Divergent Thinking: a Tool for Assessing Students' Creativity in Architectural Design Course

Maedeh Mayahi [a], MohammadEbrahim Mazhari [b,*]

[a] *Department of Architecture, Karoon Institute of Higher Education, Ahvaz, Iran.*

[b] *Department of Architecture, Faculty of Civil and Architecture, Shahid Chamran, University of Ahvaz, Ahvaz, Iran.*

Abstract

Creativity is the main and necessary element in architecture education. Many thinkers and researchers around the world have thought about creativity. They have tried to solve its mystery. In terms of psychology, creativity can be seen in both convergent and divergent thinking. But it is more inclusive in divergent thinking. A designer with divergent thinking directs his design towards different, new and extensive situations that play a significant role in its creativity. Therefore, it is important to consider creative education in architecture education, especially for architectural design courses. The purpose of this study is to discuss creative education and how to implement it into architectural education, especially architectural design courses. The research method is mixed (quantitative-qualitative) and applied in terms of purpose. The sketch has been used to gather information from library sources and students' opinions through the questionnaire along with holding a two-day workshop. The statistical population is all undergraduate architecture students (associate's and bachelor's degrees) of Karoon Higher Education in Ahvaz. To assess the students' creativity, in addition to the questionnaire formulation, the standard test of the "Torrance test for creativity" has been used. The sketch testing the held in a two-day workshop, and Cropley's creative solution diagnosis scale (CSDS) was used to assess the sketches. To analyze the questionnaire data, SPSS software was utilized. The research results explain that the level of architecture students' information about creativity and ways of its development are not enough and the creativity issue is not obvious and known for most of them. It is suggested that design professors use various methods to reach the desired designs to achieve creative studios. Also,a assignments should be implemented in the curriculum, especially during the entry and basic courses to familiarize architecture students with the phenomenon of creativity and creative education to develop creativity. Authors suggest designating graduate studies and dissertations on the Classification of creative exercises and their learning and teaching methods in architecture to elevate the creativity in architecture courses in the country.

Keywords: Creativity; Divergent Thought; Creative Thought; Education; Architectural Design Process.

1. Introduction

In the architecture field in addition to innate talents which are necessary for the art fields, the application of creativity has an important role in its innovation, technology, education, and commercialization. Creativity enables to solve the new problems, initiate, innovate, and give special solutions. In terms of psychologists, creativity is considered in both thoughts of convergent and divergent: In convergent thought, people think in such a way till they eventually reach similar results and in other words, the kind of their attitude and thought moves towards the predetermined and known states. But the divergent thought is guided towards various, new, and broad states, which is consistent with creativity. However, what takes a thought or attitude from convergent state (constraint, iteration) to the divergent state (extension, novelty) is the same new questions (or new and diverse answers to conventional questions). In other words, consciously or unconsciously random questions raised by a technique such as the glasses technique, retain their role

as a beginner of the movement and thought (divergent or convergent) (Behjouya, 2010,27). Here, it is raised 3 key ideas. First, in the primary stage of studies in architecture, media design is essential for creativity development. Second, requirement for the design increases the ability of graphical evolution, and so the drawing experience, the creative freedom that is need for the process of every art learning. And third is that spontaneity and different reactions which occur in the drawing stages, cause the person to be in a position to produce alternative thoughts (i.e. an emotional situation that lives with human completely) (Ana Torres, 2014, 9). Imagination plays a pivotal role in the start and development of creative ideas in primary design stages . The designers rely on it and emphasize necessary visual support and argument to find spatial relations between diagrams. The design problem consists of an improperly defined solution to identify, solve creative ideas that the designers evolve in interaction with design (Yi-Teng Shih, 2015,2). In the divergent thought, the person in the face of a problem is guided towards the various or new and broad states which are consistent with creativity. In another word, the

* Corresponding Author Email Address: m_e_mazaheri@scu.ac.ir

divergent pers on faced with the design subject, develops different designs and sketches with different attitudes and views in mind and draws it. Creativity skills employ subject skills in a new way with breaking molds. It means that it uses subject skills of the sketch in a new form. In the field of architecture, creativity in education plays a significant role in development and growth of students, so it can be very efficient in the future of architects' education to have a clear image of that. Manual sketches play an important role in the creation of creative ideas in the primary stages of the design process. According to the research literature, the objectives can be presented as follows: Purpose of this study is to pay attention to creative education and how to develop it into an architecture education especially for architectural design courses.

The following questions are asked to achieve the objectives of the research:

- What is the awareness of architecture students regarding the place of creativity in the architectural design process?

- What is the position of the divergent thought to assess the architecture students' creativity?

In order to achieve answers of mentioned questions relying on psychology basics and educational planning and responding to the above questions, the main hypothesis of the research is raised as follows:

It appears that the divergent thought is a tool to increase creativity in the architectural design process of architecture students.

The scope of these studies emphasizes the importance of creative education and the place of divergent thinking in the architecture education system. But none of the previous researches has shown the place of divergent thinking in architecture education, which shows the necessity of the forthcoming research. Accordingly, this study first defines creativity and its impact on the architectural design process and then discusses creativity position in architectural education.

2. Theoretical Framework
2.1. Creativity and its impact on education

The term creativity or innovation in the dictionary means to introduce a new method or way of doing . Also, it can be attributed to a discovery process or creation of the main idea of a new thing in which Innovation is the application or use of an idea. innovation is also different with the invention which is the wise application of knowledge (Alen Ji Brux, 2013). Tersa Amabail (1997) explains that it is creativity that simply provides the production of new and proper ideas in each field of human activities such as science and art, education, and business in the daily life. In 2016, Oliver Toubia, reviewing this problem whether a creative output can be improved by the motive of suitable design ideation, proposes a quantitative framework for the study of a mainly qualitative subject, production of the idea focusing on the impact of motives (Toubia,216,411). Creativity is one of the problems, which so far has not been created an agreement between the researchers and psychology for its nature and

definition. A group of psychologists knows the basis and axis of creative activities to be novelty and renewal and believe that it must be existed the collection of abilities and specific characteristics in a person, which leads to the creation of the creative thought. But renewal cannot clarify the concept of creativity, because there are many problems that are novel and new, but not creative (Emami Naeini, 2005). Hojat (2004) refers to inefficiency of current ways of architecture education in Iran and suggests reviewing and reconstructing the intellectual-philosophical foundations of this important subject with understanding of the day conditions (Hojat ,2004,36). Mir Riahi, showed that the selection of a suitable student is as the most effective factor in the creation of a successful education system. Another necessary consideration for architectural design education is to pay attention to the educational method of design professors (Mir Riahi,2003, 49). Ghadami, explains that architecture education has a considerable effect on the level of creativity and educational success of students. Meanwhile, components of flexibility, innovation, extension, and eventually fluidity are highly significant , respectively (Ghadami, 2013, 77). Mahdinejad (2016) with emphasis on the role of creativity and visual memory in architecture education is streamlining the architectural design process and proposes choosing a proper model for the promotion of the qualitative level of the architectural design. Khakzand in 2010 showed that the graphical designs that cause reminder and have been created based on the sketches, can well help the designers find interesting sources of different fields. They explore that the more comprehensive the range of visual information, the higher the increase design creativity as well (Khakzand ,2010,160). Surbiat in 2011 showed that the university teacher should not limit the student to only listening with traditional methods, but also needs various educational techniques to keep students' attention to induce the creativity thought to them using the role of software skills such as communication, team work, and criticism. Toress increased the assignment, innovation surfing, and creativity and creates several opportunities (Toress, 2014, 2513). Augelloa in 2016 showed that creativity including two convergent and divergent processes, in both forms, is clear and conceptual. This issue leads to 4 activities (i.e. exploratory, reflective, conceptual, and analytical) which have caused the tendency and motive to produce creative actions. (Augelloa ,2016,1). Mahmoudi (1999) defined a model for the employment of the students' talent in the design process using specifications of two brain hemispheres . Meanwhile, during education of the process and employment of hidden talents of students, he reviews the main structure of the design process and assignments that can promote their creativity power. In this method, the student is involved in the design issue with employing characteristics of two brain hemispheres , activating several capabilities of the mind in the back-and-forth form and simultaneously among analytical information in a hemisphere, and achieving the ideas in other one. In this way, according to the collected documents associated with creativity process, it can be expressed that creativity is not only an ability and can develop, but also there are various

models to achieve this important subject (Mahmoudi,1999, 70). Tamannaeifar showed that there is a meaningful relation among creativity and mind, emotions, psyche, and social welfare (Tamannaeifar, 2014, 37) . Bisadi, expressed that the advanced research activities as fundamental factors in the future communities, are extremely dependent on creativity and innovation. There are many opinions regarding education and creativity that some samples can be mentioned (Bisadi, 2012, 242). Ganji said that the underlying goal of education is creativity in the students; in other words, in teaching and training of all courses, the divergent thought must be considered by the professor addition to the convergent thought and asked the students to express their ideas and solutions whatever are strange and unusual(Ganji,2005,4). Mohd Surbi in his study in 2011 shows this important indicator that a university teacher requires different teaching techniques to keep the students' attention. The university teacher should not limit the student to only listening with traditional methods. He/she can induce the creativity thought in the student using the role of software skills such as communication, teamwork , and criticism(Mohd Surbi, 2011,179). Folch, Pereira, and Icart in 2019 identify the main factors facilitating and inhibiting creativity with three stages of the creative process (purposeful preparation, thought, and evaluation). Conceptualization of three underlying stages of the creative process in architecture, gives a new view to understand how the architecture students are involved in the creative process to generate the different creative results (Folch,2019,1).

2.2.   Creativity in the architectural design process
Creativity is the main discourse of architecture education. Many thinkers and researchers have thought how much and why creativity is, and tried to identify its secret (Hojat, 2014,6). Creative education (questioning) is a kind of education that tries to add to the student's questions. In creative education, the students have a major role and education is not a process independent from them and merely under the professor's authority . In this way, the instructor must put the student in the position of question and thirst with design of careful and thoughtful questions and accompany him/her to find the answer. Creative education is a dynamic education and like go-ahead planning. It is not a matter of knowledge and teaching to pay attention the student's role in creative education, creativity is a matter of his/her power and talent and must be discovered. It is improper work to impose predetermined plans on yet-unknown talents. It cannot be educated an architecture student with a regular and predetermined plan without any careful knowledge and attention to his/her reactions to data and wishes (Hojat, 2012,33). Creativity can be known a method to solve issues. Indeed, it means that a creative person with the help of his/her creative skill is continuously finding a solution for a problem and specific need (Samad Aghayee, 2007,6). Many researchers describe design as one of the most creative human searches. The general agreement is that it can be recognized five stages in the creativity process, which we call "initial reception",

"provision", "latency", "enlightment", and "denial and proof". The stage of "initial reception" includes detection of the presence of issue or issues and decision to solve them. This stage is very short; however, it may take years. In the design positions, the problem has rarely been determined at the beginning of the work and this stage may want an impressive effort. The provision stage is a conscious effort to search a problem solution. In the design subject, a kind of back and forth occurs between this stage and the first one, because it may completely be expressed another issue again during the search in the range of possible solutions. But what is agreed upon among those who write about creativity is this belief that this hard, pressed, and conscious stage is often followed by a calmer period "latency". In the
Enlightenment stage, this subject how and why the human mind acts in this way is not completely clear. Some believe that in the latency stage, the mind continues to readjust and test all data attracted in the prior busy periods. The latency period may stop the thought line and person when returns to the issue again, find his/herself freer than before to go a new way. At last, we reach the "Daniel and proof" period where during it the idea is tested, extended, and developed. It must be reminded again that in the design subject, these stages are not separate from each other in such a way that are expressed in this analysis. The denial and proof period may detect the improper idea, but its essence may still be valid. However, this issue leads to the reformulation of the issue and new search period and continues in this way (Loveson, 2012,178).
The design studio is the first and possibly the most important educational setting where architectural designstudents enter (Mehrad, Dezhdar, Talischi,2021,34). Lawson, describes the three essential steps of common designing as such: Analysis, Synthesis and evaluation. Analysis involves exploring relationships, looking forpatterns in the information available, and the classification objectives. Analysis is the ordering and structuring of the problem. Synthesis on the other hand is characterized by an attempt to move forward and create a response to the problem – the generation of solutions. Appraisal involves the critical evaluation of suggestedsolutions against the objectives identified in the analysis phase (Mahjoorian, Namari, ,Ebrahimi, 2022,35).(Architects introduce the design process as relying more on the personal and skill aspects of people (Do, Lin, 1995, 211). According to Broadbent, the design process (Analysis, Synthesis, Evaluation) has been introduced. These three stages are presented separately and the beginning of each stage requires the completion of the previous stage (Suwa, Tversky, 1996, 191). One of the first models of the creative design process was presented by Wallace (1926). He stated four stages in the formation of problem-solving: preparation, latent, presentation, and modification. In the preparation stage, the conditions of the problem are checked. Gilford (1950) changed the last two stages of Wallace's model to inspiration and evaluation, emphasizing the special importance of the latent stage. Based on these two problem-solving models,

Goberg and Bagnall (1981) developed a six-step creative design process model that Watkins (1988) applied to the design of specific products. Acceptance, definition, idea generation, idea selection, implementation and evaluation, and finally, four main processes have been recognized as the basis of creativity in design - (preparation), (incubation), (Illumination), (Dickerson & implicitly by the creative person during the creative process (Sadram, 2017,5).

In architecture, creative work is a very personal product while responding impersonal to wishes of the external issue. Mackinnon found creative architects, self-dominant and self-reliant but not sociable. They were also intelligent, self-centered, outspoken, and even aggressive and believe themselves very much (Mackinnon, 1976). The evaluation of creativity includes several aspects. The method of professor's training, course schedule, personal factors such as personal backgrounds of students, educational backgrounds, as well as learning and thinking styles, being individual or collective are all efficient on creativity (Gungor and Yorgancioglu, 2019,1). The architecture design is a creative process, because design means "creation". In this regards, it is important to highlight the role of the divergent thought in creativity. The divergent thought stands against the problems from multiple perspectives and often discovers and develops the main solutions (Hassan, 2018,1465). Scientists and artists require both of convergent and divergent thoughts. Using the mind force, it can be visualized what has been observed before to be created the images never seen at all with mind force. The mind must be prepared and received for thoughts and ideas that once reach it when drawing. Drawing has an application as a creative process whose goal is to create coordination between objective and subjective images. During the drawing, we achieve the new routes which were not available prior to take pen in hand. In this way, drawing allows the new ideas to be created during the process. The primary sketches are displayed like an outline used to arrange the main text of the work. The primary sketches help the designer to show the main and essential issues of the design in brief and then the more important cases are zoomified. As we draw, the subconscious mind is involved in the activity to convert what is seen by the mind's eye to a correct result. The fast drawings or in other words, sketches are employed to capture the short moments or sudden ideas

VerificationRaj). Persuade, divides the judgment of creativity into two branches; judging the creativity of the "process" which can be called "judging the creativity of the process", and judging the creativity in the "product" which can be called what He called "product-oriented creativity judgment". The first type of judgment happens

that reach the mind. Therefore, the sketch technique or free hand with at least tools is required to dominate the drawing (Ching, 2010,179). The presentation of solutions affected by the final goal of the design is the best definition given for the creative design process. The creative design processes lead to the production of the large design. Sobhiyah et al, express that the common goal of many architects worldwide is to teach students the creative design process (Sobhiyah et al,2088,49). Afra Gharibpour shows that the design process consists of two major parts in total; the first part includes the designer's perceptions and impressions of existing factors whose recognition is necessary and essential for the design. The second part of activities is shaped based on the designer's thoughts and mentalities . Finally, it consists of the design parts including existing data analysis, planning, growing, and presenting the final thought. The designer does the first part with received drawings and the second part with mental drawings (Afra Gharibpour,2014,7). Casakina explores the perceptual characteristics of creativity in design. He concludes that there are a collection of cognitive processes and characteristics of people with tendency for creativity in design. The main cognitive characteristics and specifications of more creative designers were compared with those who were less creative in terms of dynamic aspects, output quality as well as internal reality, personal experience expression of people and structure connection to several methods that are often associated with an unusual route. On the whole, the cognitive characteristics of the creative designer are full, variety, and mix of different tendencies which even may be in contrast with each other (Casakina,2012,166). The students recognize that the design of a problem solution is not simple and more related to art and creativity. Most of the design and creativity aspects are investigated by the students themselves (Taneri and Dogan, 2021). (Table1) shows the theories about creativity in architecture.

Table1.
Theories about creativity in architecture

Author	Article Name	Conclusion
J.T.Hemdan,D.S.TahaI.A.Cherif,2022,1	Relationship between personality types and creativity: A study on novice architecture students	Architectural education tends to give a one-size-fits-all approach to educating architects and helping with their creative potential, which neglects the students' different levels of creativity along with their personalities' individuality.
Batuhan Taneri, Fehmi Dogan 2021,1	How to learn to be creative in design: Architecture students' perceptions of design, design process, design learning, and their transformations	The results indicate the problem-solving view of design is the most common characterization, students think design is not a straightforward problem solving and is most related to art and creativity. Finally, students report school has a limited impact on how they learn designing. We conclude experiential learning in the studio create shortcomings if not accompanied with a critical and reflective stance and that undertaking design tasks one after the other without explicit

	throughout their education	reflection on these tasks is an inefficient strategy in learning about the creative design process.
Hernan Casakin 1, and Andrew Wodehouse 2021,1	A Systematic Review of Design Creativity in the Architectural Design Studio	Creativity is fundamental to design problem-solving. This paper sets out a systematic review of the literature in relation to its role in the architectural design studio to identify central issues that impact upon this activity. Challenges and best practices in relation to systematic reviews are outlined, and the procedure followed in this context is set out in detail.
Shanta Pragyan DASH 2021,346	AN EXPLORATORY STUDY ON DESIGN PROCESS IN ARCHITECTURE: PERSPECTIVE OF CREATIVITY	In the conclusions of the paper, a discussion has been made on an inter-relationship between the various stages in the design process and its relevance for a comprehensive understanding of the architectural integrative design process to address any design challenge both as a studio project for architecture students or in live projects by the practicing architects.
Happy Indira Dewi , Muhammad Hayun , Ahmad Susanto , Zulfitria Zulfitria,2021,1190	Analysis of the Effectiveness of Architectural Creative Learning Methods	The results of this study show that the design method with computer-based mass studies is superior to that of biodrawing, mass studies (without computers), mind maps, and biodrawing. However, based on qualitative observations, if this method is used to design at an early stage it will result in a design that is stiff and less beautiful.
Pavel Gregor 2021,191	Methods and techniques supporting creativity in architectural education	creative an important role, especially in the process of educating future architects, when they only begin to learn how to approach the process of creation and design. The creative person does not try to use old solutions to problems, but will look for new methods and new, more effective ways in problem solving by combining ideas that previously seemed unrelated. The creative person is not discouraged by challenges or momentary disappointments, but connects disparate ideas, is not afraid to use unorthodox methods, uses analytical methods and interrelationships between information to solve problems, and boldly follows new methods and solutions that others deem outside of their area of interest,
Behnam Kalantari , Abdolmajid Nourtaghani , Mohammad Farrokhzad,2020,15	An Educational model of Creativity Enhancement in Design Studios Using Prior Researches	it was found that the creativity enhancement elements in design studios can be classified into three main categories: conceptual framework, interventions, and assessment.
Abdollah BaghaeiDaemein, HosseinSafari 2017,100	Factors affecting creativity in the architectural education process based on computer-aided design	This research hypothesized that computer-aided design, experience, sketching, physical modeling, learning environment, and images and visual references can serve as powerful tools to stimulate creativity in the architectural design process.
Andrys Onsman 2016,1	Assessing creativity in a 'New Generation' Architecture degree	This paper develops an argument that identifying creativity as an alternate to expertise, allows teaching, learning and assessment to focus on process and product, especially in the Design Studio context. To normalize assessment a scoring rubric based on observed learning outcomes accommodate the development of expertise and creativity as aspects of both product and process generated.
Rahma M. Doheim Noraini Yusof 2020,1	Creativity in Architecture Design Studio. Assessing Students' and instructors' perception	The findings show that creativity is conceptualized differently among students and instructors. Students and their instructors have more disagreement than agreement on how they perceive creativity in the architectural context. The required areas of improvement in architecture education will be suggested.
Ar. Apurva Avinash Gour 2019,537	CREATIVE TECHNIQUES IN ARCHITECTURE DESIGN STUDIO	There is an established need to explore various Creativity techniques for idea generation as an integral part of the architectural design pedagogical process. Using methods that may enhance creativity in architectural design studios can enhance the final output of design studio produced by students. This study will consequently help design more effective strategies for architectural design studio pedagogy.

Laura Lizondo-Sevilla, Luis Bosch-Roig, Carmen Ferrer-Ribera José Luis Alapont-Ramón 2019,41	Teaching Architectural Design Through Creative Practices	it can be concluded that the experience of working the architectural design through abstraction and through the manual constructive exerciseis an effective learning method, especially for first year students.
Tomasz Sachanowicz 2018	Creativity and Use of Physical Models in Architectural Design	Physical model today is still one of the most stimulating tools for architects. Architects need and enjoy physical contact with space, materials and masses they are shaping and designing to become real life objects - buildings constructed using real materials in the future. Use of physical model in design process has a lot in common with elements of creativity theory in fact, on early stages of design process, it is equal to Intermediate Impossibles from Edward de Bono theory. Working with physical models gives better results in architectural education. There are still opportunities in the use of physical model in professional practice as well as at school.
Trupti J Dabe 2016	Function of Creativity and Innovation in Architecture Education	It has been argued here that creativity is a kind of socially recognized achievement in which novel products and/or ideas are shaped. So, creativity in architecture and architectural management, as with any other field, is a very valuable tool that should be utilized.
Alireza Mahdizadeh Hakak, Nimish Biloria and Armaghan Ahmadi Venhari.2014	Creativity in Architecture—A Review on Effective Parameters Correlated with Creativity in Architectural Design	Accentuating the role of creativity in design even more than other disciplines pushes one to underpin the understanding of creativity as a key role player in architecture .Furthermore, by identifying the basic principles of our ingenuity/creativity, researchers might be able to enhance this ability in the future. A key point in "creativity" is the role of previously gained experiences, which cause expanding the inventory of experiences.According to accepted definition in different disciplines, creativity is no more than new combinations of previous ideas. The paper explores different effectual parameters correlated with creativity in architectural design including notion of conceptual blending
G. RabinoD. BorriR. Stufano Melone.2014,223	CREATIVITY IN ARCHITECTURE: THE COGNITIVE PROCESS	Creativity is often considered as an innate ability, by which actions of original creation give rise to brand-new items and elements. On the other side, creativity can also be regarded as a process able to transform and recombine existing entities ,toward different, novel configurations.
Halime Demirkan and Yasemin Afacan 2012,1	Assessing creativity in design education: Analysis of creativity factors in the first-year design studio	The primary factor consists of the novelty and affective characteristics an artifact that are associated with its shape. The second factor has the elaboration characteristics that are integrated with its geometric and figure-ground relations and harmony of design elements. The third factor consists of rhythm, repetition, unity, order and number of design elements

2.3. Divergent thought and convergent thought

Guilford, an American scientist, has presented the most comprehensive theory related to creativity in 1959. He believes that creativity is one of the main aspects of thinking or thought. The thought is the rearrangement or change process of obtained information and symbols exist in the long-term memory. In other words, the directional mindful activities for solving a problem. Those who have the divergent thought differ on their thinking and acts from others, are distanced from the customs and habits, and employ the new and creative methods and ideas. Conversely, those who not have these characteristics have convergent thought and follow the custom and habit in their thought and acts (Sadeghi Mal Amiri, 2011,99). Most designers when they reach the first solution, have learned to be satisfied and defend it, while the creative designers' characteristic is the ability to innovate many potential solutions and such designers are thinking divergent in whole of the design process. The creativity skills are along with thought values below (Lang, 1939,66):

1. Breaking the habit: Taking aside the prior thought ways and using new ones and new designs and sketches;
2. Judgement replacement or evaluation delay in the ideas: To prevent from wasting the idea which may be interesting at first;
3. The perception of complexity according to the complicated problems and involvement with it;
4. Perceiving along with creativity or seeing issues differently: Observing issues in a new way that have not received much attention before; Extensive thought: communication among different ideas;
5. The ability to focus and pay attention to issues in thelong run ;
6. Resistance to problems;

7. High power (force) and tendency to work hard ;
8. Making the commitment to do the work correctly.

The comparison of both divergent and convergent thoughts shows that the orientation of the convergent thought towards the customs and habits of the community, ways, and thinking has been accepted, but the divergent thought distances from customs and habits and is the iconoclast. In the convergent thought, the issues related to each other are considered and nonrelated ones taken aside. But in the divergent thought, there is a relation between the unrelated issues, in other words, the person who has a divergent or creative thought tries to connect the unrelated elements and components to each other. In the convergent thought, there is not possibility of making a mistake and the person tries to avoid from that. In the creative and divergent thought, the person has the opportunity to make a mistake. For the logical and convergent thought, the orientation is known, but there is not a specific route in the divergent thought; and the destination is unknown. In the convergent thought, the result of the thought is clear in advance. It means that it always exists an answer (true or false). But in the divergent thought, it does not exist a certain answer and there are many answers in such a way that each one may be correct logically. The type of the convergent thought requires comparative skills to reach a correct and known answer. The divergent thought needs the open approach and follows the several options where there is not any correct and clear answer (Loveson, 2012). The creative thought with divergent thought try not to accept phenomena, issues, and thoughts easily as they are, but have a different view and distance from the same formats, In other words , look at the phenomena with another eye and perspective. Of course, some people also believe that creativity includes the divergent thought more and others believe that there are the stages in creativity, which consist of both thoughts. For example, Hilgard believes that in the creativity process, the person faced with the issue examines all possible solutions and then selects the best one. In other words , he/she uses both divergent and convergent thoughts. In this view, it is believed that the creative thought results from cooperation between divergent and convergent thoughts. It means a person frees his/her mind at first to solve a problem and finds various solutions, but after that, must examine the thought products using the convergent thought scientifically, practically, and usefully and reaches the best valuable answer. As a result, it can be said that creativity includes both of thoughts, however correlates with the divergent thought more. The analysis of the nature of design problems indicates this clear result that the design is a divergent issue as a whole. Since the design can rarely be considered as an optimization process led to the correct answer, the divergent thought will be required (Loveson, 2012,168). The students recognize that the design is not the solution for a simple problem and has a closely relation with art and creativity. Most of the design and creativity aspects are investigated by students' own (Taneri and Dogan, 2021,1).

2.4. Creativity assessment tests
2.4.1. Torrance test for creativity

Torrance test for creativity is one of the standard tests to assess the level of people's creativity from elementary ages to after undergraduate studies. Validity of this testing has been assessed worldwide including Iran many times. This test so far has been used more than any other test in the research and educational measurements. It has still been used in more than 2000 researches published in the valid scientific journals as a measurement tool of creativity. This test has 60 questions which have 3 options or answers. Of course, this test has some errors too, but currently is one of the most valid tests on which you can reach more accurate recognition of yourself.

Most of the scientists and researchers believe that the basis for human power is induced by his/her creativity. Torrance (1979) considers creativity as a mix of 4 main elements as following:

- **Fluidity:** the power to produce ideas and many answers;
- **Flexibility**: the essential ability to change the orientation of the thought or to produce various ideas;
- **Innovation**: the ability to produce an idea or new and novel product: which means the person's answers have not been seen before and are new.
- **Extension**: the ability to pay attention to the details dependent on an idea: which means that creative people pay attention more to details of an idea (Torrance, 1999). (Figure.1).show Torrance creativity.
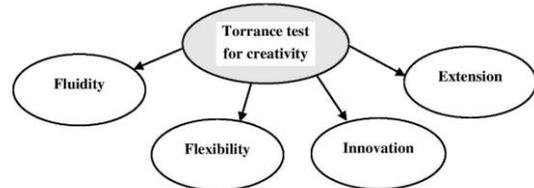

Fig1.Torrance creativity (Source: Torrance, 1999)

2.4.2.Functional creativity of Cropley's model

There are many studies related to how to evaluate a creative product. Cropley et al., focusing on the new products that serve the social aims, have tried to address the creativity subject. Although the common elements of creativity exist in all fields, creativity in engineering is obviously different with creativity in fine arts (Cropley et al., 2011,14). Creativity in engineering is induced by creativity with aim, which can be called as functional creativity. In this way, the classification of architectural products is logical under the name of functional products. In this regard, what is required is the way that can be evaluated easily by a wide range of supervisors in a high level in terms of functional creativity, i.e. observable

characteristics of products. Cropley and Cropley (2005) proposed the hierarchical four-criteria model called functional creativity to define CSDS. This model consists of the following cases:

- Relevancy and efficiency (this product solves the problem which had been considered for its solution)
- Innovation (the product is original and amazing.);
- Beauty and elegance (the product is beautiful and attractive.);
- Generalizability and flexibility (the product is extensively

Functional creativity of the product obtained from the sketches are evaluated by indicators based on CSDS,(Table2) which has been selected to confirm this

study. According to the literature review, the evaluation criteria can be limited to the fficiency and novelty. It should be noted that aesthetics has an effective role to receive the message from the "product" in the field of architecture. The "products" were evaluated by reviewers using 17 indicators according to Table 1 and with a five-point scale of the Likert spectrum with different values from "very low" to "very high". The scales are used to evaluate relatively accurate qualitative problems. In this study, the qualitative rankings have been converted to numerical points which quantify practical creativity of the "product" directly. One of 20 points has been given to every "product" and for each criterion (relevancy and efficiency, novelty and beauty, generalizability).

Table 2

Evaluation criteria of the product based on the corrected CSDS.

usable and can be used in the situations other than now and opens the perspectives to solve other problems).

Creativity criteria	Indicator		Very high	High	Medium	Low	Very low
Relevancy and efficiency	Correctness	Achieving the goal, performance, and needs of the project					
	Performance	Functionality of the design (in a great way)					
	Suitability	Achieving the goals and design limitsproportionally					
	Applicability	Easy to implement					
	Safety	Safe for the use					
	Efficiency	Each component is efficient in achieving the determined goal.					
	Durability	Powerful logically					
Novelty and innovation	Readability	Readability and ability to change the space and its impact on the space experience					
	No-duplicate	Using existing knowledge (theories, technologies, etc.) to create novelty and innovation					
	New design	The solution expresses a completely new aspect.					
	Idea innovation	The ways of obtaining new and different ideas					
Elegance and beauty	Recognition	Understandable					
	Aesthetics	Being organized, suitability, successful, and consistent					
	Sustainability	Environment friendly					
Generalizability or capability	Foresight	Design perspective					
	Generalizability	Scalability					
	Flexibility	Flexibility of the design for users' consumption					

The most important aspect of the 4-dimension model of functional creativity is that the dimensions shape the hierarchy. Relevancy, efficiency, and innovation are of underlying conditions for the product creation but not enough in themselves. Only it can be talked about

creativity if both are present; moreover, the first criterion, i.e. relevance and efficiency, must be evaluated before the second one, i.e. innovation. Elegance and generalizability are raised in a higher hierarchy. It is possible to be introduced creativity without presence of these criteria

and they are considerable when two criteria are evaluated. Based on this, the comparison of the product of functional creativity induced by different divergent thought techniques is possible via the 4-dimensional model. It means that differentiation of techniques can add a higher value to the application of the adopted method via the review of the creative design process in terms of the yield when reviewing the interface mechanism, "e.g. how to process the interface" (Hassan, D, 2018,1468).

3. Research Methodology

The current study is mixed (quantitative-qualitative) and applied in terms of purpose. The collection of library information was done by referring to written documents and part of that by field recordings. The collection of students' opinions has been performed by the questionnaire. The research has been performed as a survey via the questionnaire by a questioner and referring face-to-face to a respondent. The target population is all architecture students of Karun University of Applied Sciences in Ahvaz. The statistical population of the sample is 54 people. To determine the volume of the sample, Cochran's formula (one of the most applicable formulas for determination of the sample volume in the research studies) has been used (Cochran, 2008). Based on the Cochran's formula, the questionnaire was given to 54 people. To assess the level of students' creativity, Torrance test for creativity with acceptable validity and reliability was used in numerous studies of this field and another questionnaire was designed to assess the level of student's awareness of creativity. The questionnaire consisted of 5 Likert questions and after studying, and due to the importance of scoring and its direct impact on the sampling results of first-year students of 2018-2019, the second preliminary design of the educational institute was performed systematically and randomly in two fields of architecture education and educational psychology. The sketch testing was held to assess the level of creativity and convergence and divergence of students in a workshop during 2 days. The resulting sketches with the subject of "design of a crossway camp on a land with a forest on one side and a mountain on the other side" were evaluated by 3 reviewers who were teachers of the educational institute. The number of participants in the sketch workshop is 29 people. The reason for selecting the second preliminary design course is that at this stage, the design personality of students has not formed and answers have not possibly been influenced by the methods which the teachers apply to the design courses, but the primary familiarity with design subject, its goal, and requirements have been done due to taking the first preliminary design course. The students' sketches were analyzed till creative students were identified. To assess the sketches, Cropley's CSDS method was used. To check the validity and reliability of the measurement tool, first, the validity of the questionnaire was evaluated, during which the relevant questions were prepared in the form of a questionnaire and given to university professors to express their opinions about their ability to be measured

and compliance with grammar and writing points. Then to check the reliability of the questionnaire the primary test was performed with 10 people of students and final one with 44 people of them in two stages. In the final test, all indicators and entire questionnaires had reliability; because the value of Cronbach's alpha of the students' questionnaire obtained more than 0.77. To identify the creative students, the questionnaires and sketches of students were adapted. To analyze data, the SPSS technique has been used. Figure. 2 show the research method of the article.
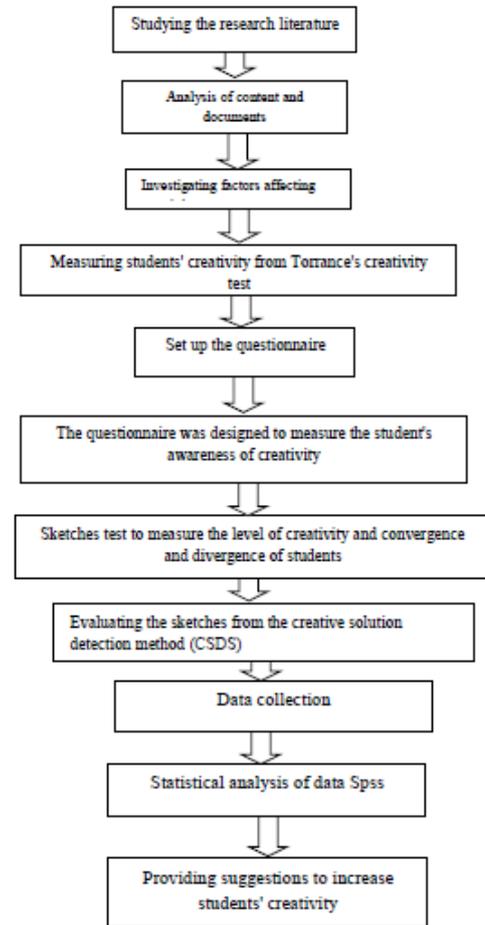

Fig. 2. Research method

4. Results and Discussion

In the current research, the sample volume is 54 people and respondents are 53.7% women and 46.3% men. In terms of education, 57.4% were continuous-undergraduate (architectural engineering), 18.5% noncontinuous-undergraduate (noncontinuous science), and 24.1% associates (architectural drawing).

First of all, reviewing the results of Table 3, normality of data was investigated. This table shows values of skewness and kurtosis indicators. These values must be between +1 and -1, which show the normal distribution of data.(Figure.3) shows Skewness and kurtosis indices.

Table 3
Data values of skewness and kurtosis indicators.

Statistics		Q1	Q2	Q3	Q4
N	Valid	54	54	54	54
	Missing	0	0	0	0
Skewness		-0.714	0.207	0.259	-0.597
Std. Error of Skewness		0.325	0.325	0.325	0.325
Kurtosis		-0.162	-0.645	-0.641	-0.122
Std. Error of Kurtosis		0.639	0.639	0.639	0.639
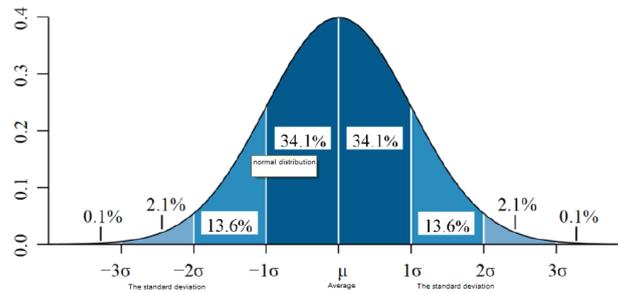
Fig. 3. Skewness and kurtosis indices: their values are between 1 and -1 Average (Source: Karimi, 2015, 133)

To address the first question of the research, 4 questions of the questionnaire were adjusted as following, respectively to be assessed the amount of students' conscious regarding creativity. In the first question, they were asked whether creativity is inherent or thematic that can be developed. 75.9% were agreed and completely agreed and others have given the neutral or opposite answer. In the first step, the results are promising and show that the students are aware of the creativity subject, and in other side, they show the 24.1% unawareness of students about creativity. The subject that is of high importance in the architecture field. (Table 4), (Figure. 4) shows the students' answer to this question.

Table 4
The subject creativity that can be nurtured and is not inherent in my opinion.

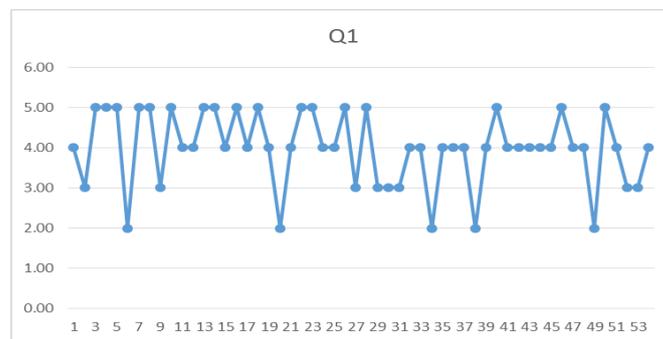|		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	5	9.3	9.3	9.3
	Neutral	8	14.8	14.8	24.1
	Agree	24	44.4	44.4	68.5
	completely agree	17	31.5	31.5	100.0
	Total	54	100.0	100.0	

Fig. 4. Shows the students' answer to this question.

5= I completely agree
4= agree
3= Neutral
2= disagree
1= I completely disagree

In the second question, the students were asked whether the professors consider them as a creative person in terms of architecture design. 42.6% gave the neutral answers. 29.6% agree with this question. The results indicate that 42.6% of students do not have accurate information on the role of creativity in the design, that shows the existing empty in this field in architecture education. (Table 5),(Figure. 5) shows the students' answer to this question.

Table 5
The professors consider you as a creative person in the field of architecture.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	8	14.8	14.8	14.8
	Neutral	23	42.6	42.6	57.4
	Agree	16	29.6	29.6	87.0
	Completely agree	7	13.0	13.0	100.0
	Total	54	100.0	100.0	
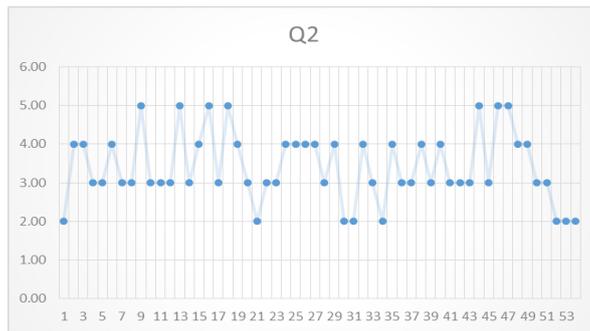
Fig. 5. the students' answer to this question.

5= I completely agree
4= agree
3= Neutral
2= disagree
1= I completely disagree

In the third question, you are asked whether you consider yourself as a creative person in the field of architecture. Table 6 showed that 40.7% of answers are neutral and 42.6% of students have been agreed with the question. The percentage of neutral answers to the second and third questions indicates that the students are not aware of the creativity subject, a creative student is not encouraged by the professors, and the creativity shopping sheet is not clear for them, and on the other side, the agreed response shows this subject that the students almost develop the same perception that professors and educational groups have on them, in their minds, in other words, the students' perception is formed under the effect of professors' opinions. (Table 6),(Figure. 6) shows the students' answer to this question.

Table 6
You consider yourself as a creative person in the field of architectural design.

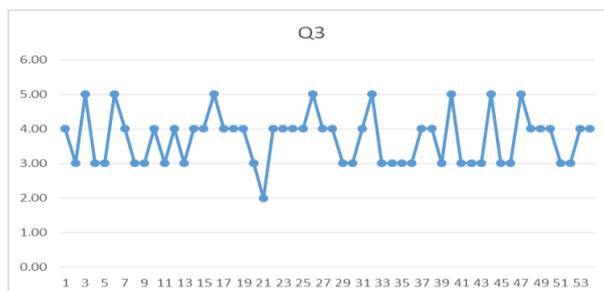|		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.9	1.9	1.9
	Neutral	22	40.7	40.7	42.6
	Agree	23	42.6	42.6	85.2
	completely agree	8	14.8	14.8	100.0
	Total	54	100.0	100.0	

Fig. 6. Shows the students' answer to this question

5= I completely agree
4= agree
3= Neutral
2= disagree
1= I completely disagree

In the fourth question, they were asked in which of the following tools, you express your creative ideas easily. 35.2% selected animation and after, followed by sketches

and manual rendering. The results express this point that modelling is an effective and efficient factor in creative increase. The relation between modelling and creativity is complex, dependent on the different factors including the kind of evaluation and culture (Yia, Pluckerb, Guob, 2015).(Table 7). (Figure. 7) showed the order of application importance of the tool in the students' opinion.

Table 7
With which of the following tools, you express your creative ideas easily?

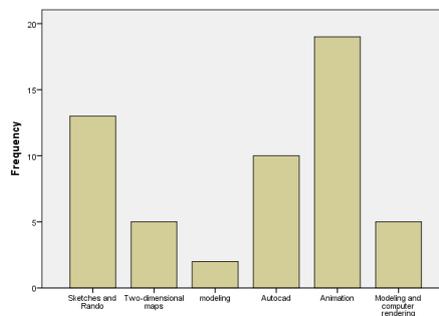|		Q5			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sketches and Rando	13	24.1	24.1	24.1
	Two-dimensional maps	5	9.3	9.3	33.3
	Modeling	2	3.7	3.7	37.0
	AutoCad	10	18.5	18.5	55.6
	Animation	19	35.2	35.2	90.7
	Modeling and computer rendering	5	9.3	9.3	100.0
	Total	54	100.0	100.0	

Fig 7. The order of application importance of the tool in the students' opinion.

The second question of the research were assessed and tested related to the divergent thought situation in evaluating students' creativity by holding the sketch workshop in two consecutive days and raising a question of students. To assess the amount of divergence and convergence, it is said to the student that "during the semester, many ideas come in your mind in the design architecture course that is hard to be collected". If the answer is "I agree" or "I completely agree", it shows the divergence of the student. It means that the student has evaluated all the possible solutions to answer the design problem and in each session draws a diverse sketch relative to the prior session. At the same time, a sketch workshop was held in two consecutive days with the subject "the design of a crossway camp" and its results were evaluated by 3 reviewers from teachers of Karun University of Applied Sciences. The reviewers used the CSDS form to assess the level of students' creativity. The number of participants in the sketch workshop was 29 students of the second preliminary design. The students' sketches were analyzed to be identified the creative (divergent) students. The names were adapted with answer to the question and sketches of students who participated in the workshop. The results showed that 57.1% of students recognized after analyzing the sketch by divergent reviewers have answered "I agree" to this question "I considers myself as a creative person in the field of architectural design". That shows the divergent

mind and creativity of the student. In other words, a divergent student faced with the design subject, brings different drawings and sketches with different attitudes and views in his/her mind (Table 8). The adaption of sketch results of convergent students to their only 25% agreed response expresses the difference between the views of two ranges of divergent and convergent students associated with creativity subject in design and architecture (Table 9).

On the one side, according to the results obtained from the mentioned questions and on the other side, the heading of the architectural engineering course, it can be said that due to promoting and growing creativity in the basic courses such as preliminary architecture design, architecture practice, and architecture design courses, professors of the architecture department must follow assignments to educate and promote the level of students' creativity through giving the creative assignments and to present course units of education and creativity in practical courses of architecture including design courses to be considered a unit to educate creativity which is one of the important factors for the students. (Figure. 8) shows divergent students' answer to these questions (Figure. 9,10,11,12) shows the sketches of a creative person with divergent thinking in two consecutive days, and her/his design process is different in two complete days.

Table 8
The divergent students.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	completely disagree	1	4.8	4.8	4.8
	Disagree	1	4.8	4.8	9.5
	Neutral	3	14.3	14.3	23.8
	Agree	12	57.1	57.1	81.0
	completely agree	4	19.0	19.0	100.0
	Total	21	100.0	100.0	
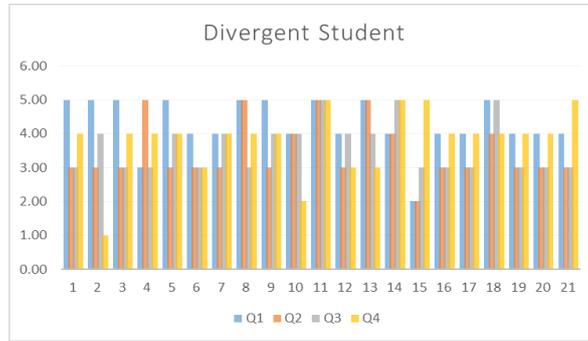
Fig. 8. Shows divergent students' answer to these questions

5= I completely agree
4= agree
3= Neutral
2= disagree
1= I completely disagree

Fig. 9 The first session of the sketch workshop of divergent student
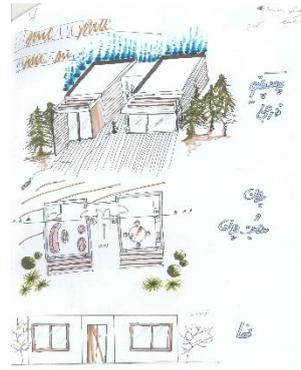
Fig. 10. The second session of the divergent student sketch workshop

Fig. 11.The first session of the sketch workshop of divergent student
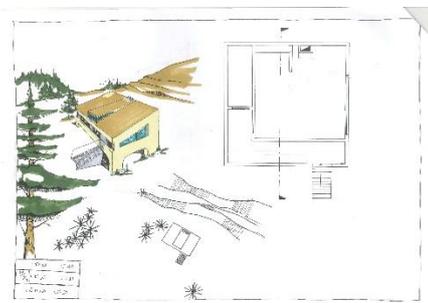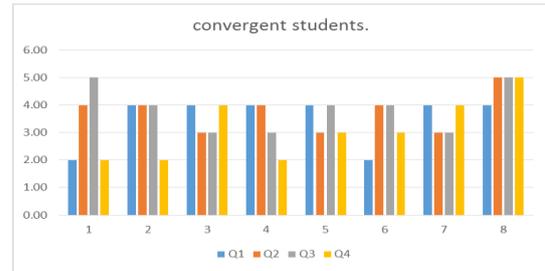

Fig .12. The second session of the divergent student sketch

Figure. 13 shows convergent students' answer to this questions. (Figure.14,15,16,17) show the sketches of a student with convergent thinking who went through a design process in two days.

Table 9
The convergent students

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	3	37.5	37.5	37.5
	Neutral	2	25.0	25.0	62.5
	Agree	2	25.0	25.0	87.5
	completely agree	1	12.5	12.5	100.0
	Total	8	100.0	100.0	

Fig.13. shows convergent students' answer to this questions

5= I completely agree
4= agree
3= Neutral
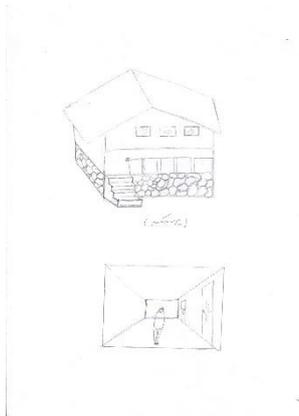2= disagree
1= I completely disagree

Fig 14.The first session of the sketch workshop of converge student
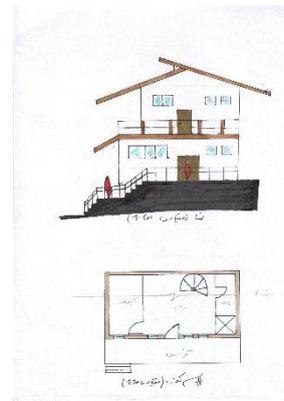

Fig 15.The second session of the sketch workshop of converge student
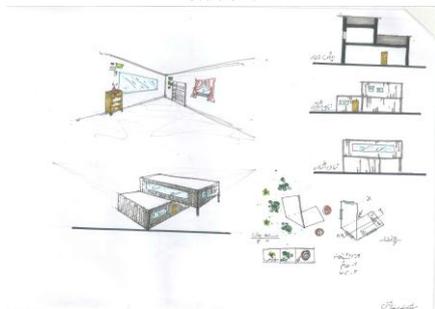

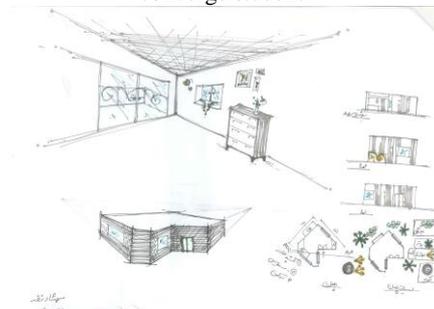Fig 16.The first session of the sketch workshop of converge student

Fig 17.The second session of the sketch workshop of converge student

4.1 The results of Torrance test for creativity assessment

The Torrance test for creativity was used based on the assessment level of convergent and divergent students' creativity. This test calculated the separated scores for 4 components of innovation, extension, fluidity, and flexibility. The data of (Table 10) show that the divergent students have higher amount of creativity than convergent ones when they are faced with a problem.

Table 10
Mean scores of creativity levels in the Torrance test for creativity for its 4 components.

	Percentage	Innovation	Extension	Fluidity	Flexibility
The number of divergent students	57%	38.6	27.7	17.3	16.4
The number of convergent students	43%	34.3	33.7	17	15

5. Conclusion

In this research, an attempt was made to discuss one of the important issues of architectural education, i.e. the discussion of creativity in architectural education. Many recent types of research in the field of architectural education have dealt with the issue of creativity in education. In general, a group of articles has dealt with the effect that creative education has on architectural education, and another group has dealt with the methods of creative education in Architectural design has been done. Among others, we can mention the research of Lawson, Mackinnon, Hassan Ching, Lang abroad, Aghaei, Sadeghi, Gharibpour, and Hojjat. As mentioned in the background and theoretical foundations of the research. The following article is consistent with the views of Lawson, Ching, and Mackinnon, 1962), Hassan is a creative and divergent-thinking student who looks at problem-solving from multiple perspectives and often discovers and develops original solutions. Such students are thinking divergently in all stages of the design process. , the results of similar internal and external research confirm or complete the findings of the current research. But none of the previous researches has considered the place of developing divergent thinking in assessing architecture students. to answer the research questions, the components of creativity should be extracted from the views and opinions of experts and the criteria should be categorized. The results divide the components of creative thinking into two categories, convergent and divergent, to answer the first question in the research method section, to measure students' creativity, Torrance's creativity assessment test, with acceptable validity and reliability in numerous studies in this field, was used and another questionnaire was designed to measure the student's awareness of creativity. To answer the second question of the research, to measure the divergent and convergent level of the students, the SKETCHES test was used in form of a two-day workshop. Students' sketches were analyzed by three judges to identify creative students. Cropley's creative solution detection method (CSDS) was used to evaluate the sketches. The results showed that creativity is the main discourse of education and a necessity for architecture students. Creativity education plays an important role in the development of architecture students. which, unfortunately, is not given much attention in architecture education today. In architecture, creative work is the expression of architecture itself, that is, a product. It can be said that divergent thinking plays a significant role in the design process.

- Authors suggest that exercises that are in line with the flourishing of creativity be introduced to students in the early years of education and in the basic courses to increase the amount of information of architecture students about creativity and ways of its development, so that the ambiguity about this issue is resolved.

Based on Torrance's creativity, four main elements such as fluidity, flexibility, innovation, expansion can be considered for the development of student creativity in exercises. By giving exercises that lead to the production of various ideas and many solutions, it becomes like conceptual sketches. Exercises to develop intellectual flexibility in students, which leads to the production of diverse ideas. Exercises that enable the student to be innovative and generate new ideas means that they use the skills of sketching in a new way. Exercises that increase the student's visual accuracy and show more attention to the details of an idea.

-Authors suggest that design professors use various methods to reach the desired designs to achieve desired designs to achieve creative studios. The methods that art students can use to develop the creativity include self actualization, self confidence, being open to experiences, appropriate education and creative education.

- It is very important for the students how the professors' perception is when they are faced with a creative person. In other words , the students have the same perception as the professors do in the face of their creativity situation. Therefore, professors and educational departments play an important role in transferring educability and scalability of creativity to the students. This issue shows how professors deal with creative design is of high importance and leads to the student's encouragement, increase in their self-confidence in increasing creativity in the designs. So, it is proposed that the professors provide creative assignments in the basic courses to grow creativity.

- It is proposed that to promote creativity in the architecture courses in the graduate studies of the architecture field, the research theses are done regarding the classification of creative assignments and their educational methods in this field based on architectural conditions of Iran.

-Students' awareness towards creativity is low, so authors suggeste Holding and presenting course units in curriculum of students' field of study to familiarize them with the subject.

References

Augelloa, A., Infantino, I., Lietob, A., Pilatoa, G., Rizzoa R, Vellaa F. (2016), Artwork Creation by A Cognitive Architecture Integrating Computational Creativity and Dual Process Approaches, Preprint submitted to BICA Journal (to appear). Pre-print version January 6, 1-29.

Amabile T M. (1997), Motivating Creativity in Organizations: ON DOING WHAT YOU LOVE AND LOVING WHAT You Do, CAUFORNIA MANAGEMENT REVIEW VOL 40, NO. I FALL. 1154-1184.

Amabile T M, Coon H, Lazenby J, Herron M. (1996), Assessing the work environment for creativity, Academy of Management Journal.

BaghaeiDaemein. A. Safari. H. (2018). Factors affecting creativity in the architectural education process based on computer-aided design. Frontiers of Architectural Research. 7, 100–106.

Behjouya, N., 2010, The Creativity Methods for Today and Tomorrow Generation, The Novel and Applicable Thinking Methods for Creative and Superior Thought of Different Ages, Tehran publication.(In Persian)

Bisadi M, Mozaffar F, Hosseini B. (2012), Future Research Centers: The place of creativity and innovation, Social and Behavioral Sciences 68.232 – 243. (In Persian)

Ching, F.D.K, (1943), Creativity of Drawing in Architecture, Translated by Mahmoudi, K., Samet, H., Moharrami, S., Omid-e-Enghelab publication, Tehran.

Cochran, V.G., 2008, Sampling Techniques, Translated by Saleh Ardestani, A., Asadi, M., Aylar publication, Tehran.

Emami Naeini, N., 2005, Creativity, Blue Art, Tehran. (In Persian)

Cropley, D.H., Kaufman, J.C., Cropley, A.J. (2011). Measuring Creativity for Innovation Management. J Technol Manage Innovat .6(3):13–30.

Cropley, D. and Cropley, A. (2005). Engineering Creativity: A Systems Concept of Functional Creativity. Creativity Across Domains: Faces of The Muse. Mahwah (New Jersey): Lawrence Erlbaum Associates Publishers. 169–85.

Casakina H, Kreitler S, (2011). The cognitive profile of creativity in design, Thinking Skills and Creativity. 6. 159–168.

Do, O., Lin, C.,(1995). *Design Protocol Data and Novel Design Decisions.* Design Studies, 16(#2, April), 211-236.

Doheim. RM. Yusof. N. (2020). Creativity in Architecture Design Studio. Assessing Students' and instructors' perception. Journal of Cleaner Production. Volume 249, 10. 2-24.

Dabe. T.J. (2016). Function of Creativity and Innovation in Architecture Education. International Journal of Research in Civil Engineering, Architecture & Design Volume 4, Issue 1, January-March, , 170-175.

Demirkan. H. Afacan. Y. (2012). Assessing creativity in design education: Analysis of creativity factors in thefirst-year design studio. front matter Design Studies 33. 262-278.

Folch, TM. Pereira, RC. Icart, IB. (2019). Exploring the creative process in architecture students and professionals, Thinking Skills and Creativity 34 100608,1-10.

Gungor, BS, Yorgancioglu, D. (2019). Analysis of the Creativity Development and Assessment of Architectural Design Education: A Case Study of Basic Design Studio, Conference Series Materials Science and Engineering · September 2019. https://www.researchgate.net/publication/335891915.

Gregor. P. (2021). Methods and techniques supporting creativity in architectural education. Global Journal of Engineering Education. Volume 23, Number 3, 191-196.

Avinash Gour. AA. (2019). Creative Technioues In Architecture Design Studio. Journal of Basic and Applied Engineering Research. Volume 6, Issue 9; October-December.537-539.

Gharibpour, A. (2014). An Analytical Comparison of Drawing by Hand and Computer in Architectural Design Process, Honar-ha-ye Ziba: Memari-va-Shahrsazi;, 19(1): 5-14. (In Persian)

Ghadami, M. (2013). Design-Based Education and Its Role in The Scientific Successes of Architecture Students, Naqshejahan;, 3(1): 67-78. (In Persian)

Ganji, H., Sahrifi, H.P., and Mir Hashei, M. (2005).The Impact of Brainstorming Method On Increase in Students' Creativity, Quarterly Journal of Education, 21(1): 89-112. (In Persian)

Hemdan J.T,Taha. D.S, Cherif. I.A, (2022), Relationship between personality types and creativity: A study on novice architecture students, Alexandria Engineering Journal, 1-22.

Hernan Casakin 1, and Andrew Wodehouse. (2021). A Systematic Review of Design Creativity in the Architectural Design Studio. Buildings, 11, 31.

Hill A, Ai-Girl Tan, Kikuchi A. (2014), International High School Students' Perceived Creativity Self-Efficacy, The Korean Journal of Thinking and Problem Solving, 18(1), 105-115.

Hojat, I. Creative Education-Experience; (2004), 18(18): 25-36. (In Persian)

Hojat, I., (2012), Architectural Exercises, University of Tehran publication, Tehran. (In Persian)

Hojat, I., (2014), The Custom and Habit in Atchitecture Education, University of Tehran publication, Tehran. (In Persian)

Mir Riahi, S.(2003). The Assessment of Design Skills in Design Architecture, Sofeh, 9(49): 61-68. (In Persian)

Hassan, D. (2018), Divergent thinking techniques discrepancy and functional creativity: Comparative study of structural and procedural techniques in architectural design, Ain Shams Engineering Journal 9, 1465–1479.

Jamaluddin, M. and Habibabad, A. (2015).The Situation of Visual Perception and Creativity On Architects' Education, Technical and Vocational Education, 4(4): 18-25. (In Persian)

Karimi, R. (2014). An easy guide to statistical analysis with SPSS. Tehran, Hengam.2014. (In Persian)

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

Khakzand, M., Mozafar F., Feizi, M., and Azimi, M. (2010). Visual Analogy" and its Position in Creative Education of Architectural Design, 4(2): 153-162.

Lang, J., (1939), The Creation of Architecture Theory and The Role of Behavioural Science in Environmental Design, Translated by Einifar, A., University of Tehran publication, Tehran.

Loveson, B., (2012), How Do Designers Think: Disambiguation of The Design Process, Translated by Nadimi, H., Shahid Beheshti University publication, Tehran.

LIZONDO-SEVILLA. L, BOSCH-ROIG .L, FERRER-RIBERA. C, ALAPONT-RAMÓN. JL. (2019). Teaching Architectural Design Thouch Creative Practices. METU JFA. (36:1) 41-60.

Mahmoudi, A.,(1999), Education of The Architecture Design Process (Employing The Hidden Talents of Students), Honar-ha-ye Ziba: Memari-va- Shahrsazi, 0(4&5): 73-81. (In Persian)

Mahdizadeh Hakak. A. Biloria. N. Venhari. AA. Creativity in Architecture—A Review on EffectiveParameters Correlated with Creativity in Architectural Design. Journal of Civil Engineering and Architecture. Volume 8, No. 11 ,pp. 1371-1379. (In Persian)

Mahjoorian Namari , S. Heidari, SH. Ebrahimi, HR. (2022). Evaluate the Relationship Between Fixation in The Design Process and the Level of Expertise of Designers. Space Ontology International Journal. 11, 2, 41, 37-48.

Mehrad, A. Dezhdar,O. Talischi, GH. (2021).Training in Basic Design Studio: Analysis of Tutor & Novice Students Interactions, Using Linkography Method. Space Ontology International Journal. 10, 37, 33-44.

Mohd Subria I, Ahmad U and Hasanah Abd Khafidz. (2014), Creativity in the teaching of shariah studies in institutions of higher education, Thinking Skills and Creativity 13 , 168–182.

Onsman. A. (2016). Assessing creativity in a 'New Generation' Architecture degree. Thinking Skills and Creativity. 1-19.

Pragyan DASH. SH. (2021). Exploratory Study on Design Process in Architecture: Perspective of Creativity. Creativity studies. Volume 14 Issue 2: 346–361.

Rabino. G, BorriR. D, Melone. S. (2014). Creativity in architecture: the cognitive process. Int. Journal for Housing Science, Vol.38, No.4 223-229.

Sobhiyah, M.H., Bemanian, M.R., and Keshtiban, Y. (2008). Creativity in Architecture Students (A Survey on Three Models for Knowledge Transfer on Students Views, 10(37): 49-67.

Samad Aghayee, J., (2007), Individual and Group Creativity Techniques, Higher Institute of Management Education and Research and Planning, Tehran. (In Persian)

Sachanowicz. T. (2018). Creativity and Use of Physical Models in Architectural Design. Conf. Series: Materials Science and Engineering 471. 1-11.

Sadram, V. (2017). Why Teaching Creativity requires More Than Just produsing more " Creativity", *Proceedings of the Fourth International Conference on New Technologies in Civil Engineering, Architecture and Urban Planning, Tehran*, Salehan University. (In Persian). https://www.civilica.com/Paper-RCEAUD04-RCEAUD04_040.htm.

Suwa, M., Tversky, B.,(1996). What Architects See in theirSketches: Implications for Design Tools. In ACMHuman Factors in Computing. Vancouver, BC: ACM, 191-192.

Tang, H-H and Gero, JS,(2002). A Cognitive Method to Measure Potential Creativity in Designing, A C Bento, A Cardoso and G Wiggins (eds) Workshop 17 - Creative Systems, Approaches to Creativity in AI and Cognitive Science, ECAI-02, Lyon, 47-54.

Tamannaeifar M R, Motaghedifard M. (2014), Subjective well-being and its sub-scales among students: The study of role of creativity and self-efficacy, Thinking Skills and Creativity 12 . 37–42.

Taneri. B, Dogan. F. (2021). How to learn to be creative in design: Architecture students' perceptions of design, design process, design learning, and their transformations throughout their education. Thinking Skills and Creativity 39 100781. 1-14.

Torres, A., Serra, J., Llopis, J., García, J., and Cabodevilla, N. (2015), The Need and Experience of Drawing with Ingeniuty. An Analysis of the Graphic Practice in Architectural Education, Procedia - Social and Behavioral Sciences 191,2505 – 2514.