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Sustainable Architectural Design Education: A Pilot Study in a 3rd Year Studio

Kamal Eldin Mohamed[1], Soofia Tahira Elias Özkan[2]

[1]*Department of Architecture, Izmir Institute of Technology*

[2]*Department of Architecture, Middle East Technical University*

Abstract

A design studio is the heart and soul of the architectural education curricula where students learn to make repetitive design decisions that result in design strategies for resource use in order to create an environmental system that reacts to the human needs and requirements or solves existing problems. Integrating sustainability principles into the undergraduate design studio is an urgent need in order to teach young architects sustainable design principles that can stop the continued environmental degradation of the planet. This study proposed a new design studio pedagogy for integrating sustainability principles with a method to test the new pedagogy and the students' final products. This paper presents the tests results of the pilot study and provides recommendations for the experimental design studio of the following semesters.

Keywords

Architectural education; Design studio pedagogy; Sustainability

1. Introduction

Architectural education intends to teach students a combination of design skills and professional knowledge. The architecture profession is an interdisciplinary science model that involves engineering, arts, environmental science, computer science, sociology, geography, culture, information technology, political science, and law disciplines. Architectural curriculum education has a unique set up which is distinct from other university education disciplines. It has special privilege of a core subject, which is the design.

The philosophy of architectural education defines architecture as a conceptual problem-solving discipline; its goal produces conceptual thinkers who are well versed in the skills, science, theory, and history of their field. The success of the education program depends on the quality of the faculty members and students connected with their commitment and passion (Cornell, 2015). Design is a strategic tactic or a roadmap of someone to accomplish a unique expectation (Bakarman, 2003). Design studio is a special and major element in the architectural education not only as course materials but also as a place where the students practice design. Successful architecture studio courses are those that integrate the practice of design activity with all other coursework and educational experiences (Kurt, 2012). Contemporary design pedagogy contains design methods, the impact of technology, preparing students for globalization, future directions, knowledge economies, sociology, and thought processes (Hall & Barker, 2010).

If the architectural design professions are to remain pertinent, architectural design education must completely

integrate sustainability into curriculum's pedagogy to tackle the current and emerging issues facing our society in order to ensure an education that embrace responsible design solutions (Walker & Seymour, 2008). The complex area of building sustainability has been included in the architectural education curriculum in many architectural schools in order to prepare the architecture students for sustainable design practice. On the other hand, there has not been clear consensus on teaching methods nor on curriculum design (Dib & Adamo-Villani, 2014).

Some of the teaching methods in architectural education can be cited as follows:

-The three principles of Ecole education: freedom, competition, and variety (Carlhian, 1979).

- The Bauhaus prime education objectives depended on integrating theory and application. Constructivist design studio concepts (Kurt, 2012).

-Integrated public interest design studio concept (Anderson, 2012).

- Charrette design studio technique (Pernice, 2013).

- Embracing deep learning approach for principles and practices of sustainability (Sarhan & Rutherford, 2014).

- Learning pyramid principles that supported deep leaning not service learning. Therefore, the questions were started with; explain, compare, and construct not describe (Wood, 2004).

Over the last two decades, the integration of sustainability in the architectural education has been an active debate. The major consent is that the reform to address the notion of sustainability is unavoidable and every school would be expected to bring a relevant contribution and progress in achieving this goal. On the other hand, the adaptation of content and ideas of sustainability will vary according to each architectural school due to circumstantial forces setting up its direction, pedagogical approaches, diversification of its philosophy, and the flexibility and ability of innovation adaptation (Ibrahim, 2008).

It is essential to consider major restructure of both the traditional studio culture and modules for integrating sustainability issues. Teachers and students should force the commitment to new studio culture and give it the priorities. Existing teaching methods, approaches, and techniques which focus on lectures and assignments providing students with theoretical knowledge is not applicable for integrating sustainability in design studio (Nikolic, Messner, Lee, & Anumba, 2010; Sarhan & Rutherford, 2014). Sustainability education is an emanate imperative that requires a paradigm shift in academic and professional training. On the other hand, issues that impede this concern can be listed as follows:

-Outdated pedagogy that focuses mainly on the form and aesthetics.

-Education program has two parallel axes technical-theoretical and design.

-Knowledge concerning environment, technology, and materials is lacking.

-Most schools use digital technology as a computer aided drafting (CAD) tool. While digital technology should be fully integrated into the whole design process.

-An ambiguous definition of sustainable architectural education exists.

The pilot study was conducted with the belief that integrating sustainability principles in the design studio would result in producing a sustainable design solution for the student's architecture project. The aim of the experimental design studio was to integrate sustainability principles into design studio project as a one of main project design concept. While the objective of the pilot study was to:

-Create an integration method

-Test the Method.

-Test the method's impact on the students' learning ability and the finished product.

2. Methodology

The study took place at the Architecture Department in Izmir Institute of Technology, in Turkey. The research was conducted in the third year design studio (AR 301 Architectural Design IV) in the spring term in 2015, with 22 students. Two instructors conducted the design studio as a team supervising all students with the help of one teaching assistant. The class had twelve working hours per week in the studio.

The proposed design studio class focused on practicing rather than just acquiring theoretical information, which would help in integrating sustainability in the design project. The fourteen weeks of in the semester were divided into time modules system that allowed students to focus on the design process and not only on the final design/product. The design process was divided into four periods; four weeks for conceptual idea, four weeks for project development, four weeks for materials and testing, and two weeks for finishing and presentation. Each period ended with an open jury. The teaching methods mentioned above were incorporated into the design studio in the following manner:

-One case study was presented by each student (24 case studies) – learning by teaching others.

- Students were required to write the project program individually then in a small group of three then in a group of eight – practice by doing and group discussion.

- Students were required to construct study models during the project design development process (4 models) – practice by doing

- Weekly panel reviews were conducted (6 panel reviews) in two formats: – deep learning (compare, contrast, and explain):

a. Group discussion of the design process and project development were conducted – group discussion.

b. Students criticized each other's project by asking each student to present his/her project to the group – learning by demonstration.

- Technical trips to:

a. The project site and surrounding area – practice by doing.

b. Existing exemplary projects – learning by demonstration

-Instructors conducted charrette design assignments during the design process (4 assignments) – practice by doing.

- Various digital technologies were used throughout the design process – practice by doing.

a. Conceptual design period; climate consultant and Sketchup.

b. Design development period; Revit, Auto CAD, and Sketchup.

c. Design evaluation period; Rivet, DesignBuilder, and Sketchup.

d. Final drawing and presentation; Rivet, Auto CAD, 3D Max, DesignBuilder, and Sketchup.

-Project owner(s)/user(s) were invited to discuss the project (2 visits) – pubic interest/immediate use practice.

- Outside expert(s) were invited for workshop (4 workshops) – learning by demonstration.

a . Instructors assigned homework related assignment ahead of each workshop studio – practice by doing.

-Instructors conducted individual desk critics (10 desk critics) – learning by demonstration.

- Class instructors offered lectures about the project topics that included visuals and audios materials (6 Lectures)

- Learning by visual, audio, and lecture.

- Juries

a. Instructors conducted midterm juries (3 midterm juries) – learning by demonstration.

b. Instructors hosted a final jury – learning by teaching others

3. Experimental Design Studio Model

All steps of the research method that were explained earlier were included in the class syllabus, studio calendar, project program, grading system, and jury's evaluations. The environmental issues aspect of the sustainability principles was the only concern for the first pilot semester. The other two, i.e. social and economic aspects of sustainability were not considered. The entire evaluation of the students' work was divided into two parts. First part was design process evaluation, embracing the sustainability integration (40% of total grade). Second was finished project evaluation (60% of total grade); of which is 60% was dedicated purely to the design aspect and 40% for the degree of integration of the sustainability principles in the project. Figures 1 - 4, illustrate four different students' projects.

4. Evaluating the Results

This section presents the results of two types of evaluations carried out with regard to the pilot studio for sustainable architectural design class. The first is an evaluation by the design studio instructors of the students' work, based on the design process they followed and the final product; i.e. their design project; as well as the degree to which the sustainability principles were integrated into their final design. The second evaluation was done by the students themselves for the way the studio was conducted and what their own journey was like.

4.1. Evaluation by the Instructors

The Environmental sustainability principles checklist evaluation (Karslı, 2013) were presented to the students during the design process. Instructors explained all elements in the checklist to the students, showed them how to integrate each element in the design project throughout the design process. At the end of the semester, each project was evaluated against the sustainability checklist as a measurement tool of project success (40% of the final project evaluation grades). Figure 9 illustrates the checklist elements, and Figure 9 illustrates the correlation between the number of sustainable elements each student used in his/her project and the final studio grade.

The trend between design process grades representing the new studio pedagogy structure and final project grade of the students show a positive result as shown in Figure 9. Naturally, the same positive trend result between design process grades and final studio grades.

Figure 1. The designed Architecture department project incorporate the use of; natural light, natural ventilation, sustainable materials (totally constructed out of wood), double skin façade,shading elements, green elements, collecting rain water, reuse of grey water, and solar panels. The proposed design had %56 reduction in annual energy consumption.

Figure 2. The designed Architecture school incorporate the use of; long ramps floors to convert kinetic energy to electricity, natural light, shading elements, natural ventilation, solar panels, green roof, rain water collection.

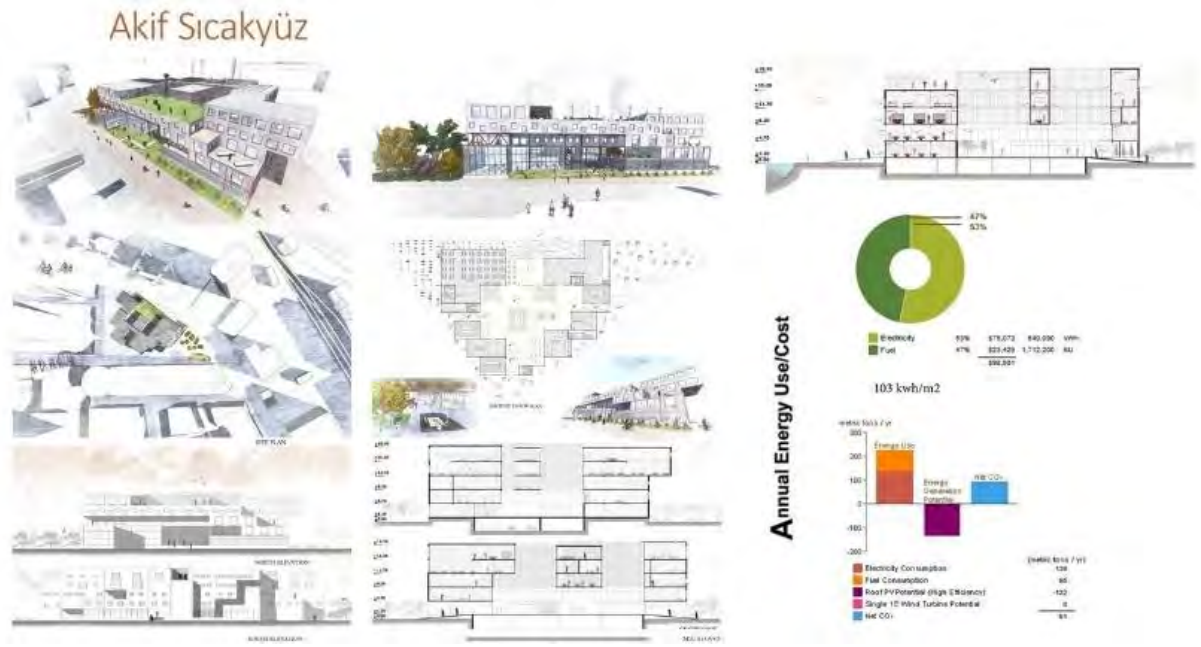

Figure 3. The designed Architecture department project in corporate the use of; natural light, green roof, natural ventilation, shading elements, collecting rain water, and solar panels.

Figure 4. The designed Architecture department project incorporate the use of; natural light, natural ventilation with wind catchers, sustainable materials (constructed out of wood and steel), double skin façade, shading elements, green roofs, collecting rain water, reuse of grey water, and solar panels. The proposed design had %32 reduction in annual energy consumption

NO	Name	Energy									Materials			Water			Health				Total Elements 19	Energy simulation tests
		Reducing the energy used for lighting		Reducing the energy used for ventilation		Reducing energy used for heating and cooling			Use of renewable energy sources													
		80% of spaces benefits from natural light	sky-gardens, skylights, atriums, light shelves	adjustable windows, air-hole	Natural ventilation by channels (wind catcher)	reduce heating loads (high insulation glass system (low-glass), double-wall application, double skin facades)	reduce cooling loads (sunshades, movable blinds between glass layers, etc.)	Passive recovery to reduce heating and cooling loads (thermal mass, etc.)	Low emission but non-renewable energy sources	Renewable energy sources like sun, and wind	Flexible design of interior space and interior furniture	Use of eco-friendly material and equipment	Reducing waste	Recollection and reuse of water: grey water and rain water	The use of rain water in interior and exterior space to reduce the cooling load during summer	The use of water in landscape to enhance the natural light in the building	Natural light and fresh air for working area	Indoor glare effect control by using façade 's solar shading	Eco friendly transportation to the site (bicycles, electric cars, etc.)	Selection of non-harmful materials		

Figure 5. Sustainable principles checklist

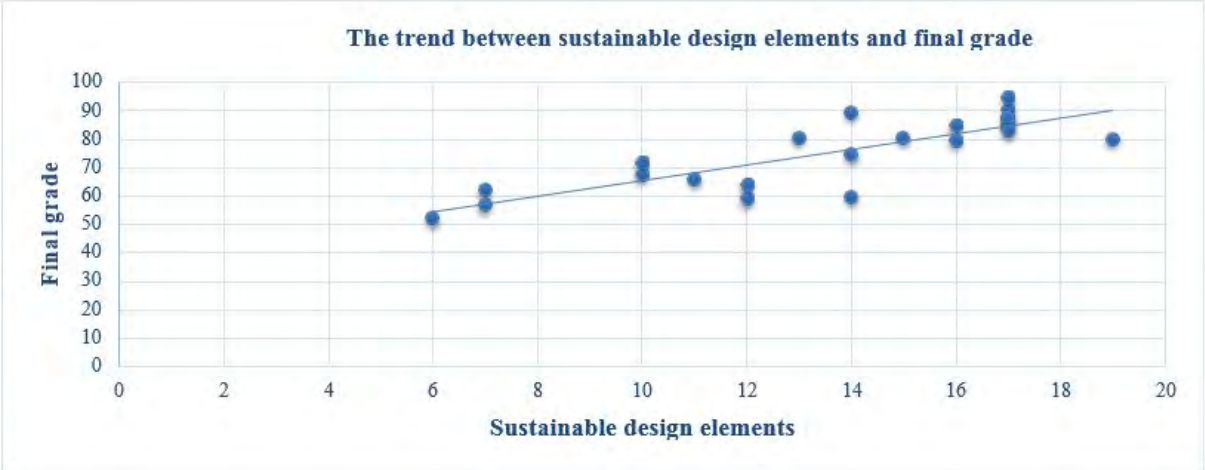

Figure 6. The correlation between the number of sustainable elements each student used in his/her project and the final studio grade

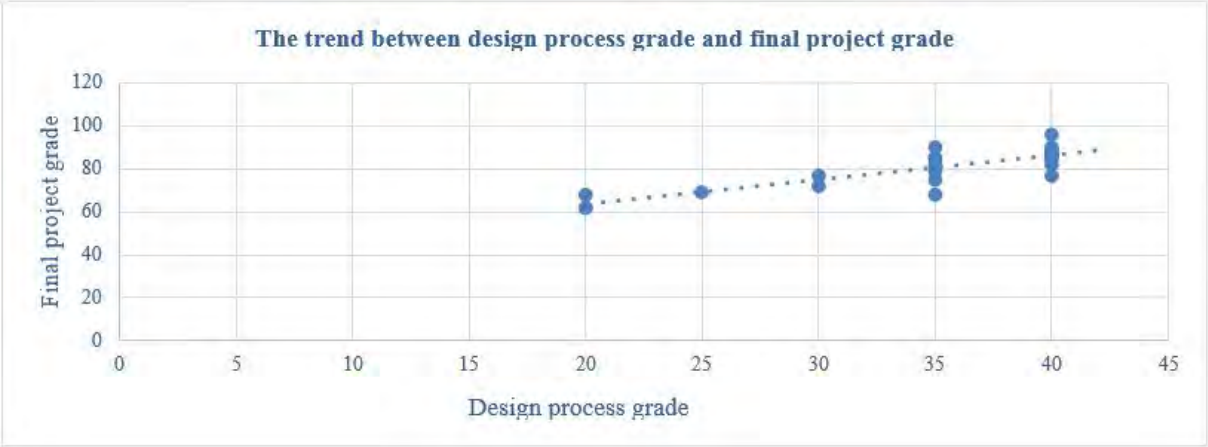

Figure 7. Positive trend result between design process grades and final studio grades

4.2. Evaluation by the students

One week after the final jury, the grades (95% of the class grade) were announced. Instructors invited the students for an open colloquium. At the beginning of the colloquium, students were handed out a questionnaire form that had various questions about the studio structure and format, sustainability issues, jury style and format, and their own comments about the studio from all aspects. Before attending the studio, 80% of the students had no knowledge about sustainable design. 95% of the students confirmed practice sustainable design in their professional life and will chose it as their graduate education study subject.

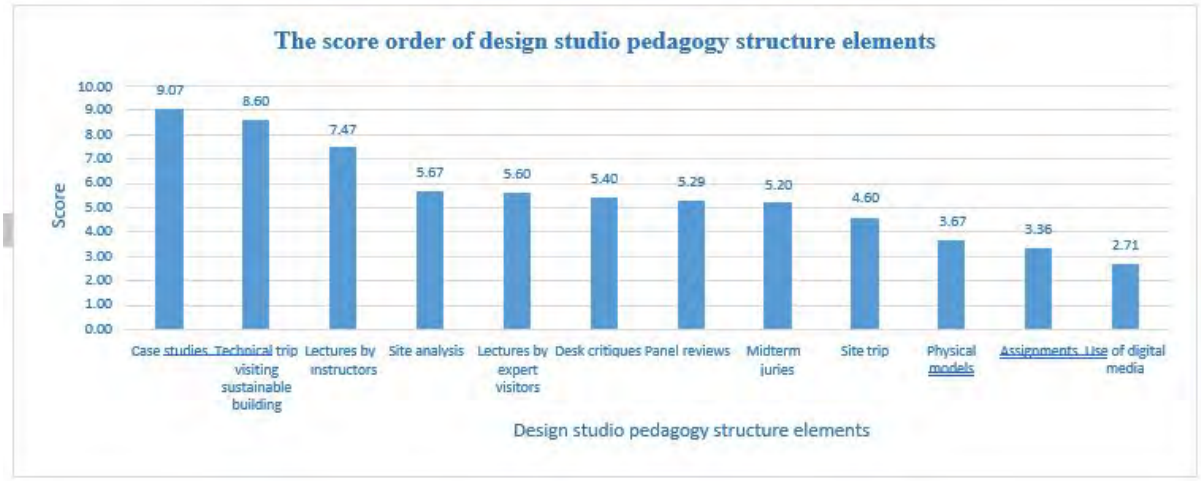

Figure 8. The case studies scored the highest points among the studio tasks

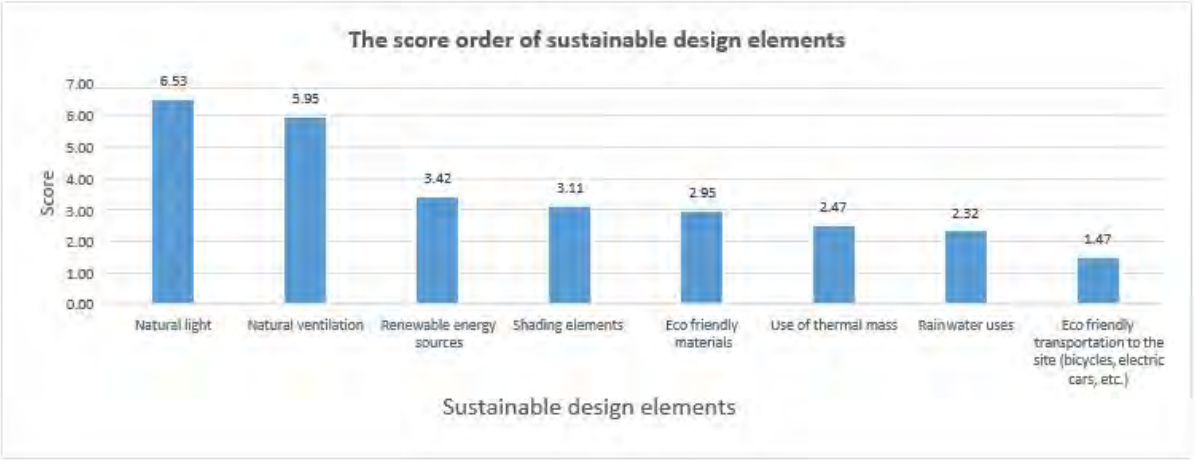

Figure 9. The natural light scored the highest points among the sustainable design elements

Generally, students stated that the difficulties of the sustainable design studio were due to the fact that they had to learn many issues before coming up with a creative sustainable design solution. However, as can be expected, students who had taken a sustainable design elective class faced less difficulties. Additionally, they pointed out that energy simulations consumed a lot of time to learn and apply.

-General personal students' comments regarding the class were:

-Appreciation of attending the sustainable studio and joy of learning the subject.

-Request for the continuation of the studio in their fourth year.

-Class is hard but we learn a lot.

- Technical trip schedule time during the semester and case studies finishing time need to be rearranged.

- Appreciation of class instructors' knowledge of the topics and their care.

5. Conclusions and Recommendations

The use of three different energy simulation programs; Sketchup, DesignBuilder, and Revit created a confusion among the students. The conversion among the three program was difficult and in some cases was impossible. Some building forms were difficult to draw in DesignBuilder software as that required higher expertise level. Importing drawings from Sketchup to DesignBuilder in some cases were unsuccessful. Revit achieved the most successful energy simulation result considering; learning time, other various work achievements, and reasonable measured results.

Students design process grades showed parallel trend with final project grade. Moreover, all students managed to include many of the sustainable design elements in their design. Furthermore, there were parallel trend between sustainable checklist elements used in each student project and final project grades.

The standard deviation of studio pedagogy structure elements, shown in figure 9, was 1.97. That showed separation between the top and bottom elements. Furthermore, the standard deviation of sustainable design elements, shown in figure 9, was 1.78. Also, that showed separation between the top and bottom elements.

Students claimed that case studies presented by them were big help to achieve their project. However, cases studies presentation need to be finished during the first step of the design process. Technical trip schedule after the first midterm review minimize the benefit of it. There was lack of applying sustainable design principles on the project landscape.

The following recommendations were applied to the following AR 301 Architectural Design Studio in Fall of 2015 (second experimental studio)

- Revit software was used for energy simulation work as the only energy simulation program.

- Design process grade distribution was kept the same

- The 40 points of sustainability checklist elements and energy simulation grades distribution were modified according to the work load, and energy saving effort.

- More attention given to the basic elements scores of studio pedagogy structure and sustainable design by providing more lectures and inviting external experts. Same strategies were applied to sustainable landscape design.

- Technical trip was arranged at the third week of the design process followed by the first midterm review with one week gap between them.

- All cases studies were presented by the students within the first six weeks of the design process.

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