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MODULAR SYSTEM APPROACH IN DESIGN EDUCATION

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Abstract

Contemporary users expect portable, flexible, environment- and user-friendly, flexible designs. In order to meet these expectations, the design forms should be organic, ecological, alive, dynamic, flexible, adaptable, versalite, and portable. Thus, the concepts such as digital and smart architecture were introduced. Therefore, formation of natural material and the harmony in nature are the inspirations for design. Nature has a unique system, which is comprised of modules. Inspiration from the nature could help creation of a system in design education using modules, facilitating the design process for the students. Thus, the modular design process, which involves the adoption of modular design approach in landscape architecture education, was discussed in the present study. The analysis of the modules is important for these types of design. Thus, the present study addressed the concepts of inspiration from the nature and modular design within the context of "Architectural Design and Project Course", which is one of the 2nd semester courses at Karadeniz Technical University, Landscape Architecture Department. The study material included models titled "urban objects" constructed in the above-mentioned course. In the application section, the models of 4 students were selected by the researchers and evaluated based on the research process (natural examples) and creative product (model) aspects. In conclusion, it was determined that the creation of design forms and spatial construct by students were facilitated in this design education that adopted the nature inspired modular approach.

1. INTRODUCTION

Although the design is considered an artificial and concrete output, it is an abstract process sourced in nature. Thus, the success in design depends not on the artificial creativity of the designer, but on the natural universe. Natural elements should be correlated and transferred into the nature as new elements as a result of the design process. Thus, it is necessary to understand the correlation between natural elements. During this modular system arithmetic, the effects of nature on design should be investigated. Because, construction of a modular system is an important activity and the purpose of the architectural creation process [1,2]. Several similar methods are attempted in architectural design, and these are the topics of architectural research in models developed especially in educational processes [3].

Scholars such as Achim (2007), Petruccioli and Kütükçüoğlu (2008) published articles on module production techniques utilized in their studios [4,5]. Modules are self-repetitive forms, shapes, and structures. Another definition of module is the concretized state of the basic principles of nature. Analysis of the modules in natural structures offers abundant information about lifestyle habits, permeability, cyclicity, speed and the relationships with other elements in the environment. According to Van Doesburg (1914), the designer-artist cannot deny the nature, however she/he does not use it exactly as well [6]. The designer utilizes the natural modules by reducing them to principal forms, colors and ratios. Thus, the

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designer recreates nature in a different image. In analysis of natural modules and the arithmetic of the nature, the details of the selected object are deconstructed and created in a simpler form. The designer, thus, learns to express ideas more easily through form, and the ability of the designer to think and to analyze the nature improves as the designer succeeds [7,8,9,10,11].

Design is an attempt to reach the non-existent by associating the existing ones. Modular arithmetic, which is a suggestion for a design act methodology, is the association of modular forms and arithmetic. Revisiting the definition of arithmetic would allow us to understand the task of association it assumes in design. Arithmetic is defined as the art of finding the expression of a single correlation that would be formed by associating several correlations. Arithmetic is an approach to the multiplicity of elements called life based on the correlations among the elements [12]. This, in turn, is a modular correlation method suitable for design.

The module is a form organized within a self-integrated systematic framework that has a beginning and an end [13]. Before creating a modular design, the selected module should be analyzed. Modules are an important factor in understanding the forms and concepts [14]. Because, the innate ability of the modules to create and sustain is the basis for analyzing correlations and understanding the system and order. The module is a design that includes relationships between objects and geometric shapes [15]. In order to produce a creative systematic, it is necessary to correlate things and construct an object as a result. Natural inspiration means creating modules, imitating natural modules, and achieve ready solutions with an infinite variety of shapes, colors, textures, materials, and combinations both formally and functionally. Thus, it is important to assist the students to acquire the ability to design with modules in landscape architecture education. The aim of the present study was to allow the students to design the original urban objects with inspiration from the modular structures in nature.

2.MATERIAL METHOD

1.1.1st Stage

The study material included the final student applications of urban object models produced within the scope of 2nd semester course “Architectural Design and Project (2 + 1)” at KTU Landscape Architecture Department (Figure 1). Architectural Design course at KTU LAD starts on an intellectual basis based on natural elements and forms and ends with the design of a concrete spatial construct. At this stage, the process that followed the path from the selected natural specimens and the final urban object models created at the end was presented modular applications were examined.

Figure 1. Final student models

2.2.2nd Stage

At the end of the semester, students took a survey about their achievements in modular design implemented in the course. In the second stage the survey constituted. The questionnaire was designed to find answers to questions such as how much the students learned modular design, how they were transformed from nature to design, what was their levels on the ability to associate design concepts and modular fiction, and how modular and natural design process affected learning. The 53 students who took the course were asked to score the statements in the survey on a 5-point Likert-type scale (1 – very little, 2 - little, 3 - moderately, 4 - much, 5 - very much).

3. FINDINGS AND DISCUSSION

3.1.Stage 1 Findings

In each course hour, natural samples were selected by the students and formal analyzes were conducted on architectural design concepts and the samples were transformed into drawings and modules. One-on-one work was conducted with each student. At the end of the semester, the students were created 1:50 models by constructing modular creative urban objects based on the natural modules learned during the above-mentioned applications. This final stage was a long process. The students working on models for weeks. In this process, unlike the in-term applications, three-dimensional and concrete constructs are obtained. These constituted the main study material. Since the transition to concrete by selecting a module from natural examples is a difficult and challenging process, the hardest work was conducted in this final stage. While the in-term applications were conducted on one course hour, the final was conducted in the last 6 weeks. The last week was devoted to the completion of the model of submission by the student after the drafts were approved by the instructor. In this stage, in-term applications and the 3 final models were evaluated and the process of transition from abstract to concrete was analyzed (Tables 1 and 2).

Table 1. Sample in-term applications

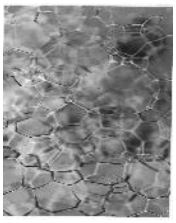
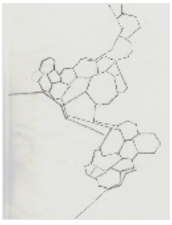
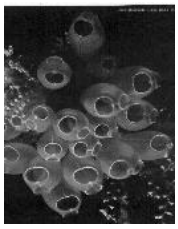
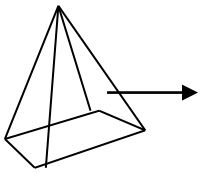
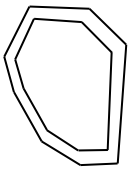
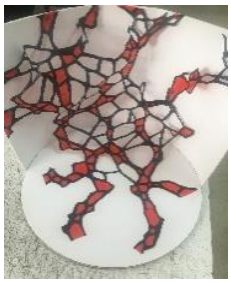
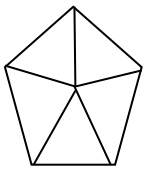
Samples	Moduler Design 1	Moduler Design 2	Moduler Design 3
			
			

Table 2. Analysis of final work

		In this work, the student selected the pyramid module, which is prevalent in nature, and combined pyramids in various sizes and created a unique urban object design
		In this work, the student selected the hexagonal honeycomb module, which is prevalent in nature, and combined the honeycombs in various sizes and created a unique urban object design
		In this work, the student selected the pentagon module, which is prevalent in nature, and combined the pentagons in various sizes and created a unique urban object design

3.2.Survey Findings

Chi-square test was conducted in this stage by using SPSS (v. 23.0) software to test significance of the responses. All categories were statistically significant according the chi-square test results.

3.2.1.Findings about Modular Design

The frequencies of the student answers to the question posed to understand how much the students learned modular design are presented in Table 3. The findings demonstrated that students' modular concept learning was "good" $\chi 2=12.939a$, 3df, $p<0.01$).

Table 3. Frequencies for the question (1) "How much did you learn modular design?"

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Little	4	7,5	7,5	7,5
Moderate	6	11,3	11,3	18,8
Good	13	24,5	24,6	43,4
Very Good	30	56,6	56,6	100,0
Total	53	99,9	100,0	

3.2.2.Findings about Transition from Nature to Design

The frequencies related to the answers given to the question posed to understand how well the students achieved the transition from natural samples to concrete formal construct are evaluated in Table 4. Based on the findings, the students were successful at the "moderate" level ($\chi2$=22.401b, 4df, p<0.01). Since this is a complex process that is difficult to understand and must be learned by experience, the level of educational achievements in the course was moderate, and this level increases with the design experience of the students increases as they receive higher level projects.

Table 4. Frequencies for the question (2) "What was your achievement level in the transition from nature to design?"

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Very Little	7	13,2	13,2	13,2
Little	24	45,3	45,3	58,5
Moderate	8	15,1	15,1	73,6
Good	10	18,8	18,9	92,5
Very Good	4	7,5	7,5	100,0
Total	53	99,9	100,0	

3.2.3.Findings about the Association of Design Concepts and Modular Construct

The frequencies related to the answers given in the question posed to understand how much they learned to construct the association between the module and the design concepts were evaluated in Table 5. Based on the findings, the students learned the concept-module association at moderate level $\chi2$=13.268b, 4df, p<0.01). Since this is a difficult association that could be learned by designing and experience, the learning level was moderate in the course; the level would improve as the students take higher term projects and their design experiences increase.

Table 5. Frequencies for the question (3) "How much did you learn to associate design concepts and space?"

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Very Little	8	15,1	15,1	15,1
Little	8	15,1	15,1	30,2
Moderate	14	26,4	26,5	56,7
Good	12	22,6	22,6	79,3
Very Good	11	20,7	20,7	100,0
Total	53	99,9	100,0	

3.2.4.Findings about the Instructive Quality of the Course

The frequencies related to the answers given to the question asked to understand the general level of architectural design course are evaluated in Table 6. Based on the results, the students considered the instructive level of the course as "good" $\chi2$=21.632c, 2df, p<0.01).

Table 6. Frequencies for the question (4) "How much do you think the course was instructive?"

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Moderate	9	16,9	16,9	16,9
Good	12	22,7	22,7	39,6
Very Good	32	60,3	60,4	100,0
Total	53	99,9	100,0	

3.2.5.Comparison of All Questions

For understanding the differences between the answers to the questions were statistically significant or not T-test was applied. It was determined that the students considered the lesson at the best level and learned the modular approach at a good level. When associating concepts with modular construct, it was found that they experienced difficulties, mostly in the transition from nature to design. The analysis results showed that the differences between the responses were significant for each question ($p < 0.01$), and the mean and standard deviation values for each question and the T-test findings are presented in Table 7.

Table 7. Mean and Standard Deviation (sd) valyes and T-test findings

	t	df	Std. Deviation	Mean Difference
Question1	36,365	52	,966	4,110
Question 2	18,580	52	1,235	2,685
Question 3	23,293	52	1,311	3,575
Question 4	53,733	52	,708	4,452

4.DISCUSSION AND CONCLUSION

The landscape architecture Similar to all art and design areas that entail creativity processes, one of the most important courses that aim the students education process aims to create spaces for persons' needs. This process is complex for students. to acquire skills in landscape architecture education programs is the Architectural Design Course. In the present study, the modular design process in Architectural Design course at KTU Landscape Architecture Department, where urban object design is achieved by the inspiration from the nature was reviewed to determine the benefits of the process in education.

- In the course, students conducted formal and modular analysis on the natural samples they selected.
- The drawings they produced in each lesson facilitated their learning on modular forms and concepts, and it was determined that they learned modular form production at a good level.
- The students considered the applied modular design education approach that included transition from 2D to 3D as instructive.
- The students experienced difficulties in the transition from natural concepts to formal construct and in establishing the association between the concepts and modular construct.

In conclusion, the students' work was evaluated based on natural inspiration and the correlations between natural modules and the design process in the present study. In the present design education where the natural inspiration approach was adopted, the approach facilitated the initiation of the design process and determination of the form by the students and learning how to design.

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