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Creating nature awareness in design education

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Abstract

In the current design practice designers mainly focus on nature as the strategy for sustainable product development and solving human problems. Nature provides wealthy of the information sources that could be used to explore new usable information (systems, processes, organizations, functions, structure, form etc.) into design. So, the inspiration from a nature also referred to as bio-inspired and biomimicry design strategies is now becoming a widespread practice in design education.

In this respect, the study searches the awareness of interior design students about ‘nature’, ‘sustainability’ and ‘nature-inspired design approaches’ and place of those approaches in design education. In this study, two questionnaire forms made of open-ended questions have been applied on 100 students as pre-test and post-test before and after the ‘Nature and Design’ seminar. After the evaluation, it has been realized that awarenesses of the students, who don’t have too much information about the subject initially, have improved and their aspects in reflecting the nature knowledge to design and the education process have changed with the seminar focused on ‘how the nature works’ and ‘design approaches’.

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1. Introduction: Nature and design

Energy crisis, shortages of energy, natural resources, water, and food, global warming, climate change, environmental pollution, and exploding population are worldwide problems we still face. According to Blizzard and Klotz, addressing these challenges requires changes in how we design our world. We must consider the interrelatedness of systems. The problems we face are intertwined and effective design solutions will have to

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account for this reality (Blizzard & Klotz, 2012).

Montana-Hoyos and Lemaitre define ‘design’ as the planning and creation of an artificial (human-made) product (understanding by product a service, system, space or object), driven by problem-solving to fulfill human necessities (of utility, comfort, beauty, emotion and communication, among others). Also, they could say that design as a human activity is mainly our conscious action to modify our environment and create the artificial world. Design affects our context at different levels. From micro to macro, we can define a local, regional, national and global context. Within this same logic, design disciplines are closely interrelated but operate at different levels of complexity and scale. In the smaller scale, we classify design disciplines as product design, industrial design and fashion design. On a larger scale we classify interior design and architecture, and on an even larger scale community design and urban planning (Montana-Hoyos & Lemaitre, 2011).

In this context, nature has become a “popular” research topic in all design-related disciplines in means of finding sustainable solutions to problems. Since design is a bridge between nature and man, it is affected by every phase of nature. Reed stressed that we need major changes in our mental models in order to contribute to improving our planet. Reed also indicated that science is rapidly changing in means of understanding nature and hence, by understanding the way the universe works, new sciences can better be reflected in designs; that it is necessary to think in a way similar to living systems; and that in order to fully participate in life systems, the notion of holistic systems and the design process should be integrated (Reed, 2007a, 2007b). Biological organisms, phenomena, and strategies provide insight into sustainable and adaptable design. Because, nature has its own laws and principles to sustain the eco-system. As Benyus asserts, after 3.8 billion years of evolution, natural systems have adapted to be resourceful, innovative and sustainable by identifying what works, what is suitable and what sustains for a survival of an ecosystem. According to Benyus, ten principles can be identified as underlying nature’s rules for sustaining ecosystems: Use waste as a resource, diversify and cooperate to fully use the habitat, gather and use energy efficiently, optimize rather than maximize, use material sparingly, don’t foul nests, don’t draw down resources, remain in balance with the biosphere, run on information, shop locally (Benyus, 1997). These winning strategies have been adopted by all organisms; hence they have been employed by both animals and plants having diverse organs and parts that harmoniously function together as a whole to sustain life and its activities (Thompson, 1999).

If our products, interior spaces, buildings and cities have designed in accordance with these principles, as Benyus suggests, we would be well on the way to living within the ecological limits of nature, and thus achieving our goal of sustainability. According to Galha Bártolo and Bártolo, design by nature can be achieved by bringing together the science of design with the creativity of nature. The strategies of living systems can provide a conceptual framework for the link between natural and human design, as humans and environment must evolve together towards a design symbiosis. In this context, nature/bio-inspired design strategies/approaches such as biomimicry, biomimetic, bionic and biognosis also industrial ecology, construction ecology, regenerative design, biophilic design, eco-mimicry focus on learning from nature for sustainability and creativity (Galha Bártolo & Bártolo, 2002). However, as Gamage and Dayarathne state, these strategies take different pathways to achieve this goal they have the same concerns but different priorities, weightings, and principles (Gamage & Dayarathne, 2012). According to Montana-Hoyos, biomimicry distincts from other nature-inspired design approaches in respect to understand the nature as model, measure and mentor. Biomimicry proposes the study of nature from a systems point of view, in which all elements are interdependent. By understanding nature as measure, it respects the limits of nature and thus respects the principles of sustaining life in our planet (Montana-Hoyos, 2009). Biomimicry as a design approach typically falls into two main categories: direct and indirect approaches. In the direct approach, a design directly mimics strategies of an organism, a behavioural pattern or a system in nature with aid of an analogical translation system, whereas in the indirect approach, the design uses abstract ideas and concepts as principles from those apparent in the domain of nature (Gamage & Hyde, 2012). Carl Hastrich suggested that a design process (design spiral) employing bio-mimicry includes six steps: identify, translate, observe, abstract, apply, and evaluate (Carl Hastrich, 2012).

2. Nature awareness in design education

Today, a paradigm change is needed for reaching an accurate understanding of sustainability and for finding solutions to problems. Design education is a milestone in this change. The education of all students who study design disciplines is of paramount importance since they are the people who will perform future applications and

who will establish the theoretical structure. In order to achieve this, a radical transition from the education approach which accelerates environmental deterioration and which cannot manage limited energy and resource use into a sustainable education approach which is in mutual relationships with nature's regenerative systems and which results in accurate resource transformation (M. Yeler, 2012). In order to educate designers for ecologically and socially responsible practice, design schools are need to be radically redesigned in their structure, content, and methods (DeKay, 1996).

A student can gain awareness of nature and transform formations in nature and biological expressions into design knowledge if education programs are revised in a way that enables the student to comprehend how these events occur in nature. It is assumed that in design courses, which constitute a gradual process, learning knowledge of nature by exploration, analyzing this knowledge, making accurate determinations, and transforming knowledge of nature into design knowledge by making connections will increase the creativity of design students. In this context, including nature-inspired design approaches in education programs of all design disciplines is prioritized in means of creating a sustainable world.

Consideration of the overall, although design teaching has occasionally looked at nature for inspiration, systematic approaches to teaching design fundamentals through nature have been rare. Some schools around the world identified teaching methods and their obstacles while exploring the potentials of employing biomimicry in design. Labs, exhibitions and workshops have also been conducted to teach and research how to emulate nature for design. Manufacturers are actively testing bio-inspired products, ideas are being discussed at international conferences. Also, educating for biomimicry however has begun only recently although numerous programs exist. For example, the Biomimicry Guild have forged a partnership to integrate organic solutions inspired by nature into sustainable design and building practices. Ask Nature[®] offers online data for biological strategies and ideas to inspire biomimetic design. Biomimicry Institute offers many educational programmes, workshops and courses for professionals related to all fields of design and engineering. The Biomimicry Portal, a prototype data-base was originally created in collaboration with the Rocky Mountain Institute, and is a precursor to Ask Nature. HOK, one of the largest architecture firms in the world, recently formed an alliance with the Biomimicry Guild to begin applying biomimetic concepts to the design and development of building projects around the globe (Biomimicry Institute Website, 2014; Gamage & Dayarathne, 2012; Goss, 2009).

In an medium where awareness and efforts regarding learning from nature in design education has increased throughout the world, this study aims to measure students' level of nature awareness and to understand how they benefit from nature in design education among students who studied interior design, associate's degree (2 year program) at Kirklareli University, Vocational School of Technical Sciences during December, 2013 in Turkey.

3. Materials and methods

This study is a questionnaire study which relies on the pretest-posttest model and recruited a total of 108 first and second year students who studied in the department of interior design. The pretest-posttest model, which was chosen for collecting data on students' level of awareness, was applied before and after the seminar on "Nature and Design". In order to avoid biasing the students, prior to administration of the pretest, the students were asked to answer questions without receiving any additional explanations other than the topic of the seminar.

The seminar on "Nature and Design" was prepared as a power point presentation and took 45 minutes. The seminar was provided separately for first and second year students. In order to determine how well the students can integrate nature and related concepts in design education, the seminar was prepared to be very comprehensive. During the seminar, concepts such as nature, ecosystem, and sustainability were explained first, the relationship between nature and design was addressed, and nature-inspired design approaches were presented. In the seminar, the topic of how negative environmental problems can be minimized via a design approach and design processes that take nature as its basis was emphasized. The characteristics of nature and organisms and how these characteristics are presented in design were explained in terms of biomimicry and nature/bio-inspired design concepts using visual material. In this way, in the seminar, it was aimed to help the comprehension of how laws of nature and design can be integrated for a sustainable life. It was aimed to analyze students' level of increase in nature awareness and to determine to what extent these topics should be included in design education via the posttest that was applied after

the seminar. At the end of the seminar, students' questions were answered and a discussion was carried out.

In the questionnaire, the students were first required to indicate their year of study. The year of study was prioritized in assessment because it was thought to determine students' approach to the topic and their awareness.

Table 1: Years of study of students

Years of study	N	%
First year students	47	47
Second year students	53	53
Total	100	100

It was assumed that gender was not determinant of the topic and therefore was not taken into account in assessments. The first 4 questions of the pretest and posttest aimed to investigate students' opinions and to measure their level of awareness regarding nature, design, and education. In both tests, the students were required to respond to the questions as "yes", "partially", and "no". The remaining 3 questions in both tests were open-ended questions that aimed to investigate students' opinions, knowledge, and requests.

Out of 108 questionnaires, 8 were excluded from evaluation due to missing posttest responses and 100 questionnaires were evaluated. In analyzing data obtained from questionnaires, percentage distribution, which is a simple statistical method, was used.

4. Findings

Students' responses to the pretest and their interpretation are provided below.

Table 2. Questions measuring the nature awareness of students before the seminar

Questions	First year students						Second year students					
	Yes		Partially		No		Yes		Partially		No	
	N	%	N	%	N	%	N	%	N	%	N	%
Q1: Does your lessons contain principles of nature and concepts (ecology, sustainability, etc.) related to nature?	30	30	0	0	17	17	26	26	4	4	23	23
Q2: Can be nature use as a source of information in the design?	46	46	1	1	0	0	52	52	1	1	0	0
Q3: Can a design based on the nature, reduce the negative environmental impacts in the world?	39	39	3	3	5	5	36	36	14	14	3	3
Q4: Have you heard about the terms biomimicry or bio-inspired design before?	4	4	0	0	43	43	5	5	0	0	48	48

Among 100 first and second year students, 56% reported that the concepts of ecology and sustainability were included in the courses, whereas 40% reported that these concepts were not included. The high number of "no" responses indicate that these concepts were included in courses in a shallow way and that these concepts were explained without relating them to the principles of nature. Therefore, it is understood that students could not internalize these concepts at a sufficient level. Nevertheless, 98% of the students stated that nature can be used as a source of knowledge in design. Students reported that they carried out pattern work particularly in design courses. Latter interviews conducted with students revealed that in pattern work, the students worked on topics of shapes, textures, and colors in nature within the framework of an approach that focus on appearance. Regarding the responses to the topic of reducing environmental problems via a design approach based on nature, 75% of the students said "yes", 17% said "partially", and 8% said "no". Therefore, it was presumed that the students have positive thoughts on being able to find solutions for design problems. 91% of the students reported that they never heard of the concepts of biomimicry and bio-inspired design, whereas 9% stressed that they heard of the concept of biological inspired design more than the concept of biomimicry.

Table 3. The sources from which the student heard about nature-inspired designs

Q5: If yes, which sources have you heard from about the terms biomimicry and bio-inspired design before?	
First year students	Book, journal, internet, television, friends
Second year students	Book, journal, internet, television

4 first year and 5 second year students (9% total) who reported to have heard of the concept of biomimicry and bio-inspired design stated that they heard these concepts mostly from resources in the following order: books, journal, internet, television, and friends. Students’ responses show that these concepts were not introduced in courses.

Table 4. The statements of students on the meanings of nature inspired design concepts

Q6: Would you explain what biomimicry or bio-inspired design means to you?	
First year students	Designs inspired from biology Designs including issues of biology Designs demonstrating the compliance of living things in nature
Second year students	Designs about living things and nature Designs utilized from nature and living things Designs inspired from structure of living things Designs inspired from biology Biological, physical (human body) designs

3 first year and 10 second year students answered the question which was prepared for understanding how students make sense of the biomimicry and bio-inspired design concepts. When the responses were evaluated, it was observed that the students used very general statements and that they made brief definitions by connecting the concepts. Some students related the concepts to the human body.

Table 5. Examples given by students to nature-inspired designs

Q7: Would you give an example for biomimicry or bio-inspired design or an implementation?	
First year students	Fridge from honeycomb
Second year students	Butterfly shaped furniture Private bathroom and kitchen supplies produced for disabled people

Only a total of 3 students (1 first year and 2 second year students) who heard of and defined these concepts could provide examples of designs produced with these concepts. Examples of fridge from honeycomb and butterfly shaped furniture indicate that the students perceive these concepts in a formal format. One student related his/her example to the human body.

Students’ responses to the posttest and their interpretation are provided below.

Table 6. Questions measuring the nature awareness of students after the seminar

Questions	First year students						Second year students					
	Yes		Partially		No		Yes		Partially		No	
	N	%	N	%	N	%	N	%	N	%	N	%
Q1: Did the presentation help you understand nature related concepts and the principles of nature?	45	45	2	2	0	0	48	48	4	4	1	1
Q2: Do you think information learned from nature can produce solutions to the aforementioned problems?	40	40	5	5	2	2	39	39	12	12	2	2
Q3: Is training on biomimicry or bio-inspired design given in your school?	9	9	3	3	35	35	9	9	6	6	38	38
Q4: Is there a need for information about nature in design and other courses?	46	46	0	0	1	1	50	50	2	2	1	1

Following the seminar which was provided before the pretest, which predominantly attempted to explain the principles of nature, and which related these principles to design, the rate of students who understood nature related concepts reached 93%. Students who used to be familiar with the concepts of nature, ecology, and sustainability in a shallow way gained significant awareness on the content of these concepts. Regarding the topic of producing solutions to structure caused environmental problems mentioned in the presentation by using knowledge obtained from nature, 79% of the students responded “yes”, 17% responded “partially”, and 4% responded “no”. When evaluated with the pretest, it was observed that nature awareness in means of producing solutions for environmental problems slightly increased. Among the students, 18% reported that education on biomimicry and bio-inspired design approaches was provided at school, 9% reported that it was partially provided, and 73% reported that it was not provided at all. In the pretest, 91% of the students reported that they never heard of these design concepts (particularly in courses), however; in the posttest 27% stated that such education was provided, leading to a contradiction. It was thought that the students answered this question as yes or partially because they approached the topic in means of nature and sustainability instead of concepts and they considered the pattern work they did during design courses. 96% of the students reported that nature and related knowledge and design approaches are necessary in design courses and other courses. Therefore, the information and numerous examples provided in the presentation are thought to affect these results.

Table 7. Semesters on which students want nature related subjects to be in the context of their education

Q5: On which semester of your training do you think a course that includes nature related subjects should be placed?	First year students		Second year students	
	N	%	N	%
I. Semester	33	33	41	41
II. Semester	8	8	6	6
III. Semester	4	4	5	5
IV. Semester	2	2	1	1
Total	47	47	53	53

74% of the students reported that it would be more beneficial for nature related topics to be included in the first semester of education. This finding indicates that the students had increased awareness on the fact that they can use the basic nature knowledge obtained during the first semester of their education in latter courses and design courses.

Table 8. The thoughts of the students on how nature related subjects could be integrated in their educational programs

Q6: How can design methods and the knowledge of nature be integrated to your training program?	First year students		Second year students	
	N	%	N	%
As a separate course	1	1	5	5
As a elective course	14	14	16	16
Integrating with design and the other courses	26	26	27	27
As a seminar	6	6	5	5
Total	47	47	53	53

Regarding the topic of including knowledge of nature and design methods in education programs, 53% of the students wanted these topics to be included by integrating them with design courses and other courses, 30% wanted these topics to be included as elective courses, 11% wanted these topics to be explained via seminars, and 6% wanted these topics to be included as a separate course. Considering the weight of design courses in education programs, it is very important for students to transform knowledge of nature, which is acquired through different courses, into design knowledge using different methods. Therefore, the students' requests regarding the integration of nature knowledge with all courses indicate that their awareness levels will increase during their education. It will be possible to gain more detailed knowledge by including elective courses and seminars in education programs.

Table 9. The thoughts of students on the place and effect of nature in their design courses and future lives

Q7: What do you think about the effects of nature in design lessons and in your life in future?	First year students		Second year students	
	N	%	N	%
I will use it at my designs deliberately	30	30	37	37
There will be a very positive contribution	8	8	5	5
I have no idea	9	9	11	11
Total	47	47	53	53

After the presentation 67% of the students stated that they would use their knowledge of nature in their design courses and their future life. While 13% of the students stated that the presentation had generally positive contributions, 20% stated that they had no opinion on the subject. These results are important in that they show that awareness on how nature can be used in design has formed in the students.

5. Conclusion and suggestions

When the questionnaire was evaluated, it was found that first and second year interior design students who took the questionnaires gave similar answers with no significant difference between years of study. It was found that students evaluated nature and related concepts superficially before the presentation, didn't have much knowledge on the subject, and didn't use those strategies in their design courses. After the presentation, their awareness was seen to increase greatly through the information they received on how they should look at nature, how they can see the solutions of nature, and how they could use those in their designs. The fact that the students hadn't heard much about nature-inspired design approaches such as biomimicry show that although spreading widely throughout the world, these concepts have not been heard, used in designs, or included in educational programs sufficiently in Turkey yet.

While a swift change and transformation process is being experienced worldwide, interior design and other related disciplines should clearly be constantly updated with a reformative approach, starting with educational levels, in order to adapt to the ever changing conditions. However, the important point to stress here is that the predominantly observed trend in the applications of all the design disciplines in this change and transformation process is keeping nature at the forefront. It is clear that the laws of nature will be understood eventually through the observation of events and processes, and that these laws of nature, when applied to design disciplines with this approach, will have the capacity change the life of humanity for the better and make it easier. However, it is natural for design students who have just started training to struggle at grasping the concept of a living system. For this reason, as an introductory course, the use of nature's richly formed patterns as a source of reference for design research can be implemented. The students can be taught to grasp the principles and elements of design more extensively and build correlations by interpreting these patterns through the methods of observation, analysis, sketching, and modeling. Approaching nature from this perspective in the introductory stages of design may enable a more fluid grasp of design, create the awareness and desire to observe and research the beauty of nature in its various dimensions, and improve creativity. Additionally, this approach may help students synthesize the knowledge of nature better in their later courses, grasp living systems and formation processes better instead of just producing forms, and thus gain the awareness, sensitivity, and consciousness necessary to produce more sustainable designs.

In this context, starting with the assumption that using information internalized in training correctly in professional life would create a correct sustainability approach, the structure, context, and methods of design training programs should be reevaluated in a multidimensional manner. Through the implementation of interdisciplinary studies in our educational system, it is thought that more solution oriented, creative, and novel design ideas may be produced from nature based knowledge. An educational approach that associates nature-inspired design approaches with human needs, social, economical, and environmental data in a holistic approach is very important to provide future designers with basic information on sustainability.

References

- Bártolo, H. M. G. & Bártolo, P. J. S. (2002). Borrowing from nature to support architectural design. In: Greenwood, D (Ed.), 18th Annual ARCOM Conference, 2-4 September 2002, University of Northumbria. Association of Researchers in Construction Management, 1, 155-64.
- Benyus, J. M. (1997). *Biomimicry innovation inspired by nature*. Harper Perennial, New York.
- Biomimicry Institute Website (2014). <http://www.biomimicryinstitute.org/resources/biomimicry-design-portal.html> (Access: 07.01.2014).
- Blizzard, J. L., & Klotz, L. E. (2012). A framework for sustainable whole systems design. *Design Studies*, 33:5, 456–479.
- DeKay, M. (1996). "Systems thinking as the basis for an ecological design education," in Campbell-Howe, R. and B. Wilkins, eds., Proceedings of the 21st National Passive Solar Conference, American Solar Energy Society, Asheville, NC, Boulder: ASES.
- Gamage, A., & Dayarathne, R. (2012). Learning from nature: Towards a research-based biomimicry approach to ecologically sustainable design (esd), STB Conference, Sustainability Through Biomimicry: Discovering a world of solutions inspired by nature. Dammam University, College of Design, Saudi Arabia.
- Gamage, A. & Hyde, R. (2012). A model based on biomimicry to enhance ecologically sustainable design, *Architectural Science Review*, 55:3, 224-235.
- Goss, J. (2009), *Biomimicry: Looking the nature for design solutions*, Master thesis, Corcoran College of Art+Design, Washington, USA.
- Hastrich, C. (2011). Using biomimicry to rethink the "wall" – design project. <https://bouncingideas.wordpress.com/tag/biomimicry-design-process> (Access:15.02.2014).
- Minsolmaz Yeler (2012). Biomorphism in architecture, *Doctoral thesis*, Trakya University, Edirne.
- Montana-Hoyos, C. A. (Bio-ID4S): Biomimicry in industrial design for sustainability, An integrated teaching-and-learning method, *Summary of doctoral thesis*, Graduate School of Design Research, Kobe Design University, <http://bioinspired.sinet.ca/files/bioinspired/papers/BIO-ID4S-summary%20paper.pdf> (Access:15.05.2014)
- Montana-Hoyos, C., & Lemaitre, F. (2011). Systems thinking, disciplinary and critical thinking in relation to creativity within contemporary arts and design education. *SLEID Journal, Studies in Learning, Evaluation, Innovation and Development*, 8 (2), 12-25.
- Reed, B., 2007a. A living systems approach to design, Regeneration and integrative design collaborative. http://www.integrativedesign.net/images/living_systems_design.pdf (Access:01.01.2014).
- Reed, B., 2007b. Shifting from "sustainability" to regeneration. *Building Research & Information*, 35:6, 674-680.
- Thompson, B.S. (1999). Environmentally-sensitive design: Leonardo was right!, *Materials and Design*, 20 (1), 23-30.