Iranian Journal of Educational Sociology

(Interdisciplinary Journal of Education)

Available online at: http://www.iase-idje.ir/

Volume 4, Number 3, December 2021

Design and Validation Product Creativity Evaluation Model in Architectural Design Education*

Elahe Hassankhouei[1], Alireza Rezvani[2**], Vahid Ahmadi[2], Fatemeh Haji Arbabi[3]

1. PhD student, Department of Architecture, Mashhad Branch, Islamic Azad University, Mashhad, Iran.
2. Assistant Professor, Department of Architecture, Mashhad Branch, Islamic Azad University, Mashhad, Iran.
3. Assistant Professor, Department of Architecture, Mashhad Branch, Islamic Azad University, Mashhad, Iran. (Department of psychology, Kavian Institute of higher Education, Mashhad, Iran.)

Article history:

Received date: 2021/05/02

Review date: 2021/07/07

Accepted date: 2021/07/12

Keywords:

product creativity, evaluation, architectural design education

Abstract

Purpose: This study aimed to plan and validate the product creativity evaluation model in architectural education. According to three product creativity evaluation models: CPAM, CSDS and PCMI.

Methodology: The research was applied in terms of purpose and in terms of data collection among descriptive studies was correlational and in terms of method was mixed exploratory research. The statistical population in the qualitative section included all experts in education and creativity in Mashhad. A sample of 10 people was selected by purposive sampling using the principles of theoretical saturation from the mentioned community. In the quantitative part, the statistical population included all university professors in the field of architecture in Mashhad, and 150 people were selected by random sampling. The required data was collected in the summer of 2020 using semi-structured interviews and upstream documents in the qualitative phase. The measurement tool in the quantitative section was a researcher-made questionnaire whose construct validity was calculated using factor analysis, and the reliability value through Cronbach's alpha coefficient was 0.82. The researcher carried out qualitative data analysis using the thematic analysis coding approach developed by Braun and Clarke and quantitative data analysis using the partial least squares method.

Findings: The results revealed that five components with 12 indicators make the status of novelty with two markers of originality and surprise. Relevance to the problem includes two indicators of regulatory compliance and practicality. In addition, the effectiveness of solutions has three indicators, namely meeting the needs of contacts, being environmentally friendly, and having durability. Design elements include two indicators, details (well-defined component) and elegance, and the collection of design elements contains the three indicators of harmonization, completeness, and well-formation (well-crafted) at the 95% confidence interval (p=.001).

In addition, confirmed element analysis of the obtained components revealed that all factor loads were significant, and there is an acceptable agreement between the creativity model of architectural design products and the data. The heavy element load related to novelty (0.91) and the light one are related to the collection of design elements.

Conclusion: Based on the findings, it can be concluded that according to the experts, the factor of novelty, such as originality and surprise, along with functional factors such as relevance, effectiveness, and artistic factors consisting of the design of elements, and the collection of design elements affects the designing creativity evaluation model of problem-solving results.

Please cite this article as: Hassankhouei E, Rezvani A, Ahmadi V, Haji Arbabi F. (2021), Design and Validation Product Creativity Evaluation Model in Architectural Design Education, **Iranian Journal of Educational Sociology.** 4(3): 11-18.

* This article is extracted from the PhD dissertation of the first author entitled "The role of educational psychology in increasing creative power in architectural design" under the guidance of the second and third authors and the advice of the fourth author in the Department of Architecture, Mashhad Azad University.

** Alireza Rezvani, Assistant Professor, Department of Architecture, Mashhad Branch, Islamic Azad University, Mashhad, Iran. (E-mail: rezvani0112@mshdiau.ac.ir)

[DOR: 20.1001.1.26453460.2021.4.3.11.6]

[DOI: 10.52547/ijes.4.3.11]

1. Introduction

In recent decades, revolutionary changes in industrialized countries have increased the consideration given the need for creativity in problem-solving. New technologies in information and communication are reshaping the material, human, and social foundations of society (Indriartiningtias and Hartono, 2018). As a result, decision-makers have emphasized the critical need for creativity and innovation to take advantage of emerging opportunities and address the many significant problems facing today's society (Tidd and Bessant, 2020). In the past, creativity was considered an innate talent and divine ability, and geniuses such as Darwin, Picasso, and Beethoven were known as creative and influential people in solving society's problems. Today, however, creativity comes in a variety of styles that are not limited to geniuses but can be taught. Encouraging creativity has received much attention in recent years, and the science education curriculum being emphasized (Altan, 2020).

Globalization impacts creativity, and creativity has become a primary educational goal, especially in problem-based learning (such as architecture) at schools and universities; some research has emphasized encouraging students to think creatively in the classroom (Denson, 2015). In architecture education, creativity in design pedagogy is an integral component of the design process (Onsman, 2016), and being creative adds value to the design work. Students in a design studio learn to identify problems, generate many solutions, and after evaluating all solutions, select the best one. By acquiring this skill, they will be able to cope with the rapidly changing world. They experiment with problems simulating real-life situations while gaining experience in integrating theoretical with practical aspects of the architectural profession. Therefore, learners will become successful innovators and problem-solvers in all areas of life (Doheim and Yusof, 2020), preparing themselves for the ever-changing world of work by practicing skills such as invention, discovery, and art (Kress and Rule, 2017).

In the twenty-first century, the world has turned towards competence and technology; other popular skills can no longer meet the diverse and dynamic needs of education (Daryaband, Oladian, and Hosseini, 2020). Overwhelming growth in technology has brought a new understanding of communication, knowledge, and meaningfulness. The gap between education and the student's digital environment influences students' understanding, and most importantly, it affects their educational expectations (Selinger, et al., 2008). New developments in creative teaching strategies that enable learners to engage in a productive way to generate novel and practical products in successful adaptation to change are needed (Ritter, Gu, Crijns, and Biekens, 2020). Evaluating creativity is an integral part of this process. The crucial point for instructors is to consider assessment as a part of the teaching-learning process (Çıkış and Çil, 2009). Vocabulary assessment usually refers to a judgment that can be justified according to specifically weighted set goals and yield either comparative or numerical ratings (Finkelstein, 2005).

Many contributions for creative evaluation have been made in the field of metrics. Some methods examine the creativity of individuals, while others relate to creativity in the design process and still others focus on creativity in products. Outcome-based (product) assessment methods have become more common because of the inherent complexity in using process-based approaches (Ylitalo, 2017). Assigning small projects throughout the semester and a larger scale one for the final will determine the assessment in architectural design studios at the end of the scholastic term. Currently, two main approaches are applied to assess the creativity of architectural design products, namely subjective tools (such as the Consensual Assessment Technique) and criterion-based methods. Although the subjective grading approach has been proven useful, it has two drawbacks: labor costs (raters usually code a large number of responses) and subjectivity (raters' perceptions and judgments differ) (Beaty and Johnson, 2020).

Furthermore, valid results depend on the judges' experience and the appropriate selection of competing products (Kaufman, 2016). There are no clear criteria underlying assessment procedures (Amabile, 1982). Another measurement approach, called criterion-based, is to break down products into attributes that contribute to creativity and substitute non-experts for experts (Besemer and O'Quin, 1986).

The criterion-based approach is best suited to providing viewers with the information they need to make decisions. Several studies have applied assessment criteria to evaluate creative outcomes. These studies have suggested different sets of criteria, rarely the same metrics, to define creative outcomes (Amabile, 1982; Horn and Salvendy, 2006). It can even be argued that the field of creativity assessment has never before been so prosperous (Kanlı, 2020).

Lack of common criteria for assessing creativity outcome can result in many negative consequences, such as uncertainties and the impossibility of correct evaluation (Rezvani, 2014). No clear and distinct criteria have prevented educators from identifying the strengths and weaknesses of their students and have tailored the educational opportunities for supporting creativity. On the other hand, students cannot meet the expectations of teachers in providing creative work (Kanlı, 2020). The lack of distinct language in assessing creativity can cause differences in raters' scores and inconsistencies among them. It also prevents the proper training of raters and makes it difficult to compare and generalize results across studies (Douglas, Jillian, Thomas, and Eric, 2006).

There are two main groups of studies on measuring creativity in architecture education that have applied a criterion-based approach. The first group involves studies that rely on multiple thinking characteristics such as originality, fluency, flexibility, and elaboration. Dr. E. Paul Torrance et al. developed multiple thinking in 1966. Some studies use these components to assess the creativity of architectural design results (e.g., Khoshtale, 2019; Talebi, Moosavi, and Poushaneh, 2020), while examining the creativity of ideas generated in early-stage product ideation. The criteria for measuring the creativity of the finished product are not suitable for the aim of the present research. The second group of studies have applied factors for the creativity assessment of architectural design results, such as novelty, appropriateness (e.g., Hong, 2015; Liou, 2018), originality, and practicality (e.g., Goldschmidt and Smolkov, 2006; Genco, Hölttä-Otto, and Seepersad, 2012). Experts in other fields, such as psychology, add factors for evaluating creative products such as elegance, effectiveness, and relevance. Studies on creative products in psychology and other fields have full theoretical foundations; an architectural project, however, is considered a product. Thus in architecture, it would be helpful to extract and validate main components and indicators of expert opinions, creative product models such as the Product Analysis Matrix (CPAM) of O'Quin and Besemer (1999) and the Creative Solution Diagnosis Scale (CSDS) of Croply (2005), and the product creativity measurement instrument (PCMI) proposed by Horn (2009). Consequently, this study aimed to plan and validate the product creativity evaluation model in architectural education based on the above-mentioned models. The fundamental objective of the present study was to determine what components and indicators of the product creativity evaluation model exist in architecture.

2. Methodology

The present study is applied research in terms of purpose, and it is a mixed-exploratory type in data collection. The statistical population in the qualitative phase included 10 experts in educational creativity and architecture selected using the purposive sampling method during the summer of 2020. The principle of maximum diversity was used to achieve theoretical saturation using semi-structured interviews based on three creativity evaluation models (CPAM, CSDS, and PCMI). Data collection was performed using the descriptive survey method. In the quantitative part, the statistical population included all professors of architecture in Mashhad universities who have at least a master's degree and five years of work experience. Using the relative random sampling method, 150 people were selected as the statistical sample. The required data was collected in the summer of 2020 using questionnaires distributed among 180 professors of architecture. Of this number, 150 questionnaires were correctly answered and used for subsequent analyses. In the qualitative phase, data was extracted through theoretical research, with emphasis on the CPAM, CSDS, and PCMI models. The Delphi technique was implemented with a semi-structured questionnaire. The questionnaires were scored on Likert's style with five options (1. very low, 2. low, 3.

[DOR: 20.1001.1.26453460.2021.4.3.11.6]
[DOI: 10.52547/ijes.4.3.11]

[DOR: 20.1001.1.26453460.2021.4.3.11.6]

[DOI: 10.52547/ijes.4.3.11]

medium, 4. high, and 5. very high) in the quantitative phase of the study. The validity of the questionnaires was confirmed in terms of content and structure by five faculty members at Islamic Azad University, Mashhad Branch. Cronbach's alpha coefficient estimated and confirmed reliability with 82%. The data analysis method is based on Lisrel software and the confirmatory factor analysis method. The current study considered various phases, as shown in the table below.

Table1. Type of research in different phases of study

Classification basis	Phase 1 Identify the factors affecting the validation of the creativity product evaluation model	Phase 2 Determine the variables of the model	Phase 3 Model test	Phase 4 Prioritize effective factors contributing to measuring creativity of output
Purpose of the research	Exploratory explanatory	Descriptive	Descriptive	Descriptive
Research result	Developmental	Developmental-applied	Developmental-applied	Developmental- applied
Research data	Qualitative	Quantitative	Quantitative	Quantitative

3. Findings

Of the respondents, 60% (90) were male and 40% (60) were female. Sixty-seven (44.6%) of the respondents were 36 to 45 years old, 50 (33%) were older than 45, and 36 (22%) were 36 to 45 years old. In the sample population, 25 (16.66%) respondents had more than 20 years of work experience, 30 (20%) had between 15-20 years, 30 (20%) respondents had between 10-15 years, 30 (20%) had between 5-10 years, and 35 (23.33%) respondents had less than five years of work experience. According to the study, 60% (90 people) of the selected respondents in the sample had a master's degree, 20% (30 people) had a doctorate, and 20% (30 people) were Ph.D.

The results from interviews with experts who included their opinions led to five main components, namely novelty, effectiveness (of solutions), relevance (to the problem), design element, and collection of design elements. Each component contains subcomponents, and each subcomponent has the questions by which the component is measured. Figure 1 shows the factor analysis of the creativity measurement model, and Table 2 gives information about the model fit indicators.

[DOR: 20.1001.1.26453460.2021.4.3.11.6]

[DOI: 10.52547/ijes.4.3.11]

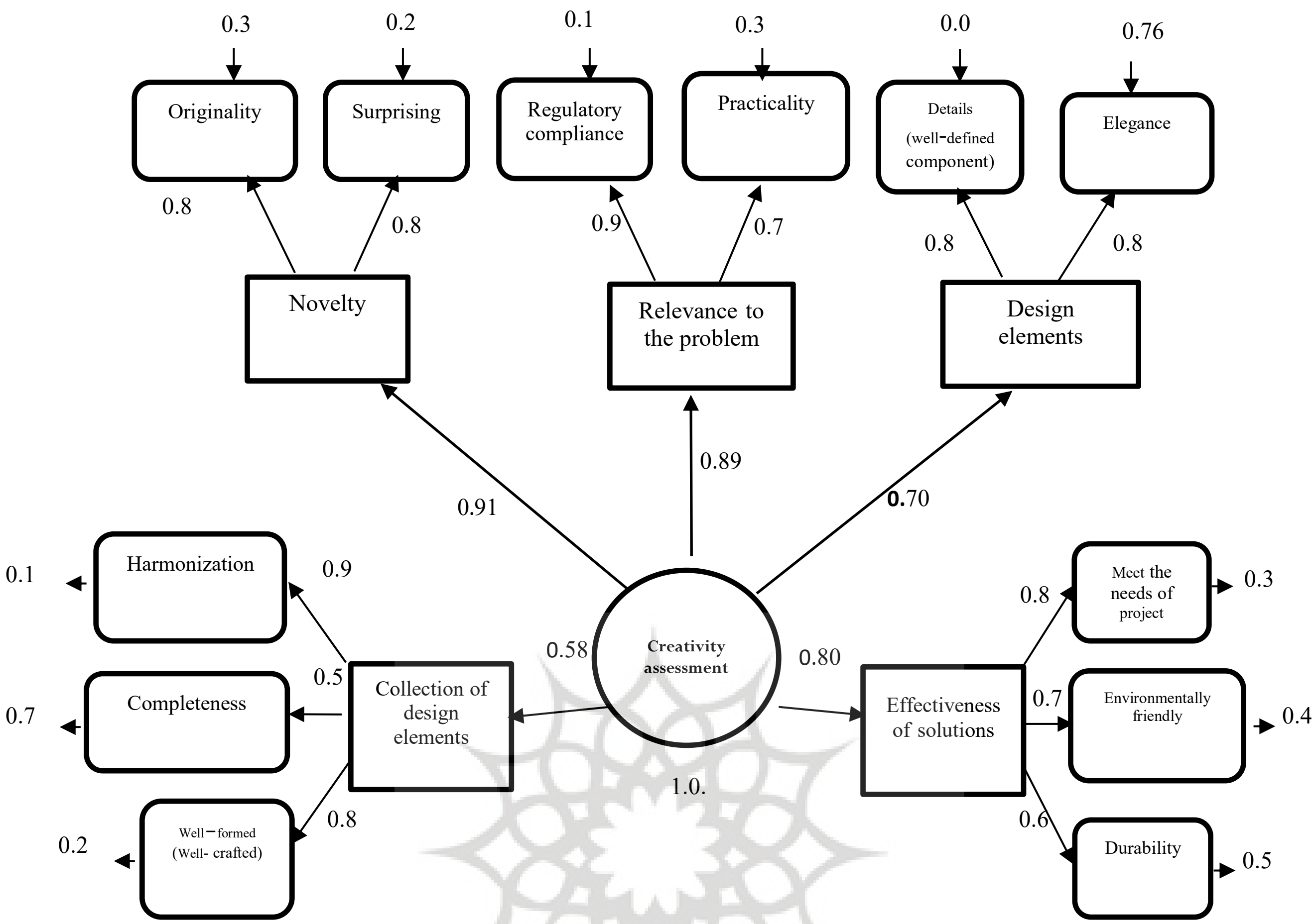

Figure1. Factor analysis of product creativity measurement model

In the diagram above, all factor loads are significant and higher than 0.5. The highest factor load is related to novelty (0.91), and the lowest one to the collection of design elements (0.5). The indicators of relevance to the problem, effectiveness of solutions, and design elements in the second to fourth priorities, respectively, influence the measurement model of creativity resulting from the outcomes assessment model.

Table2. Criteria for fitting the model of measuring the creativity in problem solving outcomes

Comparative Fit Index (CFI)	Normalized Fit Index (NFI)	Mean square root of approximation error (RMSEA)	Standard root mean square root (GFI)	$\chi 2 / df$
0.97	0.94	0.08	0.91	1.70
Optimal value: χ 2 / df ≤ 3; NFI ,CFI ,GFI ≥ 0/80; RMSEA ≤ 0/1				

The table above shows that the chi-square square is estimated at a degree of freedom of 1.70, which is less than three, so it fits appropriately with the model. In addition, the CFI, NFI, and GFI indices are more than 0.9, indicating that the model is appropriate. The RMSEA is less than one and is acceptable. Therefore, the designed model can be used with confidence, and its quality and the information are confirmed. All the valuable indicators of the creativity assessment model are good and acceptable fits. Following the initial design of the models, the ten experts received the constructed models for their opinion. Measuring the internal validity of the model met the researcher's permission. The results show the internal validity of the conceptual model.

4. Discussion

This study aimed to design and validate a model for evaluating the creativity of products in architectural education. The findings identified five components with 12 indicators which were, in order of priority, novelty with the two markers of originality and surprise; relevance to the problem included the two indicators of regulatory compliance and practicality; the effectiveness of solutions with the three indicators of meeting the needs of contacts, being environmentally friendly, and having durability; design elements with the two indicators of details (well-defined component) and elegance; and the collection of design elements with the three indicators of harmonization, completeness, and well-formation (well-crafted).

No studies like the current research were found, but some had similarities. For example, Ganjooei (2019) investigated the effect of stimuli variation on students' creativity. The outcomes were scored and judges graded the originality and practicality of the learners' products. Consistent with the findings of the present study, originality and practicality were two parameters for evaluating product creativity, but in the current research, originality was found to be an indicator of novelty and practicality an indicator of effectiveness. Alone, they cannot estimate the creativity score. Kalantari (2019) presented a conceptual framework which included person, environment, process, and product to enhance creativity in architectural design education. Moreover, the authorities considered novelty, usefulness, functionality, surprise, details, and originality as the components of a creative outcome. This is consistent with the results of the present study, but the scale of components and indicators were not considered in the reports of the two mentioned studies. For example, originality and surprise are subcomponents of novelty (Bessemer and Quin, 1998).

Usefulness and functionality have parallel meanings, and both meet the needs of the project. In addition, attention to the context of the problem in the current article is called the relation component; it was not present in the Kalantari study. The current research also had some limitations. First, because of the coronavirus, participants could not be interviewed in person; the researcher conducted telephone interviews, in which the risk of being misunderstood or coming across as underwhelming exists, as the interviewer cannot use body language or facial cues. In addition, the questionnaire was distributed online to respondents and thus faced challenges related to sampling, response rate, maintenance of confidentiality, and ethical issues. Second, correctly understanding the problem, needs, and potentials was difficult due to a lack of significant research background in the field of criteria-based evaluation of creativity outcomes. Third, this study used a synthesis approach, and as the technique has yet to be applied in practice, generalization of the results is limited, and the research's recommendation that the model be applied on a large scale is constrained.

According to the current results, creativity assessment of outcomes is an essential issue that should be considered in architectural education. Simultaneously, it is very much required by designers at offices as well, as it helps them choose the best answer to challenges and meet the demands of businesses operating in a rapidly evolving world. The studied literature indicated the lack of a theoretical foundation for the evaluation of creativity of architectural design products and the factors affecting it. These are appropriate factors for grading students: helping them identifies the strengths and weaknesses of their students, and truly promoting their students' creativity. Although this research has achieved its expected results, addressing other aspects of creativity such as person, process, and environment, and recognizing their characteristics can provide a better understanding of fostering learners' creativity. In addition, other empirical research with different methods is yet to be conducted to verify the research model and generalize its results.

[DOR: 20.1001.1.26453460.2021.4.3.11.6]

[DOI: 10.52547/ijes.4.3.11]

References

Altan E B, Tan S. (2020). Concepts of creativity in design based learning in STEM education. International Journal of Technology and Design Education, 1-27

Amabile T M. (1982). Social psychology of creativity: A consensual assessment technique. Journal of Personality and Social Psychology, 43(5): 997–1013.

Beaty R E, Johnson D R. (2020). Automating creativity assessment with SemDis: An open platform for computing semantic distance. Behavior research methods, 1-24.

Besemer S, O'Quin K. (1986). Analyzing Creative Products: Refinement and Test of a Judging Instrument. Journal of Creative Behavior, 20(2):115-26.

Çıkış Ş, Çil E. (2009). Problematization of assessment in the architectural design education: First year as a case study. Procedia-social and behavioral sciences, 1(1): 2103-2110.

Cropley D H, Cropley A J. (2005). Engineering creativity: A systems concept of functional creativity .Creativity across domains, 187-204.

Daryaband T, Oladian M, Hosseini SR. (2020). Designing a Model of Professional Competence of Managers Based on the Development of Creativity and Innovation in Primary Schools. Iranian journal of educational sociology 278.

Denson C D. (2015). Developing instrumentation for assessing creativity in engineering design. Journal of Technology Education, 27(1): 23–40.

Doheim R M, Yusof N. (2020). Creativity in architecture design studio. Assessing students' and instructors' perception. Journal of Cleaner Production, 249: 119418.

Douglas L D, Jillian M H, Thomas L R, Eric L S. (2006). Identifying quality, novel, and creative ideas: constructs and scales for idea evaluation1. Journal of the Association for Information Systems, 7(10): 646-660.

Dziekonski K. (2017). Project managers' competencies model for construction industry in poland. Procedia Engineering, 182: 174-181.

Genco N, Hölttä‐Otto K, Seepersad C C. (2012). An experimental investigation of the innovation capabilities of undergraduate engineering students. Journal of Engineering Education, 101(1): 60-75.

Goldschmidt G, Smolkov M. (2006). Variances in the impact of visual stimuli on design problem solving performance. Design Studies, 27(5): 549-569.

Hong S W, Lee J S. (2015). Nonexpert evaluations on architectural design creativity across cultures. Creativity Research Journal, 27(4): 314-321.

Horn D, Salvendy G. (2006). Consumer-based assessment of product creativity: A review and reappraisal. Human Factors and Ergonomics in Manufacturing, 16: 155-175.

Indriartiningtias R, Hartono B. (2018). The Effect of Owner Creativity on Organizational Creativity: Empirical Evidence from Surakarta Indonesia. In 2018 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM) (pp. 473-476).

Kalantari B, Nourtaghani A, Farrokhzad M. (2020). An Educational model of Creativity Enhancement in Design Studios Using Prior Researches. Space Ontology International Journal, 9(3): 15-26.

Kanlı E. (2020). Assessment of Creativity: Theories and Methods. In Creativity-A Force to Innovation. IntechOpen.

Kaufman J C. (2016). Creativity 101. Springer publishing company.

khoshtale M, VASEFIAN F. (2019). The Effectiveness of Simulation-Based Teaching in Physics on Secondary School Students' Creativity in Isfahan in the Academic Year 2018-2019. (Journal of instruction and evaluation) journal of educational sciences, 12(47):185-204.

Kress D K, Rule A C. (2017). Fifth graders' creativity in inventions with and without creative articulation instruction. Journal of STEM Arts, Craft, and Constructions, 2(2):130–154.

Liou S, Lan X. (2018). Situational salience of norms moderates cultural differences in the originality and usefulness of creative ideas generated or selected by teams. Journal of Cross-Cultural Psychology, 49(2): 290-302.

Onsman A. (2016). Assessing creativity in a 'New Generation'architecture degree. Thinking Skills and Creativity, 19: 210-218.

Park N K, Chun M Y, Lee J. (2016). Revisiting individual creativity assessment: Triangulation in subjective and objective assessment methods. Creativity Research Journal, 28(1): 1-10.

Rezvani A. (2014). Applied classification of methods and introduction of seven architectural processes.the first national conference on research methods in urban planning and architecture.

Ritter SM, Gu X, Crijns M, Biekens P. (2020) Fostering students' creative thinking skills by means of a one-year creativity training program.

Selinger M, Stewart-Weeks M, Wynn J, Cevenini P. (2008). The Future of School. Cisco Internet Business Solutions Group (IBSG).

Talebi M, Moosavi M, Poushaneh K. (2020). Evaluating the impact of Brainstorming and Scamper technique on promoting the creativity of architectural design skills. Technology of Education Journal (TEJ), 14(3): 689-706.

Tidd J, Bessant J R. (2020). Managing innovation: integrating technological. Market and organizational change. John Wiley & Sons.

Ylitalo P. (2017). Value creation metrics in systematic idea generation.