ATTITUDES OF LANDSCAPE ARCHITECTURE STUDENTS TOWARDS BIOMORPHIC AND PARAMETRIC DESIGN APPROACHES IN ENVIRONMENTAL DESIGN

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ABSTRACT

In all design disciplines, the designer attempts to find a solution to design problems using various approaches. In environmental design, the design approaches and design process are similar to other disciplines, only the design product is outdoor spaces. Outdoor spaces are the sections outside the buildings in urban and rural spaces and include all elements from the micro to macro scale.

Landscape architect can find direction in certain design principles and theories. Furthermore, a number of design approaches or trends in historical perspective also lead the design process. Thus, biomorphic and parametric design approaches have emerged during recent times.

Biomorphic design approach is the imitation of the nature by the designer to create better solutions. The parametric design approach is based on the parametric determination and organization of the data that would affect the design. In the present study, the attitudes and approach of the landscape architecture students in Karadeniz Technical University (KTU) towards these two design approaches were investigated.

To test the reliability of the developed attitude scale, the Cronbach's Alpha test was conducted independently for positive and negative statements about each design approach in the scale, and it was found that the scale was reliable. The analysis of the data revealed that the students' attitudes towards the biomorphic design approach was more positive there was a low level and negative correlation between the attitude scores and the two design approaches. Among the KTU Landscape Architecture students, 49,40% of the students adopted biomorphic design approach and 32% preferred parametric design apporach when working on environmental design projects.

Key Words: *Landscape Architecture, Environmental Design, Biomorphic Design, Parametric Design, Attitude Scale.*

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PEYZAJ MİMARLIĞI ÖĞRENCİLERİNİN, ÇEVRE TASARIMINDA BİYOMORFİK VE PARAMETRİK TASARIM YAKLAŞIMLARINA KARŞI TUTUMLARI

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ÖZET

Tüm tasarım disiplinlerinde tasarımcıların her biri çeşitli tasarım yaklaşımları ile tasarım problemlerine çözüm bulmaya çalışırlar. Çevre tasarımında da, tasarım yaklaşımları ve süreci aynı diğer disiplinlerdeki gibi olmakla beraber tasarlanacak nesne dış mekânlardır.

Peyzaj mimarı bazı tasarım ilkeleri ve kuramları doğrultusunda kendisine yön bulabilmektedir. Bunların yanında geçmişten günümüze kadar gelen bir takım tasarım yaklaşımları ya da akımlar tasarım sürecini yönlendirmektedir. Bu kapsamda son dönemde biyomorfik ve parametrik tasarım yaklaşımları ön plana çıkmaktadır.

Biyomorfik tasarım yaklaşımı; tasarımcının daha iyi çözümler yaratabilmek için doğayı taklit etmesidir. Parametrik tasarım yaklaşımı ise; tasarım sürecinde tasarımı etkileyecek verilerin parametreler olarak belirlenmesi ve organizasyonu esastır. Bu çalışmada bu iki tasarım yaklaşımına Karadeniz Teknik Üniversitesi, Peyzaj Mimarlığı öğrencilerinin tutumu ve yaklaşımı araştırılmıştır.

Geliştirilen tutum ölçeğinin güvenirliliğini test etmek için ölçekte yer alan her bir tasarım yaklaşımı için yer alan olumlu ve olumsuz ifadeler için ayrı ayrı Cronbach'ın Alpha testi uygulanmış ve ölçek güvenilir çıkmıştır. Öğrencilerin biyomorfik tasarım yaklaşımına karşı tutumun daha olumlu olduğu ve iki tasarım yaklaşımına tutum puanları arasındaki korelasyon katsayılarının negatif yönde düşük düzeyde anlamlı bir ilişki olduğu görülmektedir. KTÜ, Peyzaj mimarlığı öğrencileri, çevre tasarım projeleri tasarlarken biyomorfik tasarım yaklaşımını tercih edenlerin oranı % 49,40 iken parametrik tasarım yaklaşımını tercih edenlerin oranı % 32 dir.

Anahtar Kelimeler: *Peyzaj Mimarlığı, Çevre Tasarımı, Biyomorfik Tasarım, Parametrik Tasarım, Tutum Ölçeği*

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1. INTRODUCTION

Landscape has several connotations. Meinig (1979) argued that individuals who look at the same landscape from the same spot could observe same elements such as a houses, humans, cars, roads, mountains and stones based on their count, shape, color and size, but would perceive all these objects based on certain ideas or associations in their minds. Hence, any landscape includes both the tangible items that we could see through our eyes, and abstract items related to the landscape that only exist in our minds. Landscape architecture, in the context of creating and changing all elements that form the landscapes and the landscape, is o construct physical strategies and forms based on ecological, technical, artistic and aesthetic criteria. The designs that landscape architects create are usually called environmental design, not landscape design.

However, environment does not only reflect the structure of the nature. The environment encompasses all living and lifeless objects, biophysical and sociocultural elements (Sarı and Karaşah, 2015). The first involves the biological and physical aspects, and the second is concerned with the economic, political, and intellectual activities of an individual Mumcu et al., 2017). These two elements are interrelated and inseparable parts (Türkman, 2000). Landscape architects present their structural and planting designs by integrating these factors with architectural elements for conservation of present forms and data, development, recreation and improving the quality of life (Yılmaz, 2015; Bekçi et al., 2015). In the process, they follow certain formal, semantic, physical and functional design concerns (Yılmaz et al.; Tarakci, Eren and Var, 2017). In the present study, biomorphic and parametric design approaches that were used by landscape architecture students to design the formal dimension of environmental design projects are examined.

1.1. Biomorphic Design Approach

Biophilic environments need not be biomorphic in shape or literally full of greenery (e.g., the Alhambra in Granada, which primarily consists of rectilinear forms and patterns). They are sustainable because they resonate with humans. Both movements need biophilic design to achieve lasting cultural relevance (Kelbaugh, 2014). In biomorphic design approach, designers imitate the nature. The designers interpret the objects they perceive in the nature and create an artificial environment. Universally individuals enjoy the nature, being in a natural environment, and natural experiences (Bayazıt, 2008, p.239).

The relationship between humans and nature and its effects on the landscape architecture and environmental design has been shaped by advances in social, technological, religious and economic conditions. Nature was initially imitated in architecture and landscape architecture. Today, thanks to technological advances, biological structures and functions of natural elements are imitated in addition to their biological forms. Especially during the last fifty years, along with the emergence of ecological problems, the method of learning from the nature was reformed in landscape architecture and acquired a totally different dimension. Creation and processes of living beings have started to be used in environmental design, in the design of form-structure-plastic object-furniture and material relations. “Biomorphism,” inspired by the living forms orutilize these forms in architectural design by assigning metaphorical meanings,

is the baseline of the present study. Biomorphism is a form of biomimicry that involves the use of biological forms as models for the design of artifacts such as airplanes, computers, and islands (Shelly, 2015). Bio-morphology was studied within the context of relationships among nature, humans and architecture. The term nature here refers to living organisms and related systems in particular. When the relations between nature and humans are examined, humans' perspective towards the nature, how it utilized the nature and living forms in its quest for form were emphasized. Its inspiration, living or natural forms and the preliminary design and concept are scrutinized as a functional and symbolic extrovert shell.Biomorphism is a general concept with subdivisions. These subdivisions imclude anthropomorphism, zoomorphism, phytomorphism and micromorphism. Zoomorphism is the utilization of animal forms, anthropomorphism is the utilization of human body, and phytomorphism is the utilization of branching/blooming systems and other physiological properties of the plants.

In the field of architecture and environment design, the relationship between human and nature is transformed into most concrete products. Architecture and environmental design constructs their relationship with the nature through elements such as buildings, furniture, structures, plastic objects and all others related to the environment. Humankind created designs since the early ages using its instincts and imitating nature to interfere with the nature to create unique cultural and functional shells to protect itself from external factors and to survive and to live inside landscapes defined by buildings or shaped by human skills. As per the above definition, the system of thought defines the form of the design; the question of architectural design is related to the form itself, what it describes and itd "generation" (Jormakka, 2007; Zeytoun, 2014). One of the architects who studied the similarities between architecture and nature was Viollet le Duc. As an art, architecture is a human creation. To achieve such a creation, we need the follow the same path as nature uses when creating objects. We need to use the same elements and logical methods that nature uses, and we have to obey the same natural laws (Le-Duc and Emmanual, 1990). It was scholar-author Janine Benyus who first demonstrated that the nature-form relationship could be practiced in several different fields by theorizing this relationship, and created the concept of biomorphism. Benyus attributed three different historical roles to nature in the design world; nature as a model, nature as a measure and nature as a mentor. Similarly, Charles Jencks claimed that the concept of biomorphism would be influential in discussing architectural concepts in the late 20th century under the influence of biological engineering in his book "Architecture 2000 Predictions and Methods" published in 1971. Jencks predicted that the "Biomorphic Movement" would be effective in the post-1980 architecture in a table where he examined the evolutionary developments and movements in architecture until 2000s. Among prominent theoretical studies on biomorphic design approaches, Christopher Alexander's "The Nature of Order," William H. Gass' "Finding A Form", Peter Pearce's "Structure in Nature for a Strategy for Design", and Frei Otto and Bodo Rasch's, "Form Finding" could be listed. Alexander's statement "The ultimate goal of the design is form" summarizes the design-form relationship, which was at the focus of the abovementioned theoretical studies. Biomorphic movements have influenced design, conceptually, structurally and formally.

1.2. Parametric Design Approach

There is a global convergence in recent avant-garde architecture that justifies the enunciation of a new style: Parametricism. The style is rooted in digital animation techniques. Its latest refinements are based on advanced parametric design systems and scripting techniques. This style has been developed over the last 15 years and is now claiming hegemony within avant-garde architecture. It succeeds modernism as a new long wave of systematic innovation (Schumacher, 2009). The computer is an effective tool in landscape architecture as it is in several fields. However, computers are often used for technical calculations in design and the effective expression and presentation. However, its use in the design process is a field open for improvement for the user. Computer programming languages and techniques developed with algorithmic approach facilitated the design process for the user. The concept of algorithm, which is the basis of mathematics and computer sciences, became the subject of other sciences and disciplines over time. The algorithm that could be defined as the combination of steps required to solve a problem and the resulting algorithmic approach constitute the basis of parametric design. In its basic form, a parameter could be described as a quantity that could be defined and modified for a condition, and the condition that contains this quantity in any count could be perceived as parametrical. The number of parameters could vary based on the situation. To a large extent, the geometry modelling approach in parametric design is dependent on variation settings (Yu, Ostwald, Ning, 2015). What is important is to establish the correlation between these parameters and to manage these parameters on demand. It is important to use this term, which is frequently used by computer and mathematical sciences, in landscape architecture design. Parametric applications have inherited two crucial elements. These are that all entities start with a point in space and allow the study of architectural conditions in a three-dimensional environment, rather than the commonly used two-dimensional or layering techniques. And that the underlying concept of parametric modelling is based on data, variables, and their relationship to other entities, which can then respond to variations of input data(Schnabel, 2007). The present study scrutinized the subject of parametric design based on examples and student attitudes towards the instruction of this approach were examined. In conclusion, it was considered that the use of algorithmic approach in design, and therefore in design education, is open to development although it is a novel approach.

Furthermore, based on another perspective, parametric design is computer aided sketching or modeling. In parametric design, all parameters are combined to create forms using digital technologies. For example, a line has two parameters: length and direction. A prismatic volume has four parameters: position, length, width, and height. In addition, there are also “blocks” (AutoCad), “cells” (Microstation) “symbols” or “components” (other systems) with different parametric values from these primitive forms. In existing CAD systems, there are also tools that allow us to make some changes to these primitive elements. It easy to implement variations in design using parametric design. A parametric design is a representation of a computer-generated design (Table1).

***Table1**. Biomorphic And Parametric Design Approach And The Most Famous Examples*

DESIGNS CONSTRUCTED WITH BIOMORPHIC DESIGN APPROACH

Singapore Supertree Grove

Designed as a vertical garden, the project consists of eighteen 'supertrees' in the Marina Bay district in Singapore. It was conceived and designed to effectively revitalize and maximize the growth potential of the city. These eighteen rising 'Supertrees' contain more than 200 species, over 226,000 plants, solar energy production, rainwater collection and a number of other functions. Designed by a biomorphic design approach inspired by trees, this area was designed by Grant Associates, a UK-based landscape architecture firm. Masterplan was inspired by the form of an orchid and has an intelligent infrastructure that allows plants that normally would not grow in Singapore.

***Figure1**.https://www.treehugger.com/urban-design/biomimetic-supertrees-gardens-by-the-bay-singapore.html*

Eden Project

It was designed by the former head of Architectural Association Nicholas Grimshaw and Land Use Consultants. It was designed with a biomorphic design approach. Cornwall is the largest greenhouse in the world, built on 50 hectares of land in the United Kingdom and worths £ 37.5 million. From the exterior, it is reminiscent of a bug. One of the greenhouse areas has a rainforest climate and the other has a Mediterranean climate. The world's largest greenhouse, the Eden project, is an artificial biomass exhibition. The word 'Eden' means heaven. As the name implies, it is an admirable place that aims to impress people. Plants were brought from many parts of the world for this project. Thousands of plant species ... 3,865 plant species ... For the plants to survive, these domes aimed to provide indigenous conditions for the plants brought from all over the world.

***Figure2**.http://yapiharikalari.com/eden_projesi*

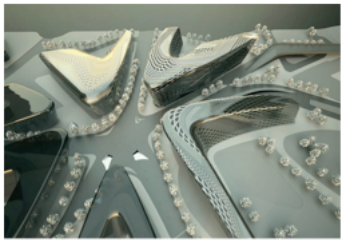
DESIGNS CONSTRUCTED WITH PARAMETRIC DESIGN APPROACH

Changsha Meixihu International Center for Arts and Culture.

The Changsha Meixihu International Center for Arts and Culture and its environment was designed with parametric design approach by Zaha Hadid. Similar to her other works, round forms are used in this work. The center includes 3 different buildings and there are wavy walking paths around the center. The structure was located at the seaside and the surroundings were constructed with abnormal angles and create interest with its characteristic features.

***Figure3**.http://www.gazetebilkent.com/2015/05/01/dunyamizi-guzellestirenler-2-zaha-hadid/*

Thyssen Krupp General Headquarters



The Thyssen-Krupp Headquarters and its environment were also designed by Zaha Hadid and is located in Essen, Germany. Designed with a parametric design approach, this project won the third prize in a two-stage international competition. The technical, innovative organic form emphasized that the buildings are compatible with the values of Theyssen Krup, and the fact that the buildings opened to the environment with a centrifugal effect created a new landscape. Thus, an iconic piece was created that included a sand dune landscape and a glacier atmosphere.

***Figure4**.http://www.mimdap.org/?p=128077*

2. MATERIAL AND METHOD

2.1. Research Model

In the study, initially, the attitudes of landscape architecture students towards parametric and biomorphic design approaches in environmental design were determined. Then, the design approach preferred by the students in environmental design the most was identified. Later on, the correlation between students' preferences and attitudes towards the design approaches were examined.

2.2. Study Group

The study group included the students that attended the landscape architecture department in Karadeniz Technical University. The survey was conducted with a total of 165 students. Out of the landscape architecture students who participated in the survey, 86 were female, 77 were male. 42 were freshmen, 46 were sophomore, 45 were junior and 32 were senior students.

2.3.The attitudes of students towards design approaches

To determine students' attitudes towards design approaches, scores obtained from the attitude scale were analyzed and the results are presented in Table 2. In Table 1, the statements that reflect positive and negative attitudes for biomorphic design approach are coded with 'B' and parametric design approach are coded with 'P'.

Table 2. *The Attitude Scale Statements*

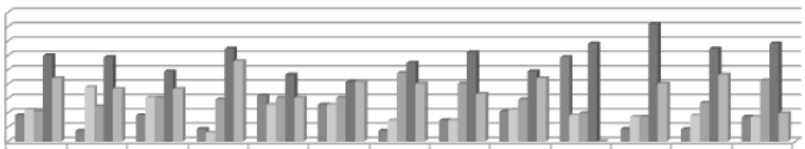
Attitude Statements On Design Approaches

Biomorphic design approach				**Parametric design approach**			
Positive attitude statements		**Negative attitude statements**		**Positive attitude statements**		**Negative attitude statements**	
B1	I consider biomorphic design approach beneficial for project education to reach its goals	**B14**	Biomorphic design approach introduces extra workload in environmental design education	**P1**	I consider parametric design approach beneficial for project education to reach its goals	**P14**	Parametric design approach introduces extra workload in environmental design education
B2	I consider biomorphic design approach improves the achievements in environmental design projects	**B15**	I consider material and tools for biomorphic design approach are more expensive	**P2**	I consider parametric design approach improves the achievements in environmental design projects	**P15**	I consider material and tools for parametric design approach are more expensive
B3	I consider using biomorphic design approach in environmental design facilitates learning	**B16**	Use of biomorphic design approach is a luxury for Turkey	**P3**	I consider using parametric design approach in environmental design facilitates learning	**P16**	Use of parametric design approach is a luxury for Turkey
B4	I consider using biomorphic design approach in environmental design increases student achievement	**B17**	I consider use of biomorphic design approach in environmental design is difficult	**P4**	I consider using parametric design approach in environmental design increases student achievement	**P17**	I consider use of parametric design approach in environmental design is difficult
B5	I consider using biomorphic design approach in environmental design increases the interest in classroom	**B18**	I consider use of biomorphic design approach in environmental design is a waste of time	**P5**	I consider using parametric design approach in environmental design increases the interest in classroom	**P18**	I consider use of parametric design approach in environmental design is a waste of time
B6	I consider using biomorphic design approach in environmental design increases student creativity	**B19**	I consider use of biomorphic design approach in environmental design is inadequate	**P6**	I consider using parametric design approach in environmental design increases student creativity	**P19**	I consider use of parametric design approach in environmental design is inadequate
B7	I consider biomorphic design approach improves the quality in environmental design	**B20**	I consider use of biomorphic design approach in environmental design is difficult	**P7**	I consider parametric design approach improves the quality in environmental design	**P20**	I consider use of parametric design approach in environmental design is difficult
B8	I consider environmental design course would be more productive with biomorphic design approach	**B21**	I do not need to use biomorphic design approach in environmental design	**P8**	I consider environmental design course would be more productive with parametric design approach	**P21**	I do not need to use parametric design approach in environmental design
B9	I consider it a pleasure when environmental design course is instructed with biomorphic design approach	**B22**	I believe that the use of biomorphic design approach is not necessary to achieve the goals of the environmental design project course	**P9**	I consider it a pleasure when environmental design course is instructed with parametric design approach	**P22**	I believe that the use of parametric design approach is not necessary to achieve the goals of the environmental design project course

B10	I consider biomorphic design approach is a source for confidence and courage for the students	**B23**	I consider use of biomorphic design approach in environmental design limits the creativity of students	**P10**	I consider parametric design approach is a source for confidence and courage for the students	**P23**	I consider use of parametric design approach in environmental design limits the creativity of students
B11	I consider biomorphic design approach improves the motivation of the students in environmental design course			**P11**	I consider parametric design approach improves the motivation of the students in environmental design course		
B12	I consider the use of biomorphic design approach requires students with knowledge and skills			**P12**	I consider the use of parametric design approach requires students with knowledge and skills		
B13	I consider biomorphic design approach necessary for a more effective environmental design education			**P13**	I consider parametric design approach necessary for a more effective environmental design education		

To determine the attitudes of the students towards the design approaches, the responses given by the students in the attitude scale were initially examined based on the items and the results were plotted on graphs. In other words, the option in the attitude scale coded with 1 means I strongly disagree, 2 means I disagree, 3 means I do not know, 4 means I agree and 5 means I strongly agree. The same scale was used for positive and negative attitude statements. However, during the interpretation and reliability studies and the determination of the internal consistency coefficient, these were calculated separately.

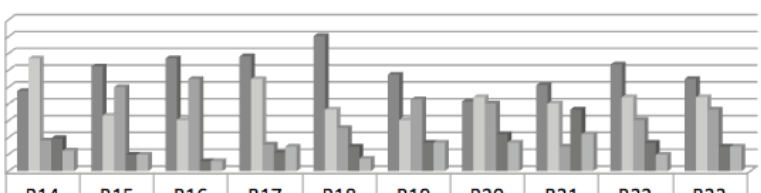
Based on the above mentioned information, the responses of the students for positive and negative attitude statements were as presented in Figures 5 and 6.



	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13
1	9,1	3,7	9,1	4,3	15,9	12,8	3,7	7,3	10,4	29,3	4,3	4,3	8,5
2	11	18,9	15,2	3	12,8	12,8	7,3	7,3	11	9,1	8,5	9,1	8,5
3	10,4	12,2	15,2	14,6	15,2	15,2	23,8	20,1	14,6	9,8	8,5	13,4	21,3
4	29,9	29,3	24,4	32,3	23,2	20,7	27,4	31,1	24,4	34,1	40,9	32,3	34,1
5	22	18,3	18,3	28	15,2	20,7	20,1	16,5	22	0	20,1	23,2	9,8

Figure 5. *The responses of the students for positive attitude statements that aimed to measure the attitudes towards biomorphic design approach (%)*

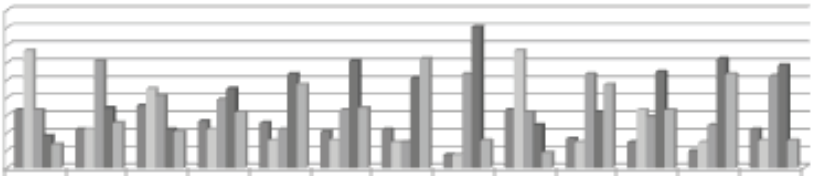
As can be seen in Figure 5, students' responses to positive attitude statements towards the biomorphic design approach were predominantly "agree" and "strongly agree." In Figure 2, in negative attitude statements the students predominantly responded with the options "disagree" and "strongly disagree." Thus, the students had positive attitudes towards biomorphic design approach.



	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23
Series1	23,8	31,1	33,5	34,1	40,2	28,7	20,7	25,6	31,7	27,4
Series2	33,5	16,5	15,2	27,4	18,3	15,2	22	20,1	22	22
Series3	9,1	25	27,4	7,9	12,8	21,3	20,1	7,3	15,2	18,3
Series4	9,8	4,9	3	5,5	7,3	8,5	11	18,3	8,5	7,3
Series5	6,1	4,9	3	7,3	3,7	8,5	8,5	11	4,9	7,3

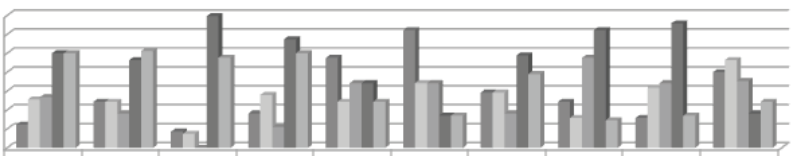
Figure 6. *The responses of the students for negative attitude statements that aimed to measure the attitudes towards biomorphic design approach (%)*

The same scale was used to determine the attitudes of the students towards the parametric design approach. In other words, the option in the attitude scale coded with 1 means I strongly disagree, 2 means I disagree, 3 means I do not know, 4 means I agree and 5 means I strongly agree. Accordingly, students' responses to positive attitude statements were predominantly options 4 and 5 (Figure 7). The responses to negative attitudes were mainly options 1 and 2 (Figure 8). As a result, the attitudes of the students positive towards the parametric design approach as well.



	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
1	16,5	11	17,7	13,3	12,8	10,4	11	3,7	16,5	8,3	7,3	4,9	11
2	33,5	11	22,6	11	7,9	7,9	7,3	3,7	33,5	7,3	16,5	7,3	7,9
3	16,5	30,5	20,7	19,5	11	16,5	7,3	26,8	15,9	26,8	14,6	12,2	26,2
4	9,1	17,1	11	22,6	26,8	30,5	25,6	40,2	12,2	15,9	27,4	31,1	29,3
5	6,7	12,8	10,4	15,9	23,8	17,1	31,1	7,9	4,3	23,8	16,5	26,8	7,9

Figure 7. *The responses of the students for positive attitude statements that aimed to measure the attitudes towards parametric design approach (%)*



	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23
1	6,1	12,2	4,3	9,1	23,8	31,1	14,6	12,2	7,9	20
2	12,8	12,2	3,7	14	12,2	17,1	14,6	7,9	15,9	23,2
3	13,4	9,1	0	5,5	17,1	17,1	9,1	23,8	17,1	17,7
4	25	23,2	34,8	28,7	17,1	8,5	24,4	31,1	32,9	9,1
5	25	25,6	23,8	25	12,2	8,5	19,5	7,3	8,5	12,2

Figure 8. *The responses of the students for negative attitude statements that aimed to measure the attitudes towards parametric design approach (%)*

The variances, the arithmetic mean and standard deviation values were determined and reliability analysis was conducted on the responses given for positive and negative statements about the two design approaches after the analysis of the attitudes of the students towards the design approaches based on the items and the results are presented in Table 3.

Initially validity and reliability tests were conducted on the scale developed to measure the attitudes of the students towards the biomorphic and parametric design approaches in environmental design courses. Out of 23 statements designed for each design approach, 13 statements were positive and 10 statements were negative. As could be observed in Table 1, statements B14, B15, B16, B17, B18, B19, B5, B6, B7, B8, B18, B9, B10, B11, B12, B13 about biomorphic design approach were positive and statements B14, B15, B16, B17, B18, B19, B20, B21, B22 and B23 were negative. Thus, reliability tests were conducted separately for these statements. Consequently, the internal consistency coefficient (Cronbach-Alpha) for the positive expressions in the scale developed to measure the attitudes towards the biomorphic design approach was 0.47 and the internal consistency coefficient for the negative expressions was 0.77. Similarly, the scale developed to measure the attitudes towards parametric design approaches included a total of 23 statements and 13 statements were positive and 10 were negative. As could be observed in Table 1, statements P14, P15, P16, P17, P18, P19, P12, P13, P12, P13, P12, P13, P12 and P13 were positive, statements P14, P15, P16, P17, P18, P19, P20, P21, P21, P22 and P23 were negative in the scale developed to measure the attitudes towards the parametric design approach. Consequently, the internal consistency coefficient (Cronbach-Alfa) for the positive expressions in the scale developed to measure the attitudes towards the parametric design approach was 0,23 and the internal consistency coefficient for the negative expressions was 0,80. Cronbach's alpha reliability test is used when the items are assigned weighed scores or scored with the grading method (Bademci, 2006). Thus, Cronbach's alpha reliability analysis was used in the present study. The general average of positive attitudes towards biomorphic design approach was 3.49 and the general average of negative attitudes was 2.65. Similarly, the general average of positive attitudes towards the parametric design approach was 3,22 and the general average of negative attitudes was 3,21. Based on these results, it could be argued that students' general attitudes towards the use of biomorphic and parametric design approaches in environmental design education were positive. However, when a comparison was conducted between the two, it was concluded that attitudes towards the biomorphic design approach were more positive.

Table 3. *Findings Based On Attitude Scale Responses*

Attitude statements towards design approaches															
Biomorphic design approach								**Parametric design approach**							
Positive attitude statements	**Variance**	**X**	**SD**	**Nagative attitude statements**	**Variance**	**x**	**SD**	**Positive attitude statements**	**Variance**	**x**	**SD**	**Negative attitude statements**	**Variance**	**x**	**SD**
B1	1,72	3,54	1,31	**B14**	1,47	2,28	1,21	**P1**	1,37	2,46	1,17	**P14**	1,61	3,60	1,27
B2	1,43	3,48	1,19	**B15**	1,41	2,22	1,18	**P2**	1,49	3,11	1,22	**P15**	2,07	3,11	1,22
B3	1,71	3,33	1,31	**B16**	1,21	2,11	1,10	**P3**	1,68	2,68	1,29	**P16**	1,11	3,45	1,43
B4	1,13	3,93	1,06	**B17**	1,58	2,08	1,25	**P4**	1,80	3,20	1,34	**P17**	1,87	3,85	1,05
B5	1,95	3,87	1,22	**B18**	1,41	1,97	1,18	**P5**	1,96	3,49	1,40	**P18**	2,07	3,56	1,36
B6	1,96	3,28	1,40	**B19**	1,78	2,42	1,33	**P6**	1,62	3,43	1,27	**P19**	1,82	2,34	1,35
B7	1,17	3,64	1,08	**B20**	1,65	2,57	1,28	**P7**	1,95	3,71	1,39	**P20**	2,09	3,23	1,44
B8	1,37	3,51	1,17	**B21**	2,11	3,77	1,09	**P8**	0,80	3,54	0,89	**P21**	1,40	3,16	1,18
B9	1,81	3,44	1,34	**B22**	1,49	3,74	1,13	**P9**	1,26	2,44	1,12	**P22**	1,35	3,22	1,16
B10	1,79	2,59	1,33	**B23**	1,61	3,34	1,14	**P10**	1,63	3,47	1,28	**P23**	1,84	2,63	1,35
B11	1,18	3,77	1,09					**P11**	1,57	3,35	1,25				
B12	1,29	3,74	1,13					**P12**	1,34	3,82	1,15				
B13	1,30	3,34	1,14					**P13**	1,34	3,18	1,16				
Mean		3,49	1,21	**Mean**		2,65	1,17	**Mean**		3,22	1,22	**Mean**		3,21	1,28
Reliability Analysis (Cronbach-Alfa)		0,47		**Reliability Analysis (Cronbach-Alfa)**		0,77		**Reliability Analysis (Cronbach-Alfa)**		0,23		**Reliability Analysis (Cronbach-Alfa)**		0,80	
×=arithmetic mean				**SD=standard deviation**											

2.4. Scale on Attitudes Towards Design Approaches

2.4.1. Correlation Between Design Approach Preferences of the Students and Their Attitudes Towards Design Approaches

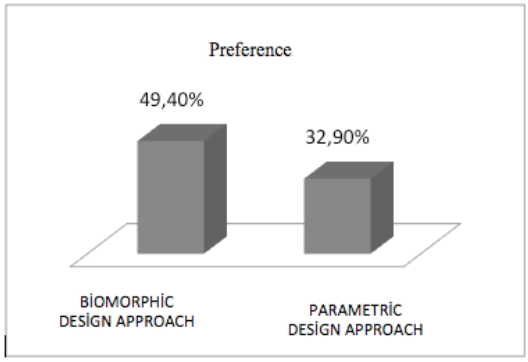


Figure 9. *Design approach preference*

Table 4. *Correlation Between Design Approach Preferences and Their Attitudes Towards Design Approaches*

		Design Approach Preferences	Student Attitudes towards Biomorphic Design Approach
Design Approach Preferences	Pearson Correlation (r)	1,000	-,645
	sig	,04	,04
Student Attitudes towards Biomorphic Design Approach	Pearson Correlation (r)	-,645	1,000
	sig	,04	,04

		Design Approach Preferences	Student Attitudes towards Parametric Design Approach
Design Approach Preferences	Pearson Correlation (r)	1,000	-,225
	sig	,009	,009
Student Attitudes towards Parametric Design Approach	Pearson Correlation (r)	-,225	1,000
	sig	,009	,009

Analysis results demonstrated that there was a negative and low level of correlation between the design approach preferences of the students and their attitude scores towards both design approaches.

RESULTS

In the present study that aimed to determine the attitudes and preferences of landscape architecture students towards biomorphic and parametric design approaches in the environmental project design process, it was found that their attitudes toward biomorphic design approach were more positive and there was a negative correlation between their preferences and attitudes, in other words, as one increased, the other decreased. The percentage of those who preferred the biomorphic design approach was 49.40%, while the proportion of those who preferred the parametric design approach was 32%.

The statement with the highest arithmetic average among the statements of attitude towards the biomorphic design approach was 'I consider the use of the biomorphic design approach in environmental design improves the student achievement. Because, with this approach, the student would find a solution for her or his project using countless examples inspired by the nature. While constructing the environmental design project, producing options in the first stage is quite significant for achieving the project objective. At this stage, biomorphic design approach would assist the students to design an artificial environment by imitation of the nature and interpretation of their perceptions. In students' attitudes towards the parametric design approach, the statement with the highest arithmetic mean was the statement 'I believe that the students using the parametric design approach require knowledge and skills'. Because, in the parametric design approach, landscape architecture students should possess algorithmic thinking skills and dominate computer program development skills and techniques, as stated in the introduction section of the present study. They would succeed in analyzing their projects with this approach if they master computer technologies. Therefore, students responded to this statement by selecting the options "I agree" and "I strongly agree". Among the responses given for the statements "I find biomorphic / parametric design approaches useful to achieve the objectives of the environmental design project education," it was determined that 51.9% of the students found biomorphic design approach useful, 20.1% did not find it useful and 10.4% stated that they did not know. About the parametric design approach, 50% stated that it was not useful, 16.5% stated that they had no idea, and 15.8% found the approach useful. Thus, the students' attitudes towards these two approaches were exactly the opposite. Overall results support this view as well. Because their attitudes towards the biomorphic design approach were more favorable when compared to their attitudes towards parametric design approach. In the assessments conducted for the success in the environmental design project, the percentage of those who think that the biomorphic design approach improved the project success rate was 47.6%, 12.4% said they did not know and 12.6% stated that it did not contribute to the success of the environmental design project. The percentage of those who think that the parametric design approach improved the project success rate was 29,9%, 30,5% stated that they did not know, and 22% stated that it did not contribute to the success. If these statements are compared for both approaches, it could be observed that the parametric design approach was preferred by less since there were less number of students who could use it. Because this approach requires proficiency in computer programs. The percentage of those who considered that the biomorphic design

approach was difficult to use in the environmental design project was 12.8%, 7.9% stated that they dis not know, and 61.5% considered it to be not difficult. Similarly, 53.7% of the students considered the parametric design approach was difficult to use in the environmental design project, 5.5% did not know, and those who think that it was not difficult were 23.1%.

In brief, the results of the present study demonstrated that the attitudes of landscape architecture students towards biomorphic design approach was more favorable when compared to their attitudes towards the parametric design approach. Student preference findings demonstrated that both approaches were preferred in the environmental design project process. However, biomorphic design approach was preferred more. In the process of environmental design project at Karadeniz Technical University, landscape architecture students utilize biomorphic actions increasingly in the conceptual and formal stages of design. Furthermore, this approach is adopted predominantly in freshmen year projects to develop the creative skills of the students. As the proficiency of the students in computer technologies improve during the later years, parametric design approach is preferred in the junior and senior years. Both design approaches result in production of very successful projects in the environmental design course.

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VISUAL LIST

Figure 1. Huge Biomimetic 'Supertrees' Taking Root on Singapore's Waterfront https://www.treehugger.com/urban-design/biomimetic-supertrees-gardens-by-the-bay-singapore.html.

Figure 2. http://yapiharikalari.com/eden_projesi.

Figür 3. Abu Dabi Gösteri Sanatları Merkezi. http://www.gazetebilkent.com/2015/05/01/dunyamizi-guzellestirenler-2-zaha-hadid/

Figure 4. ThyssenKrupp , ThyssenKrupp Genel Merkezi, Zaha Hadid Architects http://www.mimdap.org/?p=128077.

Figure 5. The responses of the students for positive attitude statements that aimed to measure the attitudes towards biomorphic design approach (%).

Figure 6. The responses of the students for negative attitude statements that aimed to measure the attitudes towards biomorphic design approach (%).

Figure 7. The responses of the students for positive attitude statements that aimed to measure the attitudes towards parametric design approach (%).

Figure 8. The responses of the students for negative attitude statements that aimed to measure the attitudes towards parametric design approach (%).

Figure 9. Design approach preference.