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Metaphor: a creative aid in architectural design process

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Abstract

In the developing world, skills in innovation and creative design have emerged as key attributes for graduating designers. Creativity is essential if we want to generate new solutions to the considerable and complex problems in architecture. Metaphor is frequently expressed as a key tool for enhancing creative design, yet little empirical research has been performed on how novice designers can use it within their design. The goal of this study is to empirically research the use of metaphor in the design studio, with a focus on its effects on design creativity and quality. A three-stage method is presented, which allows novice designers to use meanings and metaphors in the early stages of design and idea generation. This method was tested in an architectural studio with two groups as experiment and control groups. The results were evaluated using a qualitative research methodology and a questionnaire was prepared in which the students were requested to assess the use of this method in their design process. Also expert designers evaluated the design outcomes in both control and experiment groups. The results highlight that metaphor is a helpful tool for young designers to stimulate design creativity and has a noticeable effect on design quality factors such as novelty, value, flexibility, usefulness and detail. These research findings have different implication for novice architects and help them enhance creativity and quality in their design endeavors.

Keywords: *Metaphor, Creativity, Design Process, Quality.*

1. Introduction

Almost all designs proceed by transforming, combining and adapting elements and objects to find a creative idea. Pioneers of the scientific study of creativity have often defined creativity in terms of the capacity to produce new or original ideas. Ideas are developed in the mind, while also exploiting various external representations. They are thoughts, conceptions that serve us to reason with [1].

Everything can be a source of inspiration to designers. They use a variety of references: comparable designs; other types of design; images and works of art; and objects and phenomena from nature and everyday life [2].

It's obvious that architecture products require creativity. To enhance this aim, designers use different kinds of principles and tools such as metaphors.

Metaphorical thinking is defined as ''a description of an object or event, real or imagined, using concepts that cannot be applied to the object or event in a conventional way'' [3]. Metaphors are commonly used as linguistic devices in everyday communication [4], but can also be found in a variety of domains such as science, engineering, art, design, and education.

Stories and anecdotal examples about the use of metaphors can be found in the design literature [5], but empirical evidence of their utility and effectiveness during the design task is rather scarce. Apart from the use of metaphors in design, their contribution to design thinking is not completely understood. In one of experimental studies, Casakin [6] found that metaphors help to identify the design goals and to retrieve the design concepts. Metaphors also simplify the generation of innovative solutions, essentially in earlier stages of the design process [7]. Metaphorical reasoning helps to use artistic and technological knowledge and increases the assessment of various design solutions [8], and improves design outcomes by encouraging reflection on design problems anew [9]. From a cognitive opinion, metaphors are considered as a respected problem solving strategy [4, 10]. They can enable the structuring of a problem situation from a novel viewpoint that is mostly important for creative activities like design [11].

Considering creativity as a skill that can be learned and taught, the question of how creativity can be enhanced or how one can be creative in design problem-solving is still an important challenge in design education [7, 12, 13 and 14].

Additional empirical research is needed in order to gain a better insight about the use of metaphors in design problem solving, particularly in architecture. The questions of how metaphors can affect design creativity and how they should be employed by novice designers constitutes the main framework of this study, which is

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assumed to have considerable implications for teaching creativity in design.

The study aims to explore empirically how students recognize and put into practice metaphors during a three-stage process (designed by the authors), in order to deal with architectural design problems. In the first part of this research, the significance of creativity in evaluating the design product and the importance of metaphor and its relevance to design is discussed. In the second part, the authors' experience and empirical study conducted in the design studio is explained. Next, the results from a survey completed by students about the influence of the method on their designs, a survey completed by architecture experts about the assessment of creativity in the student designs, and conclusions about the use of metaphors during the important stages of the design process are described.

2. Materials and Methods

2.1. Creativity and design

Creativity is a complex human phenomenon that is widely believed to be unreachable to analysis and even less so to be measured [15].There are many definitions of creativity. In a recent complete survey, Sarkar and Chakrabarti analyzed over 160 definitions. From these, with two different methods – majority analysis and relationship analysis – they proposed a "common" definition of creativity, described as follows: "Creativity occurs through a process by which an agent uses its ability to generate ideas, solutions or products that are novel and valuable. Value, in the context of technical or engineered products (hence forth referred to as products), take on the meaning of utility, or usefulness" [16].

"The purpose of architectural design activity is to develop an initial idea or concept and transform it into a complete design for a building" [17]. "Creativity is a fundamental aspect in design problem-solving since the development of new design solutions demands to put into practice creative skills" [13]. In fact design is understood as a problem- solving involving productive thinking [18] and the generation of innovative solutions [19, 20].

Design process is described as systematic models [21, 22, 23, 24, 25 and 26]. However, it is evident that the engineering design process models are poor with regards to representing creative processes.

Antoniades [27] presents a theory of design in his book "Poetics of Architecture". The book addresses the aspects of imagination and creativity as well as the right way through which one can achieve a truly significant architectural design. He tries to help readers produce richer designs on spatial, sensual, spiritual, and environmental levels. Some of the intangible channels to creativity include fantasy, metaphor, the paradoxical and metaphysical, the primordial and untouched, poetry and literature, and the exotic and multicultural. Some tangible channels in the book are history and the study of precedents, mimesis and literal interpretation, geometry, materials, and the role of nature.

The question is how the creativity of design students and their products can be evaluated.

uilford [28] defined four main factors to assess creativity. These factors were: originality or innovation (the statistical rarity of the responses), elaboration (amount of detail in the responses), fluency (the total number of relevant responses), and flexibility (different categories of relevant responses).

The recommended factors are very important in assessments of creativity in a variety of fields. But they are not enough to evaluate creativity in architectural design, because of the complexity of design problems, which involves a large number of aspects.

Casakin and Kreitler [29] suggested additional variables for design evaluation. These factors are: (i) consideration of problem constraints; (ii) usefulness of the design product; (iii) aesthetics of the design product; (iv) practicality of the design product; (v) relation of the design to the physical context; and (vi) value of the design product.

In this paper, in addition to sited factors, the authors used some other indicators about creativity and design quality. These factors are being satisfied from the design product, using new and unique forms, considering consequence of initial beliefs, novel design and innovation instead of routine and familiar design.

2.2. Metaphor

Recent theories named metaphors as a structuring of our cognitive system [4]. Metaphors organize human thinking in every form of knowledge [30]. They are critical forms of understanding by which we symbolically cognize our experiences in the world. "The metaphors that inform our thought and structure our knowledge range from those which might be regarded as functioning on a surface level in language to those which seem to work on a more deeply embedded cognitive level" [31].

Metaphors simplify the understanding of an unfamiliar situation in terms of a known situation [32]. Metaphors are viewed by cognitive psychologists [32, 33] as effective heuristics helping problem solving, in lots of domains such as engineering [34], education [35] art and architecture [27, 36] where the invention of creative solutions is required.

The theory of metaphor presented by Lakoff and Johnson [4] and by Lakoff [10] views metaphor as a tool that enables us to categorize experiences according to a conceptual system. A main characteristic is that it influences how people think, perceive, understand, and classify experiences in their minds. The ambiguous character of these cognitive instruments allows exploring unfamiliar concepts and establishing novel correspondences with remote domains that are not connected to the problem at hand. Metaphorical reasoning permits the identification of previously unnoticed similarities regardless of the existence of vast difference. In the interplay between similarity and difference, conceptual meaning emerges and new knowledge categories such as technology are created [37].

According to these theories, metaphors are really

helpful and valuable in problem-solving tasks and can help designers to enhance creativity.

2.3. Metaphor and creative architectural design

The process of design begins with a problem [38]. Designers solve the problem by the output designed through the design process [39]. In design, metaphors are viewed as heuristics that help organize design thinking and deal with ill-defined design problems [5, 36]. Metaphorical reasoning is an iterative process through which designers gradually increase their knowledge of a design situation. Basically, the use of metaphors aids in structuring design problems, which by definition are non-routine [40]. Therefore, when solving non-routine design problems, it is hard to guess what a solution will look like. It is in the early stages of the design process, when uncertain metaphors support thinking about the essence of a situation. Not only can metaphors help in problem reflection but also help to ignore the limitations forced by initial problem restrictions [41], explore unfamiliar design alternatives, and establish novel associations with the design problem [42].

The typical solutions in design process are generally presented in models, drawings, or other external forms, which aid their communication both to other people and to the designer himself (auto communication). These external representations are always unclear and metaphorical [43]

There are numerous examples and buildings designed by architects using visual metaphors, in the design literature, that have characterized some leading architectural design movements. According to Rowe [5], metaphors stressed by several of these movements have provided the force to highlight certain design aspects over others. The result has been a clear influence over architects' actions in the direction of what is thought to be the appropriate way of designing. An illustrative example is the metaphor `form follows function' proposed by the modern movement. This metaphor strongly structured the design thinking of an entire generation of architects during the modern period.

Although the large number of examples demonstrating the aid provided by metaphors in design, and in architectural design in particular, more research is needed to gain a deeper understanding in the use of metaphors during the design process.

Metaphors are acknowledged as being integral to architecture and product design [9]. They are used by designers to structure their approach to a given problem, allowing them to set boundaries and identify the potential relationships to be made [37]. Therefore, metaphors can be a helpful starting point for the students.

Casakin and Miller [44] explained that the basic processes of metaphorical reasoning can be organized into three major phases comprised of: *identification and retrieval*, *mapping and transference*, and *application.*

So the authors used a three-stage process in the design studio to help the students use meanings and metaphors in their design. These 3 main stages are named: Idea, Concept and Form that will be explained in next section.

2.5. Empirical research

2.5.1. A unique experience in architectural studio

The design studio, the setting of most architectural design education today, is a complex and challenging experience. Not only are the students expected to grasp many new concepts and ideas but they are also asked to perform at least two tasks simultaneously: to design and to learn to design.

In studio, designers express and explore ideas, generate and evaluate alternatives, and ultimately make decisions and take action. They make external representations (drawings and three-dimensional models) and reason with these representations to inquire, analyze, and test hypotheses about the designs they represent.

The design studio is a very important educational environment where students are exposed to a variety of views from their instructors. There are different methods for teaching design and practice in design institutions around the world. A novel and remarkable experience in teaching and learning design in an architectural studio is presented here that has 3 stages: idea, concept and form.

Idea:

Principally, designers should find this stage in the world of values. So, the authors used metaphors as origins and value creators in their design studio. Not only the metaphors could be an appropriate starting point and source for young designers, but also they could improve design activity.

There are two main points the students needed to pay attention to, especially in this stage:

1. The relationship between the selected metaphors and the subject of design,
2. Containing the human values in the selected metaphors.

The students endeavored to represent the metaphor in a free-scale and free-material maquette according to the stated limitations in the studio. This free composition exercise allowed creativity in the studio. The authors called this stage “idea development” and while theorists mentioned that much like “big ideas”, the student could also select their ideas from worldwide metaphors and try to represent them as physical compositions.

The students were encouraged to immerse themselves in all text and data related or non-related to the subject of design. They found many explanations from Iranian poets, writers and even scientists.

Indeed, young designers should try to translate the words and senses within them, to shapes and physical phenomena. But a good translation is not a word-by-word one. They should understand that in the translation process, the results should not look alike or be close to the ideas (in scale, quantity of shapes, etc.). A better perception of their selected metaphor can help them complete their task in a better manner.

As seen in the examples below, the variety of products in the stage of representing metaphors in compositions is very high. So, the students according to the given criteria should start selecting the good ones.

Concept:

In this step the designer endeavors to be closer to the final form (composition). In other words, with some new criteria, the students try to represent their idea in a series of compositions. These new criteria are: using specific and appropriate geometry, being committed to composition rules, increased flexibility, good relation to the metaphor and idea presentation, existence of logical distance to final form - or mass composition.

As flexibility plays an important role in this stage, the students should learn to create flexible compositions that have the potential to become final forms. As can be seen in the examples below, creating compositions with lines, planes and volumes and other components to represent flexibility is one of the important activities the students carry out in the studio.

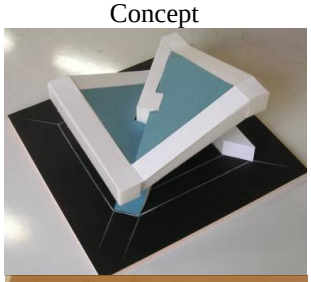
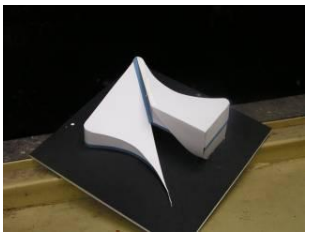
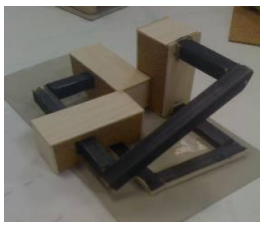
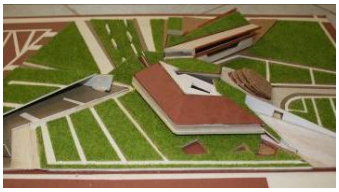
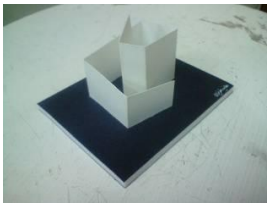
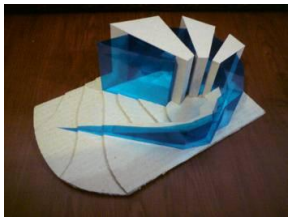
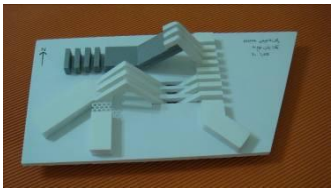
In the concept formation stage, site information and environmental and contextual concerns are effective factors, but as mentioned before they shouldn't be fixed during this period due to the flexibility criterion.

The authors believe that concept composition produces the content and basis of final form composition and if young designers were to arrive at an appropriate answer, they should iterate this step with several alternatives, whilst observing the given rules and criteria. Inevitably, given the criteria, some alternatives are closer and others are further from the "form" stage. Nonetheless, it must be said that the distance between the stages of "concept and form" is less than the distance between "idea and concept".

Form:

We can call this step the conclusion of the design activity. The result of designers' efforts can be evaluated positive if in this step form possesses conceptual and meaningful values based on good metaphors and concepts.

Table 1: some design outcomes of the experiment group

Idea	Concept	Form
		
		
		
		
		

2.5.2. Research goals

In design education, the development of the design process is difficult and not always understood. The application of knowledge transmitted by design teachers to solve a design problem demands some level of expertise and skills that novice students do not always have. Sometimes, a hidden curriculum of architectural design education is used to control the quality of designs and to impose a status quo architectural theory [45].

The first goal of this investigation is to explore and introduce a method with which novice architectural designers can utilize metaphors in their design. This method is considered a major aid for helping novice students foster their own concepts and ideas in developing design solutions and overcome their lack of knowledge and experience. The second goal is to examine how students of architecture assess the creativity of their own design processes and outcomes and to gain insight about how they behave with the use of metaphors as a new tool for design problem solving. The third goal is to determine the role of using metaphors in enhancing creativity and design quality.

2.5.3. Participants

For this research project, forty participants who were senior bachelor students of architectural design in Iran University of Science and Technology took part. They were passing their last design studio year. All of them were unpaid volunteers, who received no additional course credits for their participation. They were divided in two groups: experiment group and control group.

2.5.4. Design task

The students were asked to design a cultural center and accordingly, they could choose metaphors from culture. They were asked to produce a brief that clearly states their design goals, design requirements, and present sketches, conceptual models, final drawings, concrete models and final design outcomes.

2.5.5. Questionnaire

Upon completion of the design task, a survey of the use of metaphors and design creativity was conducted. Students were requested to assess the factors of creativity and design quality in their projects and the degree to which metaphors aided in the design process. In order to make this assessment, an ordinal scale like Likert Scale from 1 to 5 was used to assess the quality of the solutions to the design problems. A low score of 1 or 2 was assigned when the design solution did not satisfy the requirements. A high score of 4 or 5 was given when the solution was perceived as satisfying the design requirements.

In another part, eleven experts in architecture design who were teaching design studio evaluated the design outcomes. Experts assessed the chosen factors in the design products in both experiment and control group. In this evaluation they were requested to use an ordinal scale from 1 point to 100 percent. They scored the subjects' designs on the basis of the sheets and models. The judges worked independently and they volunteered their time with no compensation.

3. Results

In this section, quantitative results obtained from the use of metaphors during the design process are presented. This section is divided into two parts. In the first part, the results of the use of metaphors in the design process are described. In the second part a comparison of creativity factors between the design products of the experiment and control group is presented. A chi-square test was used for the questionnaires and observed and expected frequencies were estimated. The questionnaires were concluded with fourteen factors, related to creativity and design quality, to assess the use of three-stage method in design process. The results showed that students assess the method effective in all fourteen factors (Table 2).

Table 2 The evaluation of the participants (students of the experiment group)

Factor	Items	x2	Degree of Freedom	Level of Significance	
S1	Novelty and originality of the design product	12.800	3	0.005	Moderate- High
S2	Value of design product	7.900	2	0.019	High
S3	Flexible and fluent process	1.900	2	0.387	Moderate- High
S4	Productivity and functional design product	9.200	3	0.027	Moderate- High
S5	Responsibility to limits	16.900	2	0.000	Moderate
S6	Aesthetic aspects of the design product	7.900	2	0.019	Moderate- High
S7	Consideration of details	7.600	2	0.022	Moderate- High
S8	Relation with context and environment	20.500	4	0.000	Moderate
S9	Flexible design product	7.600	3	0.050	Moderate- High
S10	Useful design product	8.800	3	0.032	Moderate- High
S11	Satisfied from the design product	5.200	3	0.158	Moderate- Very High
S12	New and Non-repeated Forms	6.800	3	0.079	Moderate- Very High
S13	Consequence of initial beliefs	7.300	2	0.026	Moderate- High
S14	Novel design and innovation instead of routine design	1.000	2	0.951	Moderate- Very High

The results indicate that the students rate the following factors higher than others: enhance novelty and creativity instead of a routine design process (s14) with the mean of 4.00, achieve a flexible and fluent process (s3) with the mean of 3.75, consequence of initial beliefs (s13), new and non-repeated forms (s12), satisfied from the design product (s11), useful design product (s10) with the mean of 3.60. Also the responsibility to limits (s5) has the least mean in the group (Table 3 and Fig. 1).

Table 3 Descriptive statistics of experiment group' evaluation

	Factor	Mean	SD	N
S1	Novelty and originality of the design product	3.5000	0.68825	20
S2	Value of design product	3.6500	0.58714	20
S3	Flexible and fluent process	3.7500	0.78640	20
S4	Productivity and functional design product	3.5500	0.82558	20
S5	Responsibility to limits	2.8500	0.48936	20
S6	Aesthetic aspects of the design product	3.5000	0.60698	20
S7	Consideration of details	3.2000	0.61559	20
S8	Relation with context and environment	3.1500	0.93330	20
S9	Flexible design product	3.5500	0.82558	20
S10	Useful design product	3.6000	0.82078	20
S11	Satisfied from the design product	3.6000	0.88258	20
S12	New and Non-repeated Forms	3.6000	0.99472	20
S13	Consequence of initial beliefs	3.6000	0.59824	20
S14	Novel design and innovation instead of routine design	4.0000	0.85840	20

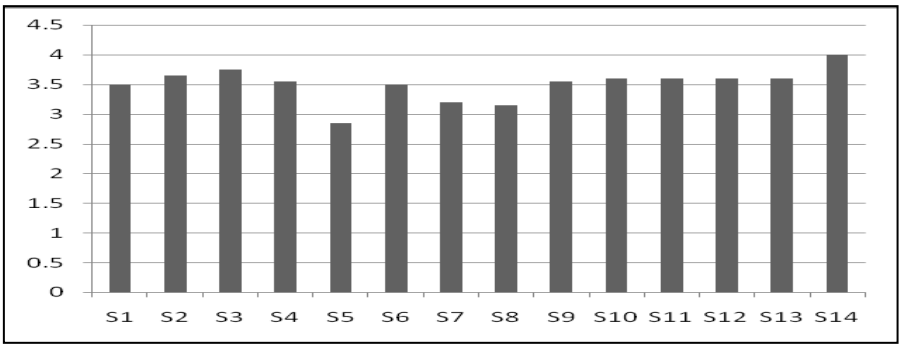


Fig. 1 Descriptive statistics of experiment group participants' evaluation

Further Pearson Correlation was performed to check the correlation of different factors of metaphor use along the three stages of the process. The results show that some factors have positive correlation and some have negative correlation (Table 4 and 5).

Table 4 Pearson Correlation between 14 factors (Positive correlation)

Factors		Pearson Correlation	Sig
S1- Novelty and originality of the design product	S2- Value of design product	0.456	0.043
S2- Value of design product	S10- Useful design product	0.459	0.042
S3- Flexible and fluent process	S14- Novel design and innovation instead of routine design	0.546	0.013
S5- Responsibility to limits	S12- New and Non repeated Forms	0.519	0.019
S6- Aesthetic aspects of the design product	S9- Flexible design product	0.578	0.008
S6- Aesthetic aspects of the design product	S11- Satisfied from the design product	0.491	0.028
S8- Relation with context and environment	S10- Useful design product	0.495	0.027
S10- Useful design product	S14- Novel design and innovation instead of routine design	0.598	0.008

Table 5 Pearson Correlation between 14 factors (Negative correlation)

Factors		Pearson Correlation	Sig
S3- Flexible and fluent process	S4- Productivity and functional design product	-0.507	0.023
S4- Productivity and functional design product	S9- Flexible design product	-0.467	0.038
S5- Responsibility to limits	S6- Aesthetic aspects of the design product	-0.443	0.50

The results of the evaluation by experts that show the comparison of design product between experiment and control group are shown below. The results indicate a distinctive difference between the scores. The architecture design experts scored all factors in the experiment group higher than the control group (Table 6 and Fig. 2).

Table 6 Expert evaluation (Design Products)

Item	Experiment group	Control Group
Novelty	55.27	34.91
Value	53.36	39.82
Flexibility	56.36	42.18
Usefulness	53.00	51.73
Detail	48.00	35.09
Creativity	58.73	33.73

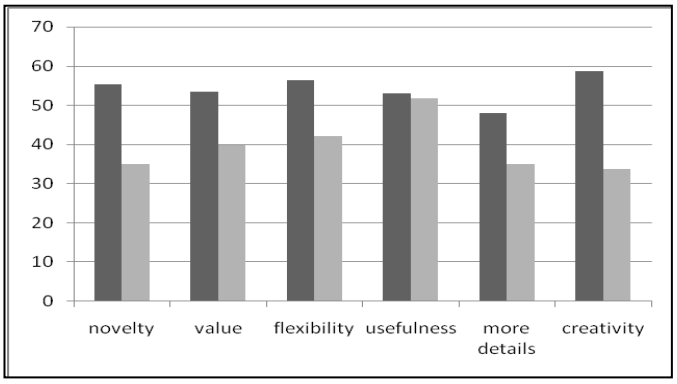


Fig. 2 Comparison of Experiment and Control Groups (Expert evaluation)

4. Discussion

First, it should be noted that empirical research about design process is rare, but such a method has important advantages. Such research methodology allows for the analysis of different aspects of the use of metaphor in the design process and allows for an investigation of the effects of this approach in each stage of design. Also, the design process can be evaluated by the designers and the design products can be evaluated by experts. It must be noted however that due to the particular nature of design and designer personalities, the conditions for this research are not completely controllable.

Analyzing the results in this research shows that the presented methodology based on using metaphor can be effective on design process and product in several aspects. First, the findings explain that it can improve all the assessment factors in design.

As stated before, metaphors reveal values, so it would be possible to extract the value factors visually from the final composition and design products. So, it's not surprising that the value factor achieves the "high degree" in the evaluation of the experiment group. Moreover, results show a significant relationship between product values and their usefulness, novelty and originality.

According to what was mentioned above, it can be argued that flexibility in the design process could cause different outcomes, which could cause a novel result. So, results show a relationship between flexibility in the design process and novelty in design outcomes.

The presented method answers many design problems and limitations beside its specific metaphoric and flexible approach. This process guides the students toward unique outcomes. It can be seen that the students could select the best choice from various solutions considering the aesthetical approaches. This final product will satisfy the designer visually and rationally, because it's one in many. Further this method can lead students to consider the design's relationship with its context and environment, thus leading to more useful designs outcomes.

In this method, novel design products can be positive and helpful. So the results indicate when designer can produce more useful outcomes, they can have a novel and unique designs.

It can be argued two items are fundamental to the design step: geometry and context. Using unique geometry relevant to the site potentials, project topic and the chosen metaphors could guide the designers to novel and original answers. Also, considering the context in the design process could lead more realistic and useful projects.

As can be seen from above, the main factors found in the results refer to the novelty and originality of products and outcomes, values of results, flexibility of the process and finally productivity and functionality of design solutions.

Experts evaluated a high distinction in two control and experiment groups. Novelty and creativity are factors that got the most difference in their assessment. It's worth noting that there is a significant difference between experts' and students' viewpoints. Experts' answers are aligned with the students but are more pronounced in each case. Perhaps their experiences cause this dissimilarity.

5. Conclusions

The focus of this study was to shed light on the use of metaphors in the early stages of design problem-solving by novice students and to inspire creativity in the design studio. In particular, this study aims to introduce a new and unique three-stage method that is designed by the authors, to use metaphors in the design studio and empirically explore how architecture students perform this cognitive strategy during the design process.

With an understanding of first principles, experience and intuition, most designers heuristically reach their design solutions. Methods to increase creativity are rarely

mentioned when the experienced designer's process is discussed and the question of creativity is often considered an implicit factor. Therefore, the authors designed a method to use metaphors as an aid to increase creativity and quality in design studio that can help young designers enhance their performance and outcomes. The three main steps of this process were: Idea, Concept and Form.

The Idea stage deals with meanings and values, where the designer tries to translate words and senses into physical shapes. In the next stage (Concept) the designer endeavors to be closer to architectural form and in the final stage (Form) the designer presents the final form.

The presented method in this paper identifies the route to achieving creative outputs and distinguishes between the creative design process and a routine one. It provides guidelines for teachers to encourage students along the creative thinking process. Also, it helps to foster creativity in the next generation, optimize the quality of solutions to the unknown problems, which cannot be solved by existing solutions.

The assessment of the use of the aforementioned method in architectural design studio was analyzed through main factors. In sum, the offered method is found to be effective for novice designers to enhance novel and original, valuable, productive, flexible, responsible to limits, useful and non-routine design products. It is believed that, this method of using metaphor in architectural design will produce a better understanding of the design process and will lead to more creativity and improve critical design abilities. This method will provide novice students with a framework to develop their own ideas and personal skills in design problem-solving.

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