Similarly, scores for the Future Design question range from 1 to 9, with a mean score of 6.22 (SD = 1.38). The total scores for the entire test range between 13 and 60, with a mean of 39.96 (SD = 7.83). To interpret this mean score on a 5-point scale, the formula [(Score × 5) ÷ 70] was applied, resulting in an average score of 2.85 for participants on the creativity test. This score corresponds to a moderate level of creative thinking ability (2.1 - 3.0 range).

Table 3. Descriptive Statistics (N=854)

Test	Questions	Min.	Max.	Mean	SD	Skewness (SE = 0.08)	Kurtosis (SE = 0.17)
	Originality	0	5	2.92	0.71	-0.31	0.33
	Flexibility	0	4	2.59	0.76	-0.21	-0.09
	Fluency	0	5	2.46	0.75	-0.20	-0.02
Alternative Use	Total	1	13	7.97	1.97	-0.27	0.06
Hypothetical Scenario	Originality	0	5	3.01	0.70	-0.44	0.50
	Flexibility	0	5	2.56	0.74	-0.52	0.33
	Fluency	0	4	2.40	0.81	-0.67	0.18
	Total	2	12	7.97	1.98	-0.65	0.23
Problem-Solving	Originality	0	5	3.15	0.76	-0.50	0.81
	Flexibility	0	4	2.74	0.81	-0.57	0.23
	Fluency	0	5	2.65	0.90	-0.76	0.65
	Detailing	0	5	2.89	0.87	-0.34	0.31
	Total	2	18	11.44	2.96	-0.67	0.47

Test	Questions	Min.	Max.	Mean	SD	Skewness (SE = 0.08)	Kurtosis (SE = 0.17)
Visual Interpretation	Originality	0	5	3.26	0.71	-0.70	0.34
	Detailing	0	5	3.09	0.65	-0.48	1.43
	Total	1	9	6.36	1.21	-0.75	1.11
	Future Design						
Future Design	Originality	0	5	3.23	0.83	-0.82	0.70
	Detailing	0	5	2.99	0.76	-0.49	0.76
	Total	1	9	6.22	1.38	-0.91	1.51
	Total Score	13	60	39.96	7.83	-0.68	0.47

Validity and Reliability Analysis Results

Confirmatory factor analysis (CFA) was conducted to test the construct validity of the Creative Problem-Solving Skills Test (CPST) developed. The CPST assesses four core components of creative thinking: fluency, flexibility, originality, and elaboration (see Figure 2).

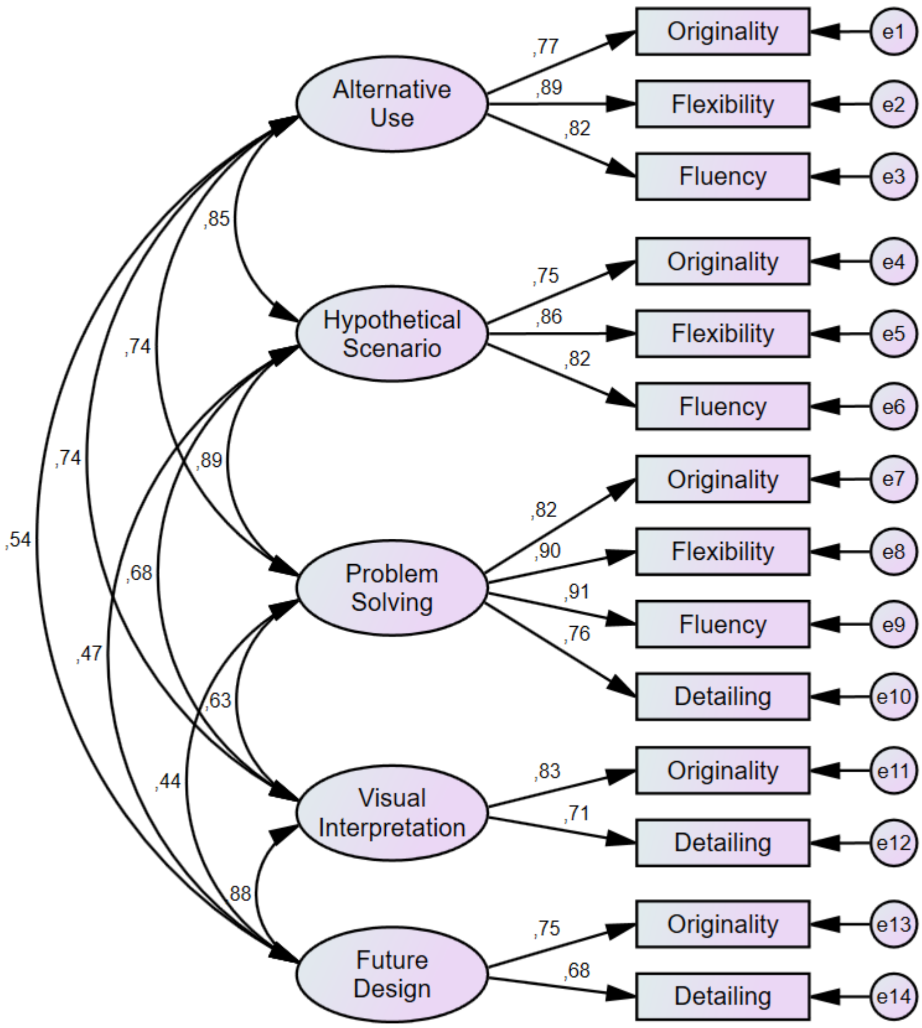

Figure 2. Confirmatory Factor Analysis Diagram, χ^2=124,81; Df=33; p<0,001

These components are grounded in Torrance's (1972) creativity theory and form the theoretical foundation of the test, structured to meet contemporary problem-solving requirements. Torrance's creativity components represent the multidimensional structure of creative thinking and serve as the building blocks of the creative problem-solving process.

CFA was performed to evaluate whether the items in the scale align with the factor structure based on this theoretical foundation. The purpose of the analysis is to determine the extent to which each item loads onto each component and establish the scale's structural validity. In this context, model fit indices, factor loadings, and the distribution of items across the specified components were examined. The CFA results aim to confirm the four-component structure of the scale, thereby supporting the validity of the theoretical model.

Table 4 presents the fit indices of the five-factor structure of the **CPSS-T**, along with the acceptable and good fit ranges for these indices. The results indicate that the five-factor structure of the Creative **CPSS-T** adequately reflects the theoretical model, with fit indices generally falling within acceptable and good fit thresholds. These findings support the construct validity of the test's five-factor structure based on confirmatory factor analysis.

Table 4. Fit Values of the Five-Factor Structure of the Creative Problem-Solving Skills Test

Fit Index	Good Fit	Acceptable Fit	Observed Values	Reference
χ^2/df	≤ 3	≤ 4-5	3.74	Byrne, 1989
RMSEA	≤ 0.05	0.06-0.08	0.06	Browne & Cudeck,
SRMR	≤ 0.05	0.06-0.08	0.03	1993
GFI	≥ 0.90	0.85-0.90	0.94	Jöreskog & Sörbom,
AGFI	≥ 0.90	0.80-0.90	0.93	1984
CFI	≥ 0.95	0.90-0.94	0.96	
TLI	≥ 0.95	0.90-0.94	0.95	Bollen, 1989
IFI	≥ 0.95	0.90-0.94	0.96	

Upon examining Table 5, the factor loadings of the five-factor structure of the CPSS-T range from 0.68 to 0.91 across all factors, with a significance level of $p < 0.001$. These values indicate that the factors are strongly defined. CR (Composite Reliability) and AVE (Average Variance Extracted) values were evaluated to assess convergent validity. Ideally, CR should exceed 0.70, and AVE should be greater than 0.50 (Hair et al., 2010). These thresholds were met for most factors, except for the Future Design factor, which had a CR value 0.68. However, since this value is very close to the 0.70 threshold, it was deemed to contribute to convergent validity overall.

Table 5. Factor Loadings, CR, AVE and MSV Values of the Creative Problem-Solving Skills Test

Questions / test	β	B	S.E.	C.R.	p	CR	AVE	MSV	MaxR(H)
Alternative Use						0.87	0.69	0.72	0.881
Originality	0.77	1							
Flexibility	0.89	1.22	0.05	27.43	***				
Fluency	0.82	1.13	0.05	25.27	***				

Questions / test	β	B	S.E.	C.R.	p	CR	AVE	MSV	MaxR(H)
Hypothetical Scenario						0.85	0.66	0.8	0.861
Originality	0.75	1							
Flexibility	0.86	1.20	0.05	25.88	***				
Fluency	0.82	1.26	0.05	24.70	***				
Problem-Solving						0.91	0.72	0.8	0.926
Originality	0.82	1							
Flexibility	0.90	1.18	0.04	32.44	***				
Fluency	0.91	1.32	0.04	33.20	***				
Detailing	0.76	1.06	0.04	25.16	***				
Visual Interpretation						0.75	0.60	0.77	0.762
Originality	0.83	1							
Detailing	0.71	0.78	0.04	20.88	***				
Future Design						0.68	0.51	0.77	0.683
Originality	0.75	1							
Detailing	0.68	0.83	0.05	16.14	***				

$^{***}p<0.001$

To establish discriminant validity, MSV (Maximum Shared Variance) values must be lower than AVE values (Hu & Bentler, 1999). This condition was satisfied for all factors. Additionally, high MaxR(H) values further supported the reliability and discriminant validity of the factors. These findings indicate that the five-factor structure of the test generally fulfills the criteria for both convergent and discriminant validity.

Upon examining Table 6, the Cronbach's Alpha and Omega Alpha coefficients for the three-component criteria, such as "Alternative Uses" and "Hypothetical Scenario," were found to be 0.87 and 0.85, respectively. These values indicate that these scales exhibit high reliability. For the "Problem-Solving" criterion, which comprises four components, Cronbach's Alpha coefficient is 0.90, and the Omega Alpha coefficient is 0.91, reflecting exceptionally high internal consistency. However, for two-component criteria, such as "Visual Interpretation" and "Future Design," the reliability coefficients were lower.

Table 6. Cronbach Alpha and Omega Reliability Coefficients

Questions / test	Number of component	Cronbach alpha (α)	Omega alpha (ω)
Alternative Use	3	0.87	0.87
Hypothetical Scenario	3	0.85	0.85
Problem-Solving	4	0.90	0.91
Visual Interpretation	2	0.74	0.74
Future Design	2	0.67	0.67
Overall Test	14	0.93	0.85

Precisely, the Cronbach's Alpha and Omega Alpha coefficients for the "Future Design" criterion were calculated as 0.67. Lower reliability coefficients are expected for scales with fewer items, and this value is considered acceptable within sufficient reliability thresholds (Taber, 2018). Coefficients within the range of 0.60–0.70 are often deemed acceptable, particularly for exploratory studies or scales with a limited number of items.

Finally, when examining the overall reliability of the scale, the Cronbach's Alpha coefficient for the 14-component overall test is 0.93, and the Omega Alpha coefficient is 0.85. These high values demonstrate strong overall internal consistency, indicating that the test provides a reliable structure for holistic evaluation. Item-total correlation values represent the degree of association between each item in a test and the total test score. These values are used to assess the test's internal consistency and individual items' contribution to the overall scale. High item-total correlations indicate that the items are consistent with the overall structure of the test and positively contribute to its reliability.

Table 7 presents the item-total correlation values for the sub-dimensions of the CPSS-T. The relationships between the originality, flexibility, fluency, and elaboration scores of the Alternative Uses, Hypothetical Scenario, Problem-Solving, Visual Interpretation, and Future Design sections with the total test scores were examined.

Table 7. Creative Problem-Solving Skills Test Item Total Correlations

Questions / test		Total
Alternative Use	Originality	0.697**
	Flexibility	0.800**
	Fluency	0.773**
Hypothetical Scenario	Originality	0.770**
	Flexibility	0.810**
	Fluency	0.749**
Problem-Solving	Originality	0.812**
	Flexibility	0.808**
	Fluency	0.812**
	Detailing	0.732**
Visual Interpretation	Originality	0.714**
	Detailing	0.647**
Future Design	Originality	0.545**
	Detailing	0.511**

**p<0.01, N=854

The results indicate that the highest item-total correlations were observed in the Problem-Solving sub-dimension for originality and fluency (r = 0.812). Similarly, high correlations were found in the Hypothetical Scenario and Alternative Uses sections, particularly for flexibility, which ranged from 0.800 to 0.810. The Future Design sub-dimension exhibited relatively lower correlation values, such as for originality (r = 0.545). All correlations were statistically significant (p < 0.01), demonstrating the high internal consistency of the test and the substantial contribution of the items to the overall scale.

Table 8 was created to examine the discriminative power of each item in the CPSS-T. In this analysis, two groups were identified based on the top and bottom 27% of test scores, and their responses to each item were compared using an independent samples t-test. For all items, the mean scores of the upper group (n = 230) were significantly higher than those of the lower group (n = 230) ($p < 0.001$). Notably, the Problem-Solving section demonstrated the highest discriminative power in the dimensions of originality ($t(458) = 28.79$) and flexibility ($t(458) = 27.57$). Although the Future Design section showed relatively lower discriminative power in originality and elaboration, the values remained statistically significant ($t(458) = 14.28$ and 12.87, respectively). These findings suggest that the test items are highly discriminative and effectively measure participants' creative problem-solving skills.

Table 8. Discrimination Levels of Creative Problem-Solving Skills Test Questions

		Group				
		Lower (n=230)		Upper (n=230)		
Questions	Component	M	SD	M	SD	*t*(458)
Alternative Use	Originality	2.33	0.64	3.57	0.54	22.20***
	Flexibility	1.82	0.56	3.27	0.51	29.07***
	Fluency	1.70	0.60	3.12	0.51	27.24***
Hypothetical Scenario	Originality	2.32	0.62	3.62	0.49	24.91***
	Flexibility	1.78	0.64	3.20	0.44	27.50***
	Fluency	1.55	0.74	3.00	0.49	24.71***
Problem-Solving	Originality	2.38	0.66	3.89	0.44	28.79***
	Flexibility	1.82	0.69	3.41	0.54	27.57***
	Fluency	1.66	0.86	3.40	0.57	25.61***
	Detailing	2.03	0.80	3.53	0.62	22.47***
Visual Interpretation	Originality	2.59	0.67	3.84	0.37	24.68***
	Detailing	2.60	0.70	3.61	0.51	17.76***
Future Design	Originality	2.67	0.92	3.72	0.63	14.28***
	Detailing	2.55	0.86	3.47	0.66	12.87***

***p<0,001

To examine the criterion validity of the Creative Problem-Solving test, 153 participants completed both this test and the Scientific Creativity test. Descriptive statistics revealed that participants' mean scores were 55.37 (SD = 18.37) for the Scientific Creativity test and 39.63 (SD = 7.28) for the Creative Problem-Solving test (see Table 9).

Table 9. Correlation Between Scores Obtained from Creative Problem-Solving and Scientific Creativity Tests

Measure	Minimum	Maximum	M	SD	1.	2.
1. Scientific creativity	16	104	55.37	18.37	—	
2. Creative problem-solving	22	53	39.63	7.28	0.62**	—

**p<0.01, N=153

Correlation analysis between the two tests showed a positive and significant relationship ($r = 0.62$, $p < 0.01$), indicating that the Creative Problem-Solving test validly measures creative thinking skills. While the two tests focus on different domains (scientific creativity and creative problem-solving), creative thinking is their shared construct. Therefore, individuals with high scores on the Creative Problem-Solving test are likely to demonstrate strong creative thinking skills, contributing to scientific creativity success. This relationship supports the validity of the test.

Discussion

Creative problem-solving is a cognitive skill that is becoming increasingly important in contemporary education and professional settings. This study focuses on the development, validity, and reliability analyses of the Creative Problem-Solving Skills Test (CPSS-T), designed to evaluate creative problem-solving processes through a multidimensional approach. The test is grounded in Torrance's (1972) theory of creativity, which assesses the core components of creative thinking—fluency, flexibility, originality, and elaboration. This theoretical framework provides a robust foundation for analyzing creative problem-solving skills and is suitable for addressing modern problem-solving needs.

In this study, the structural validity of the test was evaluated through confirmatory factor analysis (CFA), convergent and discriminant validity were examined, and reliability coefficients were thoroughly analyzed. The results demonstrated that the test provides a comprehensive validity and reliability profile. The CFA results confirmed that the five-factor structure of the test aligns well with the theoretical model. The fit indices obtained were compared with the acceptable thresholds in the literature (e.g., Byrne, 1989; Browne & Cudeck, 1993) and indicated strong structural validity for the test. For instance, the χ^2/df ratio was 3.74, within acceptable limits. Additionally, the RMSEA value of 0.06 and GFI value of 0.94 align with the good fit thresholds suggested by Jöreskog and Sörbom (1984). Other fit indices, such as CFI and IFI (both >0.95), also yielded highly favorable results, meeting the validity standards proposed by Bollen (1989).

The composite reliability (CR) and average variance extracted (AVE) values, calculated to evaluate convergent validity, met the criteria recommended by Hair et al. (2010). In particular, CR values exceeding 0.70 reflect the consistency and reliability of the test items. Although the CR value for the Future Design factor was 0.68, its proximity to the ideal value contributed positively to the overall validity assessment and was deemed acceptable. Furthermore, MSV and AVE analyses supported the discriminant validity of the factors (Hu & Bentler, 1999).

Reliability analyses revealed strong internal consistency, as evidenced by high Cronbach's alpha and Omega coefficients. For instance, the Problem-Solving subscale yielded a Cronbach's alpha of 0.90 and an Omega coefficient of 0.91, indicating high internal consistency. Similarly, the subscales Alternative Uses and Hypothetical Scenario demonstrated reliability coefficients of 0.87 and 0.85, respectively, further validating their effectiveness in measuring participants' creative thinking skills. However, the two-component subscales, Visual Interpretation, and Future Design exhibited slightly lower reliability coefficients (0.67). According to Taber (2018), reliability coefficients within the 0.60–0.70 range are acceptable for exploratory studies and scales with fewer items. These findings underscore the importance of considering subscale-specific factors in future scale development and evaluation processes.

The item discrimination analysis showed that all items exhibited significant differences between the upper and lower groups, highlighting their discriminative power. For example, the originality and flexibility dimensions in the Problem-Solving section demonstrated the highest discrimination levels, while the Future Design section exhibited lower but still significant levels of discrimination. These findings confirm the strong item-level discrimination of the test and its effectiveness in evaluating creative problem-solving skills.

To further support the validity of the CPSS-T, a correlation analysis was conducted with the Scientific Creativity test (Deniş Çeliker & Balım, 2012; Hu & Adey, 2002). The results revealed a moderate and positive significant relationship between the two tests ($r = 0.62$, $p < 0.01$). This finding highlights a fundamental link between creative problem-solving and scientific creativity, demonstrating that the CPSS-T validly measures creative thinking. The positive correlation with scientific creativity provides a crucial indicator of the test's validity and establishes a strong foundation for future research on creative thinking skills.

Conclusion

Creative problem-solving skills are increasingly occupying a central position in the educational paradigm of the 21st century. In this context, the psychometric properties of the developed CPSS-T demonstrate that the scale can be reliable and valid for assessing creative problem-solving skills. Notably, the high-reliability values obtained in the dimensions of problem-solving and alternative uses indicate that the fluency, flexibility, and originality components proposed by Torrance's creativity theory are successfully evaluated by the scale. These findings support the view that creative thinking processes can be systematically measured and evaluated. The significant relationship demonstrated with the scientific creativity test reveals that creative problem-solving skills are closely related to scientific thinking processes. This finding is important as it emphasizes the interdisciplinary nature of creative problem-solving. Furthermore, confirming the scale's five-factor structure contributes to our understanding of the multidimensional nature of creative problem-solving processes. Multidimensional test structure allows educators and researchers to evaluate students' creative problem-solving skills from different perspectives.

The relatively lower reliability values obtained in the visual interpretation and future design dimensions reflect the measurement challenges in these areas. This situation reveals the methodological difficulties encountered in measuring the visual and future-oriented dimensions of creative thinking and indicates the need for developing new measurement approaches in this field. However, the high item discrimination values observed across all subscales demonstrate that the scale can successfully distinguish between different levels of creativity. The results of this study emphasize the importance of standardized measurement tools in evaluating creative problem-solving skills. The psychometric properties of the CPSS-T demonstrate that the scale is a reliable instrument used in research and educational settings. Demonstrating the CPSS-T's reliability represents an important step toward systematically monitoring and evaluating the development of creative problem-solving skills.

Recommendations

Based on the research findings, it is recommended that revision studies be conducted aimed at increasing the reliability coefficients of the Visual Interpretation and Future Design subscales in future studies. In this context, strengthening the psychometric properties by adding new items to these subscales could be considered. Conducting adaptation studies of the scale in different cultures and languages is essential for testing its cross-cultural validity. Additionally, it is recommended that the test's predictive validity be examined through longitudinal studies and adaptations for different age groups be developed. Planning studies using cross-sectional and longitudinal research designs to understand the developmental process of creative problem-solving skills will also contribute to the literature. Finally, developing implementation guidelines for using CPSS-T in educational settings and preparing assessment guides for teachers will support the practical application of the scale.

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Author Information

Eyüp Yurt

https://orcid.org/0000-0003-4732-6879

Bursa Uludağ University

Turkiye

Contact e-mail: *eyupyurt@gmail.com*

Appendix A. Yaratıcı Problem Çözme Beceri Testi (Turkish Form)

Genel Yönerge

Sevgili Katılımcı, bu test, yaratıcı problem çözme becerilerinizi ölçmek için tasarlanmıştır. Toplam 5 açık uçlu soru bulunmaktadır. Testte doğru veya yanlış cevap yoktur; önemli olan yaratıcı ve özgün düşünmenizdir. Lütfen her soruyu dikkatle okuyun ve elinizden gelenin en iyisini yapın.

Sorular ve Yönergeler

Soru 1: Alternatif Kullanım Testi

Yönerge: Sıradan bir kalem için mümkün olduğunca çok farklı kullanım alanı düşünün. Klasik kullanımı (yazmak) dışında, bu nesneyi nasıl kullanabileceğinizi listeleyiniz. Örneğin, "saç tokası olarak kullanmak" bir alternatif kullanım olabilir.

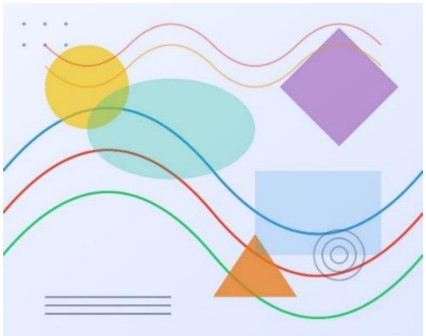
Soru 2: Varsayımsal Senaryo

Yönerge: "Eğer insanlar telepati (beş duyunun yardımı olmaksızın gerçekleştiği ileri sürülen bilgi aktarımı) yoluyla iletişim kurabilseydi, toplum nasıl değişirdi?" Bu varsayımsal durumun olası etkilerini düşünün. Mümkün olduğunca *çok ve çeşitli etki* yazınız.

Soru 3: Problem Çözme Senaryosu

Yönerge: Bir akıllı telefon üreticisi, pil ömrünü önemli ölçüde artırmak istiyor. Mevcut teknolojiler dışında, pil ömrünü uzatmak için yaratıcı çözümler üretin. Mümkün olduğunca *çok ve çeşitli çözüm önerileri* yazınız. Her birini kısaca açıklayınız.

Soru 4: Görsel Yorumlama



Yönerge: Bu görsele bakın ve ondan ilham alarak kısa bir hikaye veya senaryo yazın. Hikayeniz görsel öğeleri yaratıcı bir şekilde yorumlamalıdır.

Soru 5: Gelecek Tasarımı

Yönerge: 2050 yılında kullanılabilecek yeni bir ulaşım aracı tasarlayın. Bu araç, günümüzdeki ulaşım sorunlarını (trafik, çevre kirliliği, hız vb.) çözmelidir. Aracınızı çizin ve özelliklerini açıklayın.

Appendix B. Creative Problem-Solving Skills Test

General Instructions

Dear Participant,

This test is designed to measure your creative problem-solving skills. It consists of 5 open-ended questions. There are no right or wrong answers to the test; your ability to think creatively and uniquely matters. Please read each question carefully and do your best.

Questions and Instructions

Question 1: Alternative Uses Test

Instruction: Think of as many different uses as possible for an ordinary pencil. Apart from its conventional use (writing), list alternative ways you could use this object. For example, "using it as a hair clip" could be one alternative use.

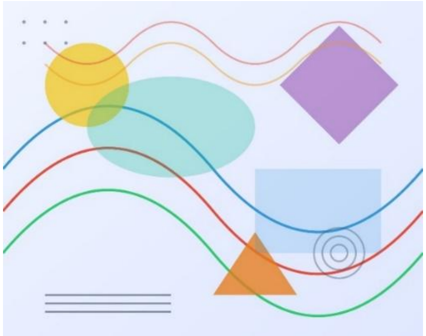
Question 2: Hypothetical Scenario

Instruction: "If humans could communicate through telepathy (information transfer claimed to occur without the help of the five senses), how would society change?" Consider the potential impacts of this hypothetical situation. Write as many varied effects as possible.

Question 3: Problem-Solving Scenario

Instruction: A smartphone manufacturer wants to increase battery life significantly. Beyond current technologies, come up with creative solutions to extend battery life. Write as many diverse solution ideas as possible and briefly explain each one.

Question 4: Visual Interpretation



Instruction: Look at this image and write a short story or scenario inspired by it. Your story should creatively interpret the visual elements of the image.

Question 5: Future Design

Instruction: Design a new vehicle that could be used in the year 2050. This vehicle should address transportation problems (e.g., traffic, pollution, speed). Draw your vehicle and explain its features.

Appendix C. Examples of Rare (Original) and Common Answers to Some Questions in the Test (Turkish)

Soru 1: Alternatif Kullanım Testi

En Nadir Cevaplar	En Yaygın Cevaplar
Soluk Borusu Tıkanıklığında İlk Yardım Aracı	Kitap Ayracı Olarak Kullanma
Müzik Aleti Olarak Kullanma	Cetvel veya Düz Çizgi Çizme
Maşa Olarak Kullanma	Stres Çarkı Gibi Kullanma
Gölge ile Zaman Belirleme	Telefon Tutucu Olarak Kullanma
Koordinat Belirleme Aracı	Saç Tokası veya Saç Şekillendirme
Mikrofon Olarak Kullanma	İşaret Aracı Olarak Kullanma
Çiçek Destek Çubuğu	Toprak Eşeleme Aracı
Kaset Bandı Sarma	Minik Delik Açma
Bitki Bağlama	Vida Sıkma
Tıbbi Amaçlı Delici Alet	Mandallama veya Sabitleme
Pervane Yapma	Dekoratif Objeye Dönüştürme
Kapalı Kutuları Kaldırma Aracı	Çizim ve Şekil Verme
Deniz Dalga Yönlerini İzleme	Masa Üzerinde Stres Atmak
Ufak Heykel veya Yapı Yapma	Nesne Sabitleyici
Portatif Sinyal Çubuğu	Mini Çekiç veya Delgeç Olarak Kullanma

Soru 2: Varsayımsal Senaryo

En Nadir Cevaplar	En Yaygın Cevaplar
Telepatinin Psikolojik Yan Etkileri	Yalan Söylemenin İmkansız Hale Gelmesi
Siyasi ve Ekonomik Güçlerin Çöküşü	Empati ve Anlayışın Artması
Telepatik Kalkan Geliştirme İhtiyacı	Mahremiyetin Sona Ermesi
Dil ve Kültürlerin Yok Olması	Duygusal ve Sosyal Bağların Güçlenmesi
Eğitimde Çarpıcı Değişiklikler	Sosyal Çatışmaların Azalması
Daha Fazla Yargılayıcı Bir Toplum	Dil ve Konuşma İhtiyacının Azalması
Özel Hayatın Tümüyle Kaybı	Suç Oranlarının Düşmesi
Sanat ve Edebiyatın Yeniden Şekillenmesi	Manipülasyonun Zorlaşması
Evrensel Ahlak ve Değerlerin Yıkımı	Hızlı Bilgi ve Duygu Paylaşımı
Manipülasyonun İmkansız Hale Gelmesi	Eğitimde Kolaylık
Suçun Tümüyle Azalması	Toplumun Gelişimi
Sır Kavramının Yok Olması	Korku ve Güvensizlik
Bilgi Kirliliği ve Anlam Karmaşası	Yargılama ve Önyargıların Artması
Sosyal Medya ve Dijital Platformların Anlamsızlaşması	Telepatiye Dayalı Yeni Teknolojiler
Yaratıcı ve Eleştirel Düşüncenin Azalması	

Soru 3: Problem Çözme Senaryosu

En Nadir Cevaplar	En Yaygın Cevaplar
Piezoelektrik sistemler eklenmesi	Telefon ekran parlaklığını düşürmek
Termal enerji dönüşümü	Gereksiz uygulamaları kapatmak
Güneş paneli entegre telefon	Telefonu şarja tam dolmadan çıkarmak
Telefonun gece otomatik kapanması	Telefonu sürekli şarjda bırakmamak
Batarya analiz uygulaması	Arka planda çalışan uygulamaları kapatmak
İhtiyaç dışı bileşenleri devre dışı bırakma	Geceleri telefonu uçak moduna almak
Mikro türbinlerle enerji üretimi	Pil tasarruf modunu etkinleştirmek
Yapay zeka destekli enerji yönetimi	Ekran süresini kısaltmak
Kinetik enerjiyle şarj eden kapaklar	Telefonu serin bir yerde tutmak
Nanoteknoloji piller	Telefonu düşük güç modunda kullanmak

Soru 4: Görsel Yorumlama

En Nadir Cevaplar	En Yaygın Cevaplar
Geometrik şekillerin bir dünya tasvirinde buluşması	Güneşli bir günde deniz kenarında oturma
Ankesörlü telefonun güneşe yaptığı yolculuk	Güneşli bir havada piknik yapma
Farklı gezegenlerin dostluk denemesi	Rüzgar ve güneşin altında yürüyüş yapma
Dağ zirvesindeki doğa betimlemesi	Sahilde vakit geçirme
Tüm renk ve şekillerin bir araya geldiği şenlik	Renkli şekillerin gökyüzünde dalgalanması
Duyguları simgeleyen geometrik şekiller	Geometrik şekillerin sahilde sıralanması
Dünyanın doğal döngüsünün geometrik şekillerle anlatımı	Renkli bir gün batımı betimlemesi
Renkli şekillerin bir koroya katılması	Farklı geometrik şekillerle resim yapma
Geometri Diyarı’nda dostluk hikayesi	Deniz kenarında güneşli bir öğle sonrası
Atmosferik bir sabah betimlemesi	Rüzgarlı bir günde arkadaşlarla yürüyüş

Soru 5: Gelecek Tasarımı

En Nadir Cevaplar	En Yaygın Cevaplar
Atmosferik Hız Kapsülü	Uçan Araba Tasarımı
Çevre Dostu Hibrit Uçan Araç	Elektrikli Araç
Kendi Yakıtını Üreten Araç	Çevre Dostu Uçan Araç
Küçülen Araç	Bisiklet
Geri Dönüşümlü Malzemelerle Yapılmış Uçan Araç	Solar Panel Destekli Uçan Araç
Işınlanma Portallı Ulaşım Aracı	Yeraltından Ulaşım Sistemi
Yerden Havaya Çıkabilen Hibrit Araç	Geri Dönüşümlü Malzemelerle Araç
Karbon Negatif Uçan Araç	Elektrikli Uçak
Yeşil Yolculuk Sağlayan Araç	Hızlı Araç
Manyetik Uçuş Sistemi	Su ile Çalışan Araç
Şehir İçi Manyetik Araç	Doğa Dostu Mini Araba

Modüler Enerji Sistemli Araç	Kapsül Araç
Kirlilik Filtresiyle Çalışan Araba	Kapsüllü Raylı Sistem
Su Arıtma ile Çalışan Araç	Araba Boyutunda Uçan Araç
Hava ve Karada Çalışan Uçan Araç	Hibrit Yakıtlı Araba

Appendix D. Examples of Rare (Original) and Common Answers to Some Questions in the Test

Question 1: Alternative Uses Test

Rare Answers	Common Answers
First Aid Tool for Choking	Using as a Bookmark
Using as a Musical Instrument	Drawing a Straight Line or Ruler
Using as Tongs	Using as a Stress Spinner
Determining Time with Shadows	Using as a Phone Holder
Coordinate Determination Tool	Hairpin or Hair Styling Tool
Using as a Microphone	Using as a Pointer
Flower Support Stick	Soil Digging Tool
Rewinding a Cassette Tape	Making Small Holes
Tying Plants	Tightening a Screw
Medical Piercing Tool	Clamping or Fastening
Making a Propeller	Converting into a Decorative Object
Tool for Lifting Closed Boxes	Drawing and Shaping
Observing Sea Wave Directions	Stress Relief on a Desk
Making Small Sculptures or Structures	Object Stabilizer
Portable Signal Stick	Using as a Mini Hammer or Hole Puncher

Question 2: Hypothetical Scenario

Rare Answers	Common Answers
Psychological Side Effects of Telepathy	Lying Becomes Impossible
Collapse of Political and Economic Powers	Increased Empathy and Understanding
Need to Develop Telepathic Shields	End of Privacy
Disappearance of Languages and Cultures	Strengthening Emotional and Social Bonds
Significant Changes in Education	Reduction in Social Conflicts
A More Judgmental Society	Reduced Need for Language and Speech
Complete Loss of Private Life	Decrease in Crime Rates
Reshaping of Art and Literature	Difficulty in Manipulation
Destruction of Universal Morals and Values	Fast Sharing of Information and Emotions
Manipulation Becomes Impossible	Ease in Education
Complete Elimination of Crime	Social Development
Disappearance of the Concept of Secrets	Fear and Insecurity
Information Pollution and Meaning Confusion	Increase in Judgment and Prejudice
Meaninglessness of Social Media and Digital Platforms	New Technologies Based on Telepathy
Decline in Creative and Critical Thinking	

Question 3: Problem-Solving Scenario

Rare Answers	Common Answers
Adding Piezoelectric Systems That Collect Energy from User Movements	Lowering Phone Screen Brightness
Thermal Energy Conversion System While Holding the Phone	Closing or Removing Unnecessary Apps
Solar Panel Integrated into the Phone Screen	Not Plugging in Before Fully Charging
Automatic Nighttime Phone Shutdown Programmed for User Sleep Time	Unplugging the Phone After Fully Charged
Battery Usage Analysis App to Inform the User	Closing Background Apps
Disabling Unnecessary Components to Extend Battery Life	Turning on Airplane Mode at Night
Micro Turbines on the Back of the Phone for Energy Generation	Activating Battery Saver Mode
AI-Supported Energy Management Software	Reducing Screen Time or Turning Off the Phone Periodically
Kinetic Energy Charging Covers from Walking or Movement	Keeping the Phone Cool to Prevent Overheating
Nanotechnology Batteries with Higher Capacity	Using the Phone in Low-Power Mode

Question 4: Visual Interpretation

Rare Answers	Common Answers
Geometric Shapes Meeting in a World Depiction	Sitting by the Sea on a Sunny Day
Payphone's Journey to the Sun	Having a Picnic on a Sunny Day
Friendship Trials Between Different Planets	Walking in the Wind and Sun
Nature Depiction at the Mountain Summit	Spending Time at the Beach
Festival Where All Colors and Shapes Come Together	Colorful Shapes Waving in the Sky
Geometric Shapes Representing Emotions	Geometric Shapes Lined Up on the Beach
Earth's Natural Cycle Illustrated with Geometric Shapes	Depiction of a Colorful Sunset
Colorful Shapes Joining a Choir	Drawing with Different Geometric Shapes
Story of Friendship in Geometry Land	Sunny Afternoon by the Sea
Depiction of an Atmospheric Morning	Walking with Friends on a Windy Day

Question 5: Future Design

Rare Answers	Common Answers
Atmospheric Speed Capsule	Flying Car Design
Eco-Friendly Hybrid Flying Vehicle	Electric Vehicle
Vehicle Producing Its Own Fuel	Eco-Friendly Flying Vehicle
Shrinking Vehicle	Bicycle
Flying Vehicle Made from Recyclable Materials	Solar Panel-Supported Flying Vehicle
Teleportation Portal Transportation	Underground Transportation System

Hybrid Vehicle Capable of Ground-to-Air Movement	Vehicle Made from Recyclable Materials
Carbon-Negative Flying Vehicle	Electric Aircraft
Vehicle Providing Green Travel	High-Speed Vehicle
Magnetic Flight System	Water-Powered Vehicle
Inner-City Magnetic Vehicle	Nature-Friendly Mini Car
Vehicle with Modular Energy Systems	Capsule Vehicle
Car Running with a Pollution Filter	Capsule Rail System
Water Purification Powered Vehicle	Flying Vehicle the Size of a Car
Air and Land Hybrid Flying Vehicle	Hybrid-Fueled Car