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Searching Creativity: (N)On Place Design Workshop

Gökçe Ketizmen Önal, Eskişehir Osmangazi University, Turkey

Abstract

This study is mainly about developing an approach for fostering creativity in design education through analyzing the interactions among creative dimensions resembling spatial and organizational pattern of folding as a technique and also by the help of cognitive action of designers: workshop participants. In order to make an assessment, a case study is structured, intended to refine and integrate the creativity with the characteristics and principles of design. Herein, two methods; retrospective protocol, and spatial- structural organizational analysis methods, are generated by the help of an informal education medium; '(N)On Place-2' architectural design workshop, which was conducted at "Eskisehir Osmangazi University Design Festival 2013" with the theme "Folding in Architecture".

Keywords

creativity; architectural design education; folding in architecture; protocol analyses method, spatial-structural organizational analysis method

Introduction

> *`I have never let my schooling interfere with my education. `Mark Twain (Samuel Langhorne Clemens)*

Mark Twain, a well-known American writer, thinks that one should isolate his/her informal education from the formal one. He implies that only informal learning can become one's experience (Ciravoglu, 2002). Beginning with but departing from this statement the aim of this study is not to discuss the validity of formal architectural design education, but to evaluate the positive effects of informal architectural design education on fostering creativity.

Education has been defined as formal, informal, and non-formal in much of the literature (Vadeboncoeur, 2006). Research studies show increasing interest in other forms of education besides formal because formal education does not account for all the learning of a lifetime (Erktin & Soygenis, 2014). An informal education approach has gained more and more acceptance in the world. It includes the acquisition of knowledge and skills through experience, reading, social contact, etc. (Turgut & Canturk, 2015). The role of the design workshops in architectural education has been very limited throughout design education's past, and thus has gone largely unnoticed by the educators of design. The drivers of this change in design education and practice; and changing student demographics brought some inevitable changes to design studio practices. The introduction of workshops, aid not only developing and sharpening design skills in a short period of time, but also

help to construct new approaches in architectural education. Many schools of architecture have taken steps to consider workshops as the part of informal education (Turgut & Canturk, 2015). As evidence to support this idea, it is possible to point out the BDA (Bachelor of Design in Architecture Program) program in University of Minnesota, which is constructed by a diverse series of workshops. The BDA workshops are organized to develop an essential, experimental, collaborative and critical discourse within the School of Architecture. It is declared that workshops encourage students and faculty to step outside the rigors of the very precise discipline of architecture in order to research specific issues, test professional boundaries, and experiment with emerging practices. (Bachelor of Design in Architecture Program Overview, 2016).

According to Eigbeonan (2013) many writers on architectural education have observed that the architectural design studio teaching is failing to meet the yearnings and needs of the users, societies, cultures, environments and technological developments. The general consensus is that creativity should and continue to be the main force in teaching the arch-design studio. These various authors stress, argue and support the concept and ideas of creativity in teaching the design studio to bridge this gap and agree that it is an important venture (Bala, 2010; Kowaltowski, Bianchi & Paiva, 2010; Parashar, 2010; Demirkan & Afacan, 2012; Dorst & Cross, 2001).

This study is mainly about developing an approach for fostering creativity in design education by defining creative design through the spatial and organizational pattern of folding as a technique and as a powerful design concept and also by the help of cognitive action of designers: workshop participants. This analyzing process is performed by the help of the (N)On Place-2 design workshop as being a free, flexible and dynamic informal medium, conducted in 2013 at the Design Festival in Eskisehir Osmangazi University at Turkey.

An overview of creativity and creative methods in the design context

According to Runco (2004, p.672) “creativity is often defined as the development of original ideas that are useful or influential”. In this point of view, creativity is not only a reaction to but also a contribution to change and evolution. He also asserts that creativity thus underlies problem solving and problem finding; it plays a role in reactions (e.g., adaptations and solutions) but it is also often proactive. According to Kahvecioglu (2007) early historical approaches to creativity defined it as centering in the creative person, process and product, which are also known as the "three Ps". This view has dominated research across disciplines. Also, Kahvecioglu (2007) declared that most theories of creativity have focused on the individual level of analysis, with the goal of describing the nature of creative minds (MacKinnon, 1962; Torrence, 1988). Individual characteristics such as personality (Barron & Harrington, 1981), cognitive abilities (Hayes, 1989; Finke, Ward & Smith, 1992), and intelligence (Guilford, 1967; Gardner, 1993; Sternberg & Lubart, 1999) have all been linked to creativity (cited in Kahvecioglu, 2007).

Beside many diverse explanations about creativity, it is absolute that it cannot be assessed only as a product or a process. As it is firstly mentioned in literature by Rhodes (1961) it is all about: person (personality characteristics or traits of creative people); process (elements of motivation, perception, learning, thinking, and communicating); product (ideas translated into tangible forms); and press (the relationship between human beings and their environment). It is an alliterative scheme that divides creative studies (and findings) into these 4 categories. Although discussed

individually, creative behavior nearly always arises from a combination of two or more of these facets. The 4P's helped designers to structure their thinking on design creativity in solving these not well defined problems (Karakaya & Demirkan, 2015). The present study aims to approach creativity on this four-facet point of view.

According to Asasoglu, Gur and Erol (2010) creativity, with all its social and physical connotations and implications, should be the guiding concept in the revision of architectural education. Some educational philosophers might argue that creativity is congenital, and that it cannot, therefore, be taught. According to authors it may be true that talent, inclination, intention and determination help to realize creativity at an early age, but through conducive and eliciting teaching methods anyone can be sensitized towards a rich variety of ideas, outside influences, knowledge and creativity at a proper age.

In several academic fields, one of the most investigated subjects related to creativity research conducted in design education, is the analysis of design activity, since the basis of creativity in design can be solved by the help of the analysis of design actions. Demirkan and Afacan (2012) informed that Casakin and Kreitler (2008) focused on the correspondences and divergences between instructors and students for assessing creativity in the design studio. Later, they tested the validity of self-perceived creativity as the measure of creativity.

According to Wong and Siu (2012) there are diverse suggestions in the literature for fostering students' creativity in design education. Authors recommended that any activities that aim at fostering students' creativity should reduce the frequency of repeating the creative thinking processes at each stage of the creative design process, and sharing the burden of repeating the creative thinking processes in brain capacity with other classmates in the design process.

Kowaltowski et al (2010) present an exhaustive research on creative methods and techniques related to their potential for being tested in the building design context and the architecture studio environment. Some of those methods are: Analogies; Attribute Listing; Axiomatic design method; Bio-Mimicry; Brainstorming; Mind Mapping; Other Peoples Viewpoints, TRIZ; Think Tank; Using Crazy Ideas; Using Experts; Visual Brainstorming; Working with Dreams and Images. (Kowaltowski et al, 2010). Like Kowaltowski et al (2010), Eigbeonan (2013) also analyzed the creative methods in litereature which are fostering or stimulating creative thinking in teaching the arch-design studio, and presents a list of them as shown in table 1.

Creative process phase	**Methods**
Problem definition	Assumption Busting; Assumption
	Surfacing; Backwards Forwards Planning Boundary Examination; CATWOE; Chunking; Six W's and Hs; Multiple Redefinition; Other Peoples View Points/Definitions; Paraphrasing Key Words; Why Why Why?

Idea generation	Analogy; Attribute Listing; Biomimicry; Mind Mapping;
	Morphological Analysis; Nominal Group Technique; Pictures as Idea Triggers; Pin Cards; Random Stimuli; Talking Pictures; TRIZ, Metaphor, Brainstorming.
Idea selection	Advantages, Limitations/Restrictions and Unique Qualities; Anonymous
	Voting; Consensus Mapping; Idea Advocate; NAF; Plusses Potentials and Concerns; Sticking Dots; Unique Qualities.
Idea verification	PDCA; QFD; Six sigma.

Table 1. Table of classification of various methods that may stimulate creativity in relation to phases of the creative process (Clegg & Birch, 2007; Mycoted, 2007; cited in Eigbeonan, 2013)

These methods are traditionally part of the design process and cover idea generation, selection and verification with problem definition. According to Kowaltowski et al. (2010) these methods are singled out since they are especially useful in the visualization of ideas of design processes. In creative literature, common properties of all creative methods rely on conceptualization. There are not proper or directly associated approaches focusing on the relation of issue, concept and form that are the basic domains of architectural design, where concepts are fundamental to design thinking, since they operate on an ideational level. All architectural design is about the connection of these three basic domains (Oxman, 2004).

As cited in Eigbeonan (2013), Koutsoumpos (2007) recalls that architectural design education is expected to teach creativity. Creativity, with all its social and physical connotations, should therefore be the guiding concept in the revision of architectural education. Therefore, creativity must be fostered in teaching in the arch-design studio because it takes care of designs that work (serve functional requirements, satisfactory, buildable, etc.).

Aiming to develop a creative approach in architectural design, a creative approach or a model needed to be determined. The creative approach in this study is based on Rhodes 4P`s of creativity model - design creativity defined as the component of 4 domains: person: student, product: design artifact and press: informal (design workshop) and process: architectural design practice (idea generation + form making). With the purpose to construct a creative assessment in architectural design, two analysis techniques: retrospective protocol analyses and spatial, structural-organizational diagram are generated by the help of a short-term design workshop: (N) On Place-2' Design workshop. The intention is to explore the interaction among the artifact creativity, the spatial elements of design, and design concepts by the help of two creativity assessment tools: retrospective protocol, and spatial, structural-organizational diagram analyses using the theme `folding`.

The selection of the theme of the design problem plays a crucial role in this study because the evaluation criteria's two analysis techniques are structured around the concept of folding, which has a special architectonic language. The theme has its roots in Origami, the ancient Japanese art of

paper folding. It is important to be willing to accept Deleuze's theory of the fold to fully realize its potential in an architectural discourse. The fold, not as a technical device, but ontology of becoming, of multiplicity, of a differentiation while maintaining continuity and it is more important for the development of an individual architectonic form (Vyzoviti, 2004). Fold is more important for the development of methods to achieve a new architecture, and for the development of an individual architectural form. As Vyzoviti (2004) points out, folding produces a language of architecture: The first folds must thus be viewed as sounds that only much later become words. It is a new language at least for the student, which must be learned (Vyzoviti, 2004).

As mentioned above, in architecture, folding is a way to produce individual insight and architectonic language. It is not a metric or dimensional change, but one that could operate as a degree of development and variance. Folding is a challenge with great individual possibilities. Opening a fold in a surface creates spaces, which in our minds are filled with volumes, thus, the technique of folding makes it possible to re-appraise every step (Vyzoviti, 2004).

Nowadays this technique is considered as a design approach in so many architectural projects (Folding Architecture, 2016). Also, this technique became well accepted in architectural design education. In literature, there are many different kinds of design studios that focus on folding as a design approach. The most remarkable example is the studies of "D10: Het Lab-Proeftuin voor Ontwerpenen Nieuwe Theorieen" instructed by Sophia Vyzoviti at Faculty of Architecture in Delft University in 2004. D10 design studio consists of photographical documentation of working models in all phases of the studio process. Studio project is an example of an architectural design process with a circular nature in contrast to a linear process. It allows one to encircle a problem, understand and confront it in all its relationships (Vyzoviti, 2004).

In addition to Sophia Vyzoviti, Pablo de Souza instructed a studio titled ` Folding in Architecture` in the spring semester of 2011-2012 academic year at the Department of Architecture in University of Thessaly, Greece (Vyzoviti and Souza , 2012). The design objective of that course was the creation of an architectural shell that integrates folding criteria of pliancy, diversity and the ability to integrate heterogeneous contexts in a continuum. The design ontology of the assignment interwove historic precedents of folded plate structures with recent models of single surface architecture. Special emphasis was given to the fusion of dynamic computational models with material studies.

The common objectives of all these workshops are to teach students how to create three-dimensional structures or objects, and dynamic computational models by using folding techniques. Additionally, this technique provided an opportunity for the students to get acquainted with folding strategy, and also aimed to teach them the potential of folding criteria of diversity. This technique seems to provide diverse design approaches. So, it could be claimed that folding techniques have advantages to create diverse designs in a short period of time, which helps trigger creativity.

As architectural design process includes many different domains, this study also deals with this diversity. First of all, the study attempted to develop an approach in architectural design process that could be utilised in an educational medium, which aims to foster creativity. Secondly, two analysis methods are utilised in order to itemise the dimension of creativity and its relation to elements of architectural design. Hence a powerful concept / design issue, folding, was chosen to achieve this goal.

The design activity (process) assessment is accomplished by the help of the retrospective protocol analysis technique, used to understand the designer's cognitive activities and track the changes of design activities during the design process. The design artifact (in terms of product) assessment is structured with the help of the spatial structural-organizational diagram analysis method, developed with the help of D10 studio work instructed by Sophia Vyzoviti.

Methodology

This study examines the dimensions of creativity by analyzing the interactions among its dimensions. The `(N)On Place-2' Design workshop, selected as a case study that was built on the framework of observation, documentation and analysis of design process and products with the help of the theme/design issue `folding`. Workshop was held on October 10-11, 2013 with the title "Folding in Architecture" which was announced as part of the Bademlik 2013 National Design Festival Program (Bademlik Tasarim Festivali, 2013). The aim of the workshop was to encourage creative thinking in a short period of time, and highlight the importance of conceptual thinking. The methodology of study focused mainly on the interaction of design activity (in terms of process) and design artifact (in terms of product), where press (design workshop) and person (students attended to the workshop); are the other supportive domains. The methodology relies on the analysis of design process and products with the help of `folding` theme that helps enable the production of the architectural space and concept in a short period of time, which has the potential to create a dialect of architecture. To test the introduction of methods that may enhance creativity in the design-studio an exploratory study, as a structured interview, was conducted with eight architecture students.

The design task

The present study examines eight different products of `(N) On Place-2' workshop participants who are BArch students (6 females, 2 males) from different Architectural Departments in Turkey. They are sophomore or junior students, who are able to cope with architectural design problems. The design problem of `(N) On Place-2' workshop is "designing a city structure" where students asked to prepare a model of a design idea by utilising folding techniques, which they experienced on the first day of the workshop. On the first day, a power point presentation about the history and theory of fold was introduced and the aim /scope of the workshop and examples of buildings designed by folding techniques was presented. Series of movies about "folding in architecture" was screened. The movies were chosen from Paul Jackson's "Folding Techniques for Designers: From Sheet to Form" book cd. The book explains the key techniques of folding, such as pleated surfaces, curved folding and crumpling. It is a practical handbook about step-by-step drawings, crease pattern drawings, and specially commissioned photography (Jackson, 2011). The task was to extensively explore transformations of a single paper surface into a volume. After watching each movie, students were asked to make the exact folding techniques using paper (Photo 1).

Photo 1. First day of workshop. Learning and experiencing folding techniques (Author's archive, 2013)

Photo 2. Second day of workshop: Design by folding. (Author's archive, 2013)

In the second day, students started to think about "designing a city structure" in which they were asked to elaborate on their own programme. During the working process students were asked to design the structure following these steps:

- Think about basic concepts about city structure, and produce concepts that will lead the design process. They were reminded not to forget to design the structure by using folding techniques.
- Produce a model that will represent your idea.

The aim of presenting such steps during the design process was to be able to perform a clear observation of all movements and design concepts of each student. During the process, students developed certain concepts and a programme on their design.

Before the commencement of this experimental study, two assessment methods were developed in order to assess design creativity in the workshop (see Table 2). Retrospective protocol analysis method was utilised in the first assessment process called design activity. The aim of this assessment is to expose content aspects of the design activity by using recorded verbal protocols of the students at the end of design process and also pre-model studies of their design products. All interviews are conducted after the whole design process, and recorded design session interviews utilised as cues during retrospection to assist in the recall of the design activity. The aim of the utilisation of this method is to observe the cognitive aspects of the design processes by the help of two information categories: perceptual and conceptual.

Design creativity dimension	Method	Measurement items	Scope of assessment
Design activity	Retrospective protocol analysis method	Verbal protocols of students Pre-model studies of the design artifact	observe the cognitive aspects of the design processes with the help of two information categories; perceptual *and conceptual*
Artifact creativity	Spatial structural-organizational Diagram Analysis Method	Spatial structural-organizational diagram patterns of folding technique: *(continuity*, *connectivity*, *stratification*, *serial variation: spiral*, *loop and crossing*, *entanglement*, *enclosure*, *interlacement: strips)*	perceive and configure the space between the folds as an actual space and find out the design concept for each artifact.

Table 2. Design creativity assessment tool dimensions and related items

The second assessment method, called artifact creativity, included the spatial structural-organizational diagram analysis method that was proposed by Vyzoviti (2004). The aim for the utilisation of this method is to find out the design knowledge of each design artifact.

Design activity assessment: Retrospective protocol analysis method

The design activity assessment process focused on the coding of design principles, concepts and cognitive aspects (perceptual-conceptual features) of design processes. As shown in Table 2, the aim of design activity assessment is to observe the cognitive aspects of the design processes with the help of retrospective protocol analysis method that covers two information categories of perceptual and conceptual. Many systems for describing and analyzing design protocols have been developed over the recent years (Dorst & Dijkhuis, 1995; Suwa & Tversky, 1997; Gero & McNeill, 1998; Suwa et al, 1998; Bilda & Demirkan, 2003; Tang & Gero, 2000). The retrospective protocol analysis method developed in this study adapted from the analysis method proposed by Suwa and Tversky (1997). They conducted an experiment that consisted of two design and report tasks. In the design task, each student worked on a design problem through successive sketches, and in report task student's reports lagged behind the videotape and they were allowed to stop the tape until reporting all that they remembered about the current topic. Here, in this study these two same steps were implemented, but in a distinctive way. In the design task, through the workshop process, students did not use sketches; instead they utilized conceptual 3D models, in order to express their design thoughts. Here in this folding technique, the creative process begins with 3D modeling. Hence this technique remains its uniqueness as thinking starts with a three dimensional focus.

In their study, Suwa and Tversky (1997) used four different information categories (see Table 3). First category, 'emergent properties', possesses explicit shapes and sizes, but sometimes they are embedded as partial elements or implicit objects and emerge to the viewer's eyes only when he/she discovers a new way of restructuring the whole configuration that includes those elements.

'Spatial relations' are inherently visual features in the sense that architects/designers could see them in their own sketches. Functional relations in this domain denote interactions among spaces, things, people visiting or using them, and/or environments. Unlike emergent properties and spatial relations, functional relations are inherently non-visual aspects of architectural designs. The past history of studies in cognitive science has indicated that every cognitive task performed by human beings is mediated by background knowledge about the domain to which the task belongs (Suwa & Tversky, 1997).

A new protocol analysis approach is generated in this study based on the context of the design and report tasks of the workshop process. All these relations are evaluated and a new coding scheme is developed. (see Table 4). As depicted in Table 4, basically two main cognitive dimensions; perceptual and conceptual were considered as the main cognitive aspects of design activity. Perceptual refers actions of attending to visuo-spatial features of depicted elements on external representations. It covers all the emergent, spatial and functional relations of a design artifact.

Major category	Subclasses	Examples of phrases in protocols as evidence
Emergent properties	Spaces	"Areas", "places"
	Things	Descriptions or names of something
	Shapes/angles	"Round", "prolonged", "wavy line", "too sharp a comer"
Spatial relations	Sizes	"Big", "tiny", "narrow"
	Local relation	"Adjacent", "far", "connected", "lined up"
	Global relation	"Symmetrical", "configuration", "axis"
Functional relations	Practical roles	"A ticket office should be close to an entrance."
	Abstract features/reactions	"Waves/forces (from this shape)", "good show to visitors"
	Views	"View line", "the appearance (of this building)"
	Lights	"(This place is always) bright, having sunshine"
	Circulation of people/cars	"People meander through (this narrow space)"
Background knowledge	-	"Post/beam structures",
		"An important thing in an urban setting is..."

Table 3. Information categories and subclasses (Suwa & Tversky, 1997: 388)

As Suwa and Tversky (1997) stated for the domain of architectural design, abstract relations typically correspond to functional relations. In the light of the above-mentioned description of perception, all visual and abstract content of design, which are the indications of emergent properties, can be evaluated as the perceptual level of design.

Therefore, the perceptual level of the coding scheme consists of (a) emergent properties: emergent spaces and visual features, such as areas, places and creation of or attention to a new relation(P1-P2) (b) spatial relations such as organizational or comparison elements, and emphasising the meaning of spaces (P3-P4) (c) functional relations, which can be interpreted as a consideration of psychological reactions and abstraction of features and reactions, such as assigning non-visual information or meanings to visual depictions or perceptions, and exploring the issues of interactions between artifacts and conditions of the people/nature. (P5-P6). Besides the perceptual features, the conceptual category refers to cognitive actions that are not directly suggested by physical depictions

or visuo-spatial features of elements. There are two types of actions. The first type is the goal of a designer that covers the decisions on the positions, arrangements and design requirements. (C1) The second type is the knowledge about the relevance and influence of the architectural designs (C2). This structure distinguishes itself by its focus on the cognitive aspects of the designer behavior, and on the conceptual and perceptual aspects of the design process. (see Table 4). Students' statements that occur during the retrospection are transcribed into text word by word (see Table 5).

Major Category	Levels	Content	Code	Actions /Descriptions
Perceptual	Emergent properties	`Emergent spaces`	**P1**	"Areas", "places"
		`Visual features `	**P2**	Create or attend to a new relation
	Spatial Relations	`Spatial Relationships`	**P3**	Organize or compare elements
			P4	Emphasize meaning of spaces
	Functional Relations	`Consider psychological reactions `	**P5**	Assigning non-visual information or meanings to visual depictions or perceptions
		`Abstract features/reactions`	**P6**	Explore interaction issues between artifacts and conditions of people/nature
Conceptual	Esthetic Evaluations	`Make preferential and aesthetic evaluations`	**C1**	Deciding the positions, arrangements and design requirements
	Set up goals		**C2**	` Knowledge about the relevance and influence of the architectural designs `

Table 4. Coding scheme of design activities (adapted from Suwa and Tversky, 1997)

In the assessment process of design activities, each eight student's verbal protocols are recorded and all protocols are decoded. Then the entire protocol is separated into small units and segments by interpreting the way in which concepts shifted in the designer's mind. Sometimes the sequence of the retrospective protocol has been rearranged according to the behaviors and intentions of the designer. Table 5 shows the structure of frames with various slots, into which the contents of designer's actions in a single segment are coded. Actions of each student for all segments were coded in table 6 respectively. The entire structure of segments consists of two major action categories and each is in turn divided into the subcategories that are presented in Table 6. Each row under each of the main or sub-categories is a frame corresponding to a single action.

Students	Retrospective Reports of Students
Student 1 (S1)	*"I am thinking about a city structure which has no limits. People can live wherever they desire. There are no limits. The goal of this structure is to ensure free living spaces for its occupants. If I need to state a concept it can be: `infinity`". I think this technique is so helpful. I will use it in my project at school."*
Student 2(S2)	*"I try to design a space which has so many directions. I want people to feel different in every space of structure. People will experience different feelings in every part of this space. I was thinking it might be exciting and playful place for its occupants. I think asymmetry is the best concept for this kind of space. This kind of designing is really fast "*
Student 3 (S3)	*"Yesterday while I was experiencing folding techniques, I noticed that technique has so many advantages. I also detected that I can design spaces with triangular surfaces. I explore many triangular spaces and I decide to design a city structure that has different layers, and surfaces and also I like to design them in order.*
Student 4 (S4)	*"It is exciting to fold the papers and I think it is one of the best ways of designing. You can make so many different designs. I folded papers in so many ways and I think that spiral is the best pattern. I thought that spiral is the best shape for gathering people and I think that spiral has an esthetic value. I found out that rhythm is the best word for this kind of design. I cannot believe I did it in two days! "*
Student 5 (S5)	*"I am trying to design a space with so many different forms. I tried many forms but I decided to make curves and also I could design floors between these curves. So the occupants of this space can experience different layers and surfaces. This technique helps me a lot to see the potentials of paper. A paper can be a space. It is sofunn.."*
Student 6 (S6)	*" I decided to design with curves. I think in a public space curved walls will be so interesting. But also I want to make different curves with different dimensions and in different directions. Curves will provide different kinds of experiences for people. This comes up now. It is really fast! I wish I could be fast also in my design studio at school. But I am not."*
Student 7 (S7)	*" I try to fold the papers distinctly. It is the first time that I am trying to design this way. It is amazing. I crease papers, then open them and I put them together. Is this a method in folding? I am not sure, but it seems so exiting. I also want to use colors in order to explain the main area in color red) in the whole design, which I suppose will be found interesting by its occupants. I think people will be lead into there. It is the focus point of design."*
Student 8 (S8)	*`I cut the papers and start to join them. I recognize that there exists so many different kinds of spaces. So I continue to join them and realize a big chaos in there. I like it so much. I think complexity is the core of my design idea.*

Table 5. Retrospective Reports of Students

The interpretation of the first student's segments and codes are conducted in the following way: Her words `*People can live wherever they desire. There are no physical limits*` suggest the emergent spaces of design and also that she is considering the psychological reactions of its occupants. (P1 and P5). Besides she is also emphasising the meaning of spaces by her words '*I am thinking about a city structure which has no limits*' (P4). Additionally, she is also deciding about the arrangements and design requirements (C1). The design of this city structure also happened to be an example of `exploring the issues of interactions between people and physical spaces (P6) `with the help of the statement: '*People can live wherever they desire*.' She also set up the goal of her design by `*the goal of this structure is to ensure free living spaces for its occupants*`, which refers to the conceptual code C2.

The present coding scheme has two benefits. First, it could be easily declared that the definitions of primitive design actions can be driven in a systematic way. Consequently, design behaviors of a designer in each segment can be represented as a structure consisting of those defined actions, as illustrated in Table 5. This would provide the basis for dissecting the structures out of a designer's cognitive processes.

Additionally, it is determined that students feel creative during the design process. Each one emphasized that folding techniques were inspiring. They were mostly exciting during the production of creative ideas for their projects. Each student represented in Table 4 that folding techniques provided them with a way to produce several kinds of architectural space concepts. They mostly declared that the technique was useful to design the project in a short period of time. As a result, we could argue that folding techniques have a power to provide diverse conceptual meanings in a short period of time, and also help produce different kinds of architectural spaces.

DESIGN ACTIVITY ASSESSMENT					
Students	**PERCEPTUAL LEVELS**			**CONCEPTUAL (BACKGROUND KNOWLEDGE) LEVELS**	
Codes	**Emergent Spaces**	**Spatial relations**	**Functional relations**	**Set up goals**	**Esthetic Evaluations**
S1	*`People can live wherever they desire. There is no physical limits`*	*"I am thinking about a city structure which has no limits.`*	*``People can live wherever they desire.`*	*` the goal of this structure is to ensure free living spaces for its occupants.`*	*"I am thinking about a city structure which has no limits.`*
CODE	**action**: P1/P5	**action**: P4/P5	**action**: P6	**action**: C2	**action:** C1
S 2	*I try to design a space which has so many directions.*	*`People will experience different feelings in every part of this space.`*		-	*` I was thinking it might be exciting and playful place for its occupants. `*
CODE	**action**: P1	**action**: P4	**action:** P5	-	**action:** C1
S3	*`... I can design spaces with triangular surfaces.`*	*....and also I like to design them in order. `*	*`I decide to design a city structure that has different layers and surfaces `*		-
CODE	**action**: P1	**action**: P3/P2	**action:** P6	**action:**C1	-
S4	*` I folded papers in so many ways and I think that spiral is the best pattern. `*		*`I thought that spiral is the best shape for gathering people.`*	-	*`I think that spiral has an esthetic value. `*
CODE	**action**: P2	**action**: P3	**action:** P6/P5	-	**action:** C2
S5	*"I am trying to design a space with so many different forms. `*	*`I decide to make curves and also I can design floors between these curves. `*	*So the occupants of this space can experience different layers and surfaces`*	-	**-**
CODE	**action**: P1/P3	**action**: P3/P2	**action:** P5/P6	-	**-**
S6	*" I decide to design with curves.*	*`I think in a public space curved walls will be so interesting.`*	*Curves will provide different kinds of experiences for people.*	*`But also I want to make different curves with different dimensions and in different directions.`*	*I think in a public space curved walls will be so interesting.*
CODE	**action**: P1	**action**: P4	**action:** P5/P6	**action:**C1	**action:** C2
S7	*I crease the papers, then open them and put them together.*	*I also want to use colors in order to explain the main area (in color red) in the whole design, which I suppose will be found interesting by its occupants.*		*I think people will bel lead into there. It is the focus point of design*	*.... which I suppose will be found interesting by its occupants.*
CODE	**action**: P1	**action**: P4/ P6/P5		**action:**C1/C2	**action:** C2

S8	*`I cut the papers and start to join them.`*	*`I recognize that there exist so many different kinds of spaces. So I continue to join them and realize a big chaos in there`*		*`So I continue to join them and realize a big chaos in there`*
CODE	**action**: P1/P2	**action**: P4/P5	**action:** C1	**action:** C2

Table 6. Design activity assessment: The coding of segments shown in table 5

Artifact creativity assessment: Spatial structural-organizational diagram analysis Method

As is depicted above, an artifact creativity assessment tool is implemented with the help of the four phase transitions introduced by D10 studio work as instructed by Sophia Vyzoviti, 2004. The spatial-structural-organizational diagram of folding is chosen as the design patterns for the artifact creativity assessment tool: continuity, connectivity, stratification, serial variation: spiral, loop and crossing, entanglement, enclosure, and interlacement: strips. All these patterns are an integral part of the folding process where they manage the complexity of disparate elements into a continuous system. The aim of utilisation of this method is to perceive and construct the space between the folds, and to find out the design decisions made through the creation process for each artifact.

All eight spatial, structural and organizational diagram patterns (continuity, connectivity, stratification, serial variation: spiral, loop and crossing, entanglement, enclosure, and interlacement: strips) in folding are specified at the beginning of this study. All conceptual decisions of design artifacts were evaluated in the light of these patterns. (see Table 7). During this analysis, retrospective interview analysis results were also considered. The aim of making this comparison is to investigate the relationships between spatial, structural, and organizational diagram patterns of folding techniques and conceptual meaning of architectural space. With the help of the comparison diagram, it was determined that architectural space configurations are 3D reflections of the concepts that students declared during the design process.

ARTIFACT CREATIVITY ASSESSMENT

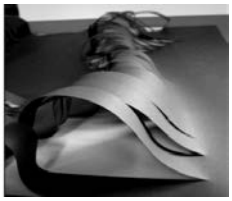
Students	Verbal Protocols	Design Concepts	Spatial, structural and organizational diagram patterns in folding	Design Artifacts
S1	*If I need to state a concept it can be: `infinity`".*	infinity	**Continuity**	
S2	*`. I think asymmetry is the best concept for this kind of space*	asymmetry	**Connectivity**	
S3	*`I decide to design a city structure that has different layers, and surfaces and also I like to design them in order.`*	order	**Stratification**	
S4	*`I find out that rhythm is the best concept for this kind of design.`*	rhythm	**Serial variation: spiral**	
S5	*`I am trying to design a space with so many different forms`*	differentiation	**Loop and crossing**	
S6	*`I want to make different curves with different dimensions and directions`*	multi directional spaces	**Entanglement**	
S7	*`...occupants. I think people will lead to there. It is the focus point of design."*	concentric	**Enclosure**	
S8	*`I think complexity is the core of my design idea.`*	conflict	**Interlacement: Strips**	

Table 7. Artifact creativity assessment: Spatial structural-organizational diagram analysis

Results and Discussion

Table 8 displays the results of the two assessments; the total number of cognitive codes in the design activity, and the design concepts related to spatial, structural, and organizational diagram patterns in the students' folding.

Design Creativity Dimensions	**Measurement Items**	
Design Activity Assessment	**Total Numbers of Conceptual Codes**	**Total Numbers of Perceptual Codes**
	6 C1 6 C2	7 P1 4 P2 4 P3 5 P4 8 P5 6 P6
Artifact Creativity Assessment	**Spatial, structural and organizational diagram patterns in folding**	**Related Design Concepts**
	• Continuity • Connectivity • Stratification • Serial variation: spiral • Loop and crossing • Entanglement • Enclosure • Interlacement: Strips	• infinity • asymmetry • order • rhythm • differentiation • multi directional spaces • concentric • conflict

Table 8. Design creativity assessment tool dimensions and related items

These results can be summarized by the following insights:

- The findings in the design activity assessment showed that the predominant cognitive actions are emergent properties and functional relations.
- The highest number of codes are indicated as `as a consideration of psychological reactions,` which is described as assigning non-visual information or meanings to visual depictions or perceptions(P5). This result shows that design decisions made through the creation process is mostly dependent on conceptual meanings.
- Students particularly paid attention to the psychological features of spaces, and they tried to find out their physical appearance. This could be interpreted as mapping the paper fold as a spatial diagram, which requires an abstraction of spatial relations.

- One of the most employed perceptual code of design is `areas and places,` which is the subcategory of emergent properties (P1). This is the explanation for the fact that the students gave particular importance to the form-function relationship in design.
- All design artifacts symbolized a whole physical system, which could be interpreted as the students acknowledging the design as a whole not a partial system. They intended to create uncertainty between boundaries, instead of defined boundaries of separation.
- Moreover, the `abstract features-reactions` functional code has the highest number of utilisations (P6). Students generally focused on the exploration of the issues of interactions between spaces and their occupants. They mostly tried to connect the physical dimensions of the spaces to their occupants. This result illustrated that students expressed regard to the scale and proportion.
- During this stage of cognitive action, students also emphasized the meaning of spaces (P4). They defined the spaces related to their abstract meaning. They used conceptual cognitive actions as guidance for their designs. This result shows the considerable amount of utilisation of the conceptual codes (C1 and C2).
- As the last perceptual actions (P1 and P2); organizations and comparisons among more than one element, such as grouping of elements, and the similarity/uniformity and the difference/contrast of the visual features of the elements were the least used codes. These actions were inherently dependent on physical actions, which constitute the basic actions for all cognitive stages.
- All spatial and organizational diagram patterns have conceptual response in design. By the help of verbal protocols of the students, design concepts for each artifact revealed, and matched to the related spatial, structural and organizational patterns:
    - Continuity as a pattern of spatial diagram is related to the concept of infinity. It is obvious that infinite space signifies continuity.
    - But some other examples like asymmetry and connectivity do not have the same relation in the way that continuity and infinity do. The design product designed with an asymmetry concept was assessed as a connected space. It is interpreted that the architectural space either has an asymmetric or a connected character.
    - Alike with `asymmetry and connectivity ` relation; the pattern `stratification` is matched with the design concept `order`. As being the act of dividing things into different groups or layers, stratification is approved as the explanation of concept `order` in form-concept relation.
    - In the other example, namely the serial variation; spiral and rhythm also have the same relationship with the former case. A serial variation folding technique might supply several different space options for the design process. But, during retrospective interviews it was observed that the students mainly focused on the rhythm concept and regularly utilised spiral folding.
    - The word differentiate interpreted as the conceptual reflection of `loop and crossing` design patterns where they have competency to design dissimilar space forms.

- Entanglement; meaning of being confused or intertwined is admitted as the formal reflection of multi -directional spaces. This relation is approved based on the design concept of sixth student, that covers design act of creating different dimensions and directions with multi-curved spaces.
- The concept concentric is interpreted as the explanation of creating centrality in design. And this design relation states confined space that signify the term enclosure as a design pattern.
- The last concept conflict, approved as the conceptual meaning of interlaced spaces where design artifact completely designed by the help of strips that interlaced with each other as the reflection of complexity in space.

Assessments of Design Creativity Dimensions and Potentials of Folding Techniques as Fostering Creativity in Architectural Design Education

As formerly discussed, there are several approaches and models in literature about fostering and stimulating creativity in architectural design education. Most of them are about concept development (like brainstorming) or emphasizing visualization of ideas (like bio-mimicry). There is not enough study directly focused on the morphologic or conceptual relation between concept and architectural design elements (form, spatial, structural and organizational diagram patterns). This creative design approach has the power to fill this gap in design education.

The most important feature of all these investigations and observations, creative design process in folding, starts with form making before conceptual thinking. Conventionally; a design process starts with abstraction then concrete definition (3D models) of design is stimulated, as in a decision-making model where a design problem is first analysed and defined at varying levels of abstraction, then synthesized in a way that adds to the designer's knowledge of successive and hence more concrete-levels of understanding (Kirk and Spreckelmeyer, 1988: 40). The folding technique displays a new perspective. As it is mentioned in the findings, students first started to make a model and then developed concepts that seem related to the actual fold spaces. The process then turned into spatial arrangements and organization. Hence, this approach seems inspiring for students to develop morphologic and theoretical relations between design issues (as in the design problem itself), form and concept.

Conceptual knowledge, the ideational basis of design, constitutes one of the most significant forms of knowledge in design. Concepts are fundamental to design thinking, since they operate on an ideational level. They are the fundamental material of design thinking. And developing a conceptual knowledge related to architectural space for design students is one of the most complicated phenomenon. At the early stages of architectural education, students have difficulty to produce forms. Students, during the design process, comfortably use basic geometrical elements one by one. However, they are not able to diversify them by transformation because of the fact that students are not capable enough to transform basic geometrical forms in accordance with arithmetical operations and geometrical transformation (Yavuz and Akcay, 2012). Hence by the help of the folding technique it is quite easy to help students to produce form-concept relations by initially creating topological geometric forms.

As Vyzoviti (2004) claims, folding is a challenge with great individual possibilities. Opening a fold in a surface creates spaces, which in our minds are filled with volumes; thus, all architectonics like space, organizational and structural patterns emerged during the process. As it was also mentioned in the retrospective and spatial analysis results, students decided on their design concepts after choosing the best folding form. And all patterns have the power to create conceptual meaning of an architectural space. Students developed the design concept after or while making the 3D models. It is obvious that in folding process, design product is not the a priori target to be achieved. Besides, all products were different from each other. And they could not be repeated again. It is clear that folding is a strong theme, which displays diverse individual architectonic form. There is no doubt the folding project is unique in the end results created.

Conclusion

Creativity has been explored for more than a century and during this time it has been recast from a mysterious ability of humans to a more cognitive and practical ability, which can be taught and learnt. But teaching and learning to be creative is still an area that needs to be examined. One would expect creativity to be taught in architectural design education since in the design studio students are supposed not merely to learn how to form space or how to shape places. It also involves helping students become independent thinkers, proficient at self-regulated thinking. It is needed to make them think innovatively, to have a fresh view of the built environment. Architectural design is also an exploration of creating the finest forms for the settings of human activities. Because of the complexity of the design process there are no exact and fixed formulas that bring together form, function, concept and technology. In order to ensure creativity is fostered in architectural design education, there are some creative methods that could be proposed to achieve these goals, which are mostly focused on idea generation, problem definition, idea selection and verification. These methods are accepted as a guide to thinking creatively in design processes. But creative thinking in architecture design not only deals with conceptualization but also with components or elements of a structure or system and unifies them into a coherent and functional whole, according to a particular approach. Architectural design is essentially about the conceptions, configurations, connections, shape, and orientations of physical forms.

This paper discusses folding techniques as a creative design approach that should come to the forefront in design studio education. The result of this study indicates that folding is a unique technique that offers a new perspective in architectural design processes. Contrary to conventional approaches design starts and ends with 3D models. In conventional architectural design, drawings are the primary form of representation; they carry a design from conception to construction. But this study shows that design thinking starts with 3D modeling; conceptualisation can occur afterwards or in the course of process. This helps designers to comprehend the spatial and conceptual relations of architectural form instantaneously. This technique is therefore unique as it helps students, especially beginners, deal more easily with issue-concept-form relations in design. It is also vital not to forget the effect of the medium that the experiment was performed in. Informal education mediums like design workshops are believed to have an effective role in allowing students to free their minds and help them to create novel artifacts. So, in order to enhance creativity in design

studios, the social-cultural aspect of the medium also should be considered as an effective tool in learning and teaching design.

As a contribution to these debates, this technique has many aspects that can help to facilitate flexible thinking in design, and it has more potential in spatial comprehension than conventional architectural conception. Although this study presents strong evidence to challenge the conventional way of design: “creative design can start with 3D representation”. It is a creative way of thinking that enables designers to perceive the interactions of spatial, conceptual and volume at the moment of creation. It is a creative way of starting with 3D form representations.

Design disciplines dealing with issue-concept-form relations should find innovative ways such as the folding technique. This kind of approach could be adapted as an educational pedagogy in other design disciplines such as urban design, landscape design, or interior design.

This study thus fills a gap in the literature about design approaches that foster creativity in design education, by proposing a logical and practical way of understanding architectural design processes specifically for design students who are at the beginning of their education. This study is a starting point for future studies about developing new and unconventional creative approaches in architectural design education.

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gokceonal07@gmail.com