

The Factor Structure of Creative Problem-Solving in Design Studio-Based Learning in Architecture

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Abstract

Creative problem-solving (CPS) is the ability to generate new and valuable ideas for solving problems. Fluency, flexibility, and originality are the three main components of CPS that can provide architects with effective solutions. The conceptual research framework revealed the traits of CPS fluency, flexibility, and originality through creative self-reports. It identified the correlation of these components in constructing undergraduate architecture students' CPS skills. This study aimed to examine the factor structure of CPS in architecture education by confirming the factor structure of a set of observed variables. Based on the minimum, 655 respondents will be surveyed using multistage random sampling from a pool of 4,000 undergraduate architecture students in Thailand (Hair et al., 2010). All indicators affect the factor of CPS at a significant level of .01. Fluency has the highest factor loading at 0.912, having many solutions (0.736) and creating wide-range solutions (0.659). Originality is the second factor and factor loading is 0.788. Finding unusual ideas (0.798) and providing rare solutions (0.739) is essential. Flexibility is the lowest factor, loading at 0.688. Even though its indicator combines different solutions (0.927), it has the highest factor loading. The second item to note is complex problem solutions (0.732). This self-report investigates the relationship between CPS traits and the learning styles of architecture students. These findings could be useful for creating studio-based learning plans that encourage students to consider various solution options. Flexibility leads to different ideas, while originality generates unique solutions.

Keyword: Creative Problem-solving; Architecture Education; Studio-based Learning; Confirmatory Factor Analysis

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โครงสร้างองค์ประกอบทักษะการแก้ปัญหาอย่างสร้างสรรค์ในการเรียนรู้แบบสตูดิโอออกแบบเป็นฐานในสาขาสถาปัตยกรรมศาสตร์

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บทคัดย่อ

การแก้ปัญหาอย่างสร้างสรรค์คือความสามารถในการสร้างความคิดที่ใหม่และมีคุณค่าเพื่อการแก้ปัญหา ประกอบด้วย คิดสั้นไหล คิดยืดหยุ่น และคิดริเริ่ม เป็นทักษะที่ช่วยให้สถาปนิกสร้างงานออกแบบได้อย่างมีประสิทธิภาพ กรอบแนวคิดการศึกษาในครั้งนี้แสดงองค์ประกอบการแก้ปัญหาอย่างสร้างสรรค์ คิดสั้นไหล คิดยืดหยุ่น และคิดริเริ่ม ผ่านแบบประเมินตนเองด้านความคิดสร้างสรรค์ ผลข้อมูลแสดงความสัมพันธ์ขององค์ประกอบทักษะการแก้ปัญหาอย่างสร้างสรรค์ของนิสิตนักศึกษาสถาปัตยกรรมศาสตร์ ระดับปริญญาตรี โดยมุ่งยืนยันโครงสร้างองค์ประกอบการแก้ปัญหาอย่างสร้างสรรค์จากตัวแปรแฝง โดยสำรวจผ่านแบบประเมินตนเองของนักศึกษาทั่วประเทศ 600 คน จาก 4,000 คน (Hair et al., 2010) โดยการสุ่มอย่างมีลำดับชั้น ตัวชี้วัดทั้งหมดส่งผลอย่างมีนัยสำคัญที่ .01 คิดหลากหลายมีค่าสัมประสิทธิ์คะแนนมาตรฐานของน้ำหนักสูงสุดที่ 0.912 วัดจากตัวแปรสังเกตได้ 5 ตัวแปร โดยการแก้ปัญหาวิธีที่หลากหลายมีความสำคัญมากที่สุด รองลงมาคือการแก้ปัญหาอย่างครอบคลุม ค่าสัมประสิทธิ์คะแนนมาตรฐานของน้ำหนักเท่ากับ 0.736 และ 0.659 ตามลำดับ คิดริเริ่มมีค่าสัมประสิทธิ์คะแนนมาตรฐานของน้ำหนักที่ 0.788 ประกอบด้วยตัวแปรสังเกตได้ 6 ตัวแปร ความคิดที่ไม่ธรรมดา มีความสำคัญมากที่สุด รองลงมาคือการสร้างทางเลือกไม่ซ้ำใคร มีค่าสัมประสิทธิ์คะแนนมาตรฐานของน้ำหนักเท่ากับ 0.798, 0.739 ตามลำดับ คิดยืดหยุ่นมีค่าสัมประสิทธิ์คะแนนมาตรฐานของน้ำหนักน้อยสุดที่ 0.688 จากตัวแปรสังเกตได้ 5 ตัวแปร ถึงแม้ว่าตัวชี้วัดมีค่าสัมประสิทธิ์คะแนนมาตรฐานของน้ำหนักสูงสุดคือ การเชื่อมโยงการแก้ปัญหาที่แตกต่าง (0.927) รองลงมาคือมองหาความเป็นไปได้ของการแก้ปัญหาที่ซับซ้อน (0.732) ผลจากการศึกษาพบความสัมพันธ์ของคุณลักษณะทักษะการแก้ปัญหาอย่างสร้างสรรค์และรูปแบบการเรียนรู้ ที่เป็นประโยชน์ต่อการจัดการชั้นเรียนแบบสตูดิโอเป็นฐานที่สนับสนุนทักษะการแก้ปัญหาอย่างสร้างสรรค์ของนิสิต นักศึกษาสถาปัตยกรรมศาสตร์ คือ สามารถพัฒนาให้ผู้เรียนหาทางเลือกที่หลากหลาย ยืดหยุ่นในการคิด และริเริ่มคิดแตกต่างเพื่อการแก้ปัญหาอย่างสร้างสรรค์ที่มีลักษณะเฉพาะตัว

คำสำคัญ: การแก้ปัญหาอย่างสร้างสรรค์; การศึกษาสาขาสถาปัตยกรรมศาสตร์; การเรียนแบบสตูดิโอเป็นฐาน; การวิเคราะห์องค์ประกอบเชิงยืนยัน

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Introduction

The World Economic Forum identifies creativity as a vital 21st century skill essential for artists, writers, scientists, and inventors. It is also a key attribute for graduates. Providing innovative problems to solve can foster the learners' creativity (Lubart, 2017). Thailand needs to develop its creative economy for 12 creative industries, including architecture, to escape the middle-income trap due to slow economic growth when the competition is focused on low-cost labor production. According to the CEA, the Creative Economy Agency (Public Organization), a creative economy can provide a competitive advantage through Thailand's strengths in cultural diversity and biodiversity. A multitude of dimensions in the creative economy require a set of knowledge-based activities, and it is combined with economic, cultural, and social aspects (CEA, 2019). Developing economies create new trading opportunities, creative industries enhance new dynamic growth, and transform income generation. Creative goods and services and new job creation increase revenue for countries' economies and lead countries to achieve sustainable development (United Nations Economist Network, 2023).

Thailand National Strategy 2018-2037 aims to develop Thai people of all ages into good, skillful, and quality citizens. The strategy for human capital development is to improve and accommodate changes in the learning process, and this policy encourages lifelong learning skills. Policy development comprises strategies to promote and establish essential skills through educational systems to promote academic excellence at the international level (National Strategy Secretariat Office, 2017). Architecture is at the forefront of creative industries to accommodate the new working system. The emerging economic system of the Creative Economy Agency in Thailand aims to introduce new creative services to the existing system. It combines knowledge, creativity, and technology to drive innovative advancement. This situation and the growth of creative economies could enhance the learning style of architecture. Architecture education is a complex field with social and cultural aspects, including philosophy, technology, and other related areas. Integrating diverse subjects with studio-based learning for design disciplines is an essential course offering innovative, creative, and holistic architectural skills (Ibrahim & Utaberta, 2012). Design studio based disciplines, along with related knowledge, tend to cultivate innovative and creative expert architects who produce innovative and creative design solutions. Certain explicit theories that inform creativity and wisdom may involve creative psychomotor skills and be related to constructivist learning theory. In architectural education, the design studio is a core methodology for developing design skills and enhancing the creativity of architecture students. It provides them with opportunities to practice. This study aimed to determine

the relationship between significant factors of creative problem-solving skills, and study results could offer insights for further enhancing studio-based design learning in architecture education.

Research Objectives

This research aimed to confirm creative problem-solving components in architecture students in Thailand through confirmatory factor analysis. It identifies correlations between CPS factors and components and intends to verify other aspects of CPS.

Research Hypothesis

This research confirms the relationship between creative problem-solving components, fluency, flexibility, and originality.

Literature Reviews

Many psychologists define creativity as the production of novel ideas or products that are useful. Creativity can transfer to any domain and bring something new (Amabile, 1996). Creativity components for overall outcomes; distinct production evolves from certain processes, is composed of specific personality transformations, and occurs in particular environments. In 1950, Guilford defined creativity as an ability to differentiate people from others with aptitude interests through activities such as inventing, designing, composing, and planning. Guilford stated that creative persons should be able to sense problems, ideate new, fluent, and flexible ideas, and have evaluation skills to analyze, synthesize, recognize, and redefine an idea structure (Guilford, 1958). Lubart (1994) defined creativity as the capacity to generate appropriate original ideas, encompassing quality, significance, and productivity. "Creative ideas should be based on social consensus and reflect cognitive, personality, motivational, and environmental factors. Creativity can manifest in various domains such as music, drawing, dance, writing, science, and social problem-solving, but it is not limited to any specific domain." (Lubart, 1994). Runco and Jaeger (2012) believe creativity requires originality and effectiveness. Originality with novelty must be combined with utility for balance and appropriate creativity. These attributes are defined as creativity for a creative economy. The worthy criterion for the definition of creativity already exists; effective surprise has shown it (Runco & Jaeger, 2012). In 1931, Hutchinson conducted research on materials used to induce creative thinking. The study aimed to find out the extent of the creative thinking process. Creative thought is transformed into an open-ended problem, requiring an experimental process and fundamental knowledge to explore specific aspects of creative output.

Lubart notes that six components of creativity will appear through people's abilities and circumstances. People could do specific tasks with the intellectual ability to find possible solutions by considering hierarchies' knowledge and creativity to create solutions. The intuitive thinking style is an intellectual ability that fosters higher creativity. Personality traits and cognitive attitudes enable individuals to transform ideas into tangible products. Motivation is an essential component that drives cognitive attributes through enjoyment, interest, and goal focus. Finally, an environment with sufficient resources can enhance cognitive benefits and influence creativity (Lubart, 1994).

CPS is a system that helps individuals or groups better understand task information, essential needs, goals, and inputs to make effective decisions that lead to meaningful results. CPS is a powerful and effective method that can unlock creative potential and drive productive change (Isaksen & Treffinger, 2004). Creative problem-solving is a rational approach to creating vital aspects, generating alternatives, and deciding the best solution (Higgins, 2006). In the beginning, Osborn defined seven processes of CPS, which are the processes of generating a wild idea and refining it. Osborn's seven processes included identifying problems, gathering data, analyzing materials, generating alternative ideas, seeking illumination, integrating ideas, and evaluating them. This process involves modifying ideas to find the best solution (Osborn, 1952). The CPS process has been developed into four steps: 1) problem identification and construction, 2) identification of relevant information, 3) idea generation, and 4) idea evaluation. Lubart (2017) outlines three main components of creative problem-solving. The first component involves generating ideas, while the second focuses on preparing for action. The final component is understanding the challenge. These stages aid in understanding the situation, framing problems, focusing on subsequent efforts, and seeking creative possibilities (Lubart, 2017).

One of the architect's competencies is a strength of problem-solving skills because architects must play a leading role in critical decision-making. Their design process works with diverse ideas, good awareness, and responsibility for proper actions. "Solving the problem" is the phase of "decision making," which involves the process of divergent thinking with investigation, exploration, and experimentation to pursue understanding and look for possibilities for open-ended problems. This meaningful learning makes learners active participants, and this practice becomes a lifelong learning skill (Britz & Richard, 1992). This process also includes convergent thinking, the essential process of discovering the most helpful solution for a particular problem (Sternberg, 1985; Sternberg, 2010; Amabile, 1996). Hokanson (2017) has introduced the application of creativity to problem-solving skills. Creativity cultivation with a rich body of knowledge could enhance creative thinking and skill improvement. Many research findings illustrated that problem-solving could help architects make wise decisions using knowledge implemen-

tation to find a suitable solution (Hokanson, 2017). There is a model that describes how cognitive flexibility and cognitive persistence contribute to creative outputs. The model focuses on ideation tasks, which involve brainstorming possible ideas and demonstrating flexibility, fluency, and feasibility. Flexibility refers to the number of ideas per category, fluency indicates the number of content categories, and feasibility shows the degree to which ideas can be realized. This ideation task can measure flexibility and persistence within the dual pathway to the creativity model. Additionally, researchers have found that group brainstorming fosters more creativity than individual brainstorming, sustains individual performance for longer tasks, and cultivates more systematic creativity (Nijstad et al., 2010).

Studio-based learning is the core discipline of architecture education that focuses on the design process and learning with experts. Students build up their creative problem-solving skills with working experience and social life through the dynamic design-studio environment, hands-on learning activities, jury assessment with experts, student reflection, and building up their future self-learning process (Ioannou, 2018; Ciravoğlu, 2014). Therefore, studio-based learning for architects is authentic learning that provides qualified design performance, gives greater understanding, encourages creative thinking, encourages cognitive orientation, and motivates architecture students to engage in real-life problem-solving (Casakin et al., 2010). An essential trait for architects is to be curious, take risks, and adapt suitable design methods (Barbot et al., 2011). Creativity involves generating original solutions through knowledge and insight to get a suitable and worthwhile solution.

The design process is an investigative, creative, rational, and decision-oriented procedure. The design process is an intellectual-ideological approach to dealing with a design problem. Designers deal with multiple models of design processes: the logical, rational, creative, intuitive, and participatory collective models for design problem solutions (Ostime, 1998). In a study of creative problem-solving, architects attempted to solve problems and make decisions based on relevant, helpful knowledge. They sought additional information to support new ideas by asking friends or communicating with others. (Hong et al., 2013). Architecture programming demonstrates design outcomes throughout the design process. Design studio-based learning has been adapted to the design process through a learning plan to enhance architecture students' design skills. The architecture design process integrates gathering all general data and objectives, function and activity analysis, analysis process, case study, and concept design. These processes could bring out creative problem-solving factors. Gathering all the data could lead to fluency, while analysis processes might bring about flexibility. Finally, the concept design process might reflect the originality of architecture students. Architect

students with creative problem-solving skills can transform ideas and generate new and unique inventions.

In Jonassen's (2000) study, the relationship between problem types, case components, and cognitive skills was examined. The design process involves using problems, case studies, prior experiences, and alternative perspectives to provide casual argumentation and mental stimulation for the decision-making process. Problem-solving can enhance the cognitive process by transforming knowledge globally. There is an advantage to increasing innate intuition, creative abilities, and practical solutions (Jonassen, 2000).

Studio-based learning creates dynamic learning environments for architect students. It also provides feedback and lets them reflect on reasonable design solutions. This learning approach harmoniously works with the architecture design process, raising the design skills of architecture students. This relationship between studio-based learning and the design process could construct creative problem-solving skills composed of fluency, flexibility, and originality.

Conceptual Framework

The objective of this study is to identify the factors that influence the creative problem-solving skills of undergraduate architectural students in Thailand. It will investigate the key indicators of creative problem-solving skills among undergraduate architecture students and explore the potential causal relationship between studio-based learning and the development of these skills.

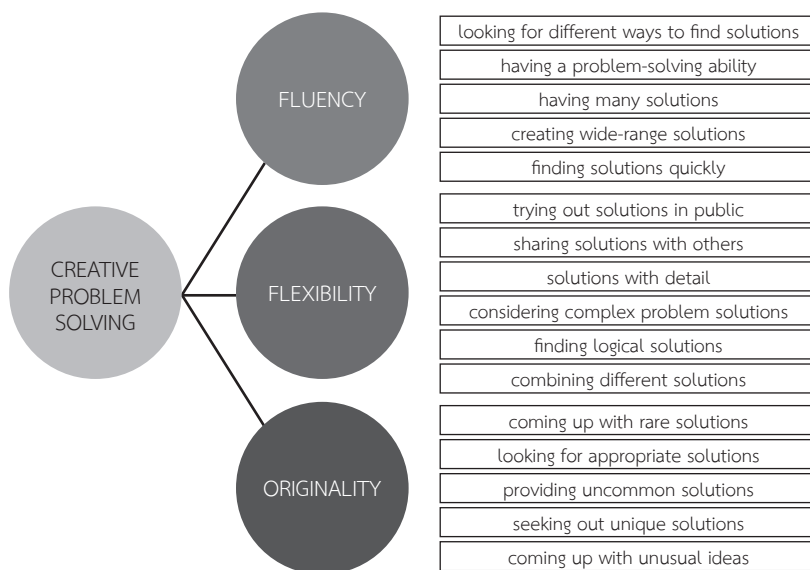


Figure 1. The Structure of Creative Problem-Solving

Source: Adapted from Hokanson (2017)

Research Methodology

This study surveyed components of creative problem-solving through a questionnaire to probe undergraduate architecture students from the Public Universities of Thailand. Four- or five-year curriculum professional degrees in architecture and related fields have design studio classes as a core pedagogy. Multistage sampling is the way to define a sample group. The calculated sample size should be 400 of 5000 undergraduate architecture students. Ten parameters will be calculated through the G*Power program, and the total sample size is 655, which is very close to the previous minimum sample size. First, the research population will be divided into subgroups by region, such as Bangkok and Central, Northern, Northeastern, and Southern, and then these will be used to calculate regional samples. Next, research samples will be assumed to be randomly sampled from the universities allocated in the Bangkok metropolitan region and other parts of Thailand. Lastly, through simple random sampling of respondents, the researcher collects data from a self-evaluation form.

A CPS self-evaluation questionnaire derived from Prof. Brad Hokanson's self-reflect creative survey is the research instrument (Hokanson, 2017). This questionnaire consists of 2 parts. The first part is for respondents' background information that might affect CPS of undergraduate architecture students through activities and learning environments. The second one is a CPS self-evaluation form to investigate the components of creative problem-solving skills of undergraduate architecture students. Question items delve into cognition, motivation, and personality traits influencing creative behavior. Three experts in architectural education will use purposive sampling to verify the quality of this research instrument. The three-rating scale ranges from -1 to 1 according to Cronbach's alpha and is applied to validate the items; it is used for internal consistency and scale reliability. A reliability coefficient of 0.5 or higher was considered appropriate, and the items with less than 0.5 were deemed inappropriate, and would be revised following the experts' suggestions.

Demographic information

The surveys were collected from 655 respondents. The majority were female, with 429 respondents (68%), and the others were 225 male respondents. Twenty years was the average age. The survey responses were from architecture faculties or related fields from public universities such as Chulalongkorn University, Silpakorn University, King Mongkut's Institute of Technology Ladkrabang (KMITL), and Kasetsart University. All survey respondents are currently enrolled in senior-level studies at the university, specializing in the Architecture and Interior Architecture departments, with a minority focusing on Landscape Architecture. Approximately 59.54% of the students are at the

junior level, and the rest, 40.46%, are at the senior level.

Table 1. Demographics of respondents

General information (total 655 respondents)	Frequency	Percentage	Valid (%)	Cumulate (%)
Gender				
Female	429	65.5	65.5	65.5
Male	226	34.5	34.5	100
Age of respondents				
Below 18 years old	4	1.5	1.5	1.5
18-20 years old	397	60.5	60.5	62
21-23 years old	254	38	38	100
Department				
Architecture	259	39.5	39.5	39.5
Related Fields to Architecture	396	60.5	60.5	100
Level				
Junior level	391	59.54	59.54	59.54
Senior level	264	40.46	40.46	100
University				
Chulalongkorn University	186	28.4	28.4	28.4
Silpakorn University	86	13.1	13.1	41.5
KMITL	296	45.2	45.2	86.7
Kasetsart University	85	13	13	99.7
Etc.	2	.3	.3	100
The overall grade point average (GPAX)				
Below 2.00	2	0.3	0.3	0.3
2.00-3.00	217	33.1	33.1	33.4
3.00-4.00	436	66.6	66.6	100

Ethical Considerations

The survey data from a CPS self-evaluation form is strictly anonymous. Research data will be kept confidential and will not identify individual responses. The researcher will maintain the confidentiality of the research data and materials throughout the entire research process. This research has been reviewed and approved by the Office of the Research Ethics Review Committee for Research Involving Human Subjects: The Second Allied Academic Group in Social Sciences, Humanities, and Fine and Applied Arts at Chulalongkorn University.

Research Results

From Table 2, the five indicators of fluency are 1) looking for different ways to find solutions, 2) having a problem-solving ability, 3) having many solutions, 4) creating wide-range solutions, and 5) finding solutions quickly. All indicators significantly affect the factor of thinking fluency at the significance level of 0.01. The highest factor loading indicator was “having many solutions”, 0.736, and the second highest factor loading was for “creating wide-range solutions”, 0.659.

The six indicators of flexibility are 1) trying out solutions in public, 2) sharing solutions with others, 3) solutions with detail, 4) considering complex problem solutions, 5) finding logical solutions, and 6) combining different solutions. All indicators significantly affect the factor of thinking flexibility at the significance level of 0.01. The highest factor loading was for indicator “combining different solutions” 0.927, and the second for “considering complex problem solutions” 0.732.

The five indicators of originality are 1) coming up with rare solutions, 2) looking for appropriate solutions, 3) providing uncommon solutions, 4) seeking out unique solutions, and 5) coming up with unusual ideas. All indicators significantly affect the factor of thinking originality at the significance level of 0.01. The highest factor loading was for indicator “coming up with unusual ideas” at 0.798, and the second highest for “coming up with rare solutions” at 0.739.

Table 2. Confirmatory factor analysis results for three factors

Questions	Factor loading		
	Factor 1: Fluency	Factor 2: Flexibility	Factor 3: Originality
No.1	0.533	0.447	0.739
No.2	0.504	0.349	0.709
No.3	0.736	0.680	0.798
No.4	0.659	0.732	0.725
No.5	0.479	0.641	0.579
No.6		0.927	

$\chi^2=274.812$, $df=86$, $p=0.00$, $\chi^2/df \leq 4$, $RMSEA=0.058$, $SRMR=0.049$, $TLI \geq 0.9$, $CFI \geq 0.9$

** Correlation is significant at the 0.01 level (2-tailed).

Table 3. Model fit information

Metric	Estimate	Threshold	Interpretation
X ²	274.812	n/a	n/a
DF	86	n/a	n/a
CFI	0.943	> 0.900	pass
RMSEA	0.058 (0.05, 0.066)	< 0.100	pass
SRMR	0.049	< 0.080	pass

Number of Free Parameters 66; Klien (2005) $\chi^2/df \leq 4$;

Hu and Bentler (1999) RMSEA < 0.06; SRMR < 0.05

The three-factor measurement model of creative teaching gave $\chi^2=274.812$, $\rho=0.01$, $\chi^2/df=3.196$. CFI=0.943, RMSEA=0.058. This means it adequately describes the structure, validating the factorial structure of the three-factor model of creative problem-solving.

Correlation between each variable was significant at level of 0.01. The highest correlation was for Originality and Fluency ($r=0.526$), and the second for originality and flexibility ($r=0.378$). The lowest was for flexibility and fluency ($r=0.168$) (Table 4). Originality is highly related to fluency and flexibility, and it aligns with the literature review in that brainstorming is vital in an early stage to get many ideas (Osborn, 1952; Lubart, 2017). It confirms that the relationship between factors is essential for creative problem-solving skills to discover the most helpful solutions (Sternberg, 1985; Sternberg, 2010; Amabile, 1996).

Table 4. Correlation coefficient matrix of fluency, flexibility, and originality among architecture students

Variable/factor	Fluency	Flexibility	Originality
Fluency	1		
Flexibility	0.168**	1	
Originality	0.526**	0.378**	1

** $P < 0.01$

In conclusion, Figure 2 illustrates the second-order confirmatory factor analysis (SCFA) model to confirm factors from the theoretical framework. As shown in Figure 2, the second order has factor loadings from 0.688 to 0.912. Furthermore, the first-order factor with indicators has factor loading from 0.349 to 0.927.

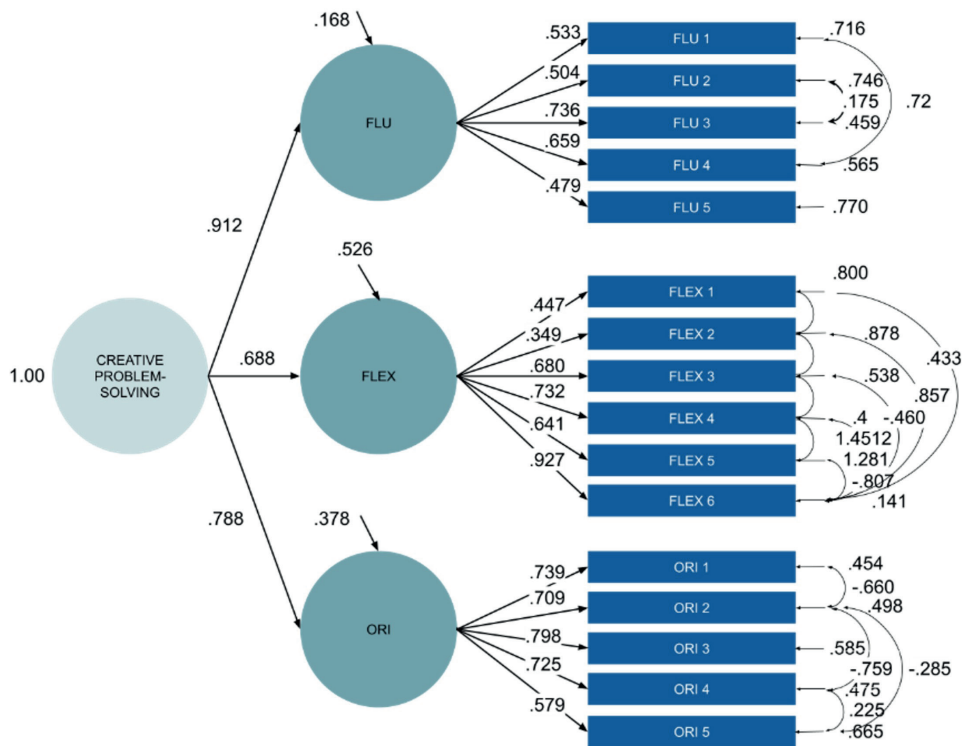


Figure 2. Path Analysis of The Creative Problem-Solving with indicator/factor influences.

Discussion and Conclusions

The factor analysis of the data led to the following conclusions.

1. The study illustrates the causal relationship in which fluency of thinking had the highest factor loading toward creative problem-solving. This finding conforms to previous research by Guilford (1950). Creativity is the cognitive ability to think diversely for many solutions. Fluency is the most common measurement for finding the number of solutions. A well-known divergent thinking test is the Torrance test for creative thinking. Wallach and Kogan's creativity test, created in 1965, is also widely used as a creative thinking test for divergent exploration (Kim, 2006). In 2004, a pilot test for a creative problem-solving course reported fluency as the most increased metric for creativity at .05; it increased on an average by 34.5% (Hokanson, 2017). The study examined the differences between creativity, innovation, and intelligence. Creativity is the ability to develop divergent and applicable ideas rapidly. Creativity seeks new opportunities and generates new ideas or solutions (Hokanson, 2017). This current study has demonstrated how fluency is still one of the most crucial factors influencing undergraduate architecture students' creative problem-solving skills.

2. The originality indicator is the second crucial factor influencing creative problem-solving skills. The loadings for most originality indicators are over .700, and all items are about finding different solutions. Originality is about seeking outcome ideas that should be uncommon, rare, and unique. Corresponding to other studies about creative problem-solving, it is about a cognitive process designed to inspire and foster creative problem-solving skills (Olteteanu, 2016). Osborn's brainstorming approach for creative idea generation stated that evaluating and selecting focuses on constraints and opportunities to offer valuable solutions. Originality is one of the CPS processes that as a cognitive approach leads to creative problem-solving solutions (Lubart, 2016; Ravenell, 2018). The investigation of relationship of fluency and originality indicates that these are positively correlated, among the dependent variables. The two are relatively autonomous skills (Park et al., 2021). Wieth et al. (2019) imply that the creative problem-solving framework is constructed with different perspectives, leading to multiple solution choices. Also, originality includes seeking possibilities to generate valuable solutions (Wieth et al., 2019). This statistical result could confirm that creative problem-solving in architecture education requires solutions distinctively generated by idea explorations and finalized by the pursued idea.

3. Creativity is dynamic, and it can be increased. The way to improve creativity is to expose other ideas and provide a wide range of information for different ideas. Then, examining the value of ideas with critical skills can redefine the problem and transform it into a good solution (Hokanson, 2017). According to the Working Trend of Creative Economies, an awareness of the new working environment, knowledge, and technology could promote architects' creativity and innovative skills. The results of the study could explain factors of creative problem-solving skills that enhance good decision-making for architecture students, such as making the right decisions and contributing to the right solution. Regarding combinations of the three factors, fluency provides a wide range of solutions, flexibility considers complex and different solutions, and both factors enhance originality to assign appropriate and unique solutions. Over and above that, the highest score in flexibility was for combining different solutions, which could be implemented to find unique solutions.

4. This study's limitation is the lack of prior research on this topic. While many research topics touch on various aspects of creativity and creative problem-solving, no directly related factors exist. There is no prior published study on factor analysis for creative problem-solving using these exact components, leading to a limited literature review on creative problem-solving. This study aimed to concentrate on creative problem-solving in architectural education, and the research findings could provide valuable insights for designing architecture instruction more effectively.

Recommendations

1. The confirmatory factor analysis information states that fluency is essential to generating ideas. Originality has a vital role in providing valuable solutions. There are more diverse values for factor effects for flexibility indicators. Moreover, this indicator has a wide range of highest and lowest value factors. Further studies should investigate the flexibility factor to establish a more causal relationship.

2. The architecture education curriculum should prioritize preparing students with the necessary knowledge and skills to excel in the profession. Factors influencing architecture students' creativity should be considered to provide a well-rounded education. Further research could explore additional influences on architecture students' creativity, such as their motivation for learning and the effects of other external factors.

3. Based on the literature review, architecture education necessitates a dynamic learning environment. The study results strongly correlate with creative problem-solving, fluency, flexibility, and originality. It is recommended that these findings be incorporated into the design of studio-based learning environments. Furthermore, the analysis reveals the connection between creative problem-solving and key elements, which can be integrated into the instructional design for architecture education.

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