INTEGRATING SUSTAINABILITY PRINCIPLES
INTO
ARCHITECTURAL DESIGN STUDIO

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

KAMAL ELDIN MOHAMED

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
BUILDING SCIENCE IN ARCHITECTURE

AUGUST 2018

Approval of the thesis:

INTEGRATING SUSTAINABILITY PRINCIPLES
INTO
ARCHITECTURAL DESIGN STUDIO

Submitted by **KAMAL ELDIN MOHAMED** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Building Science in Architecture Department, Middle East Technical University** by,

Prof. Dr. Halil Kalıpçılar
Dean, Graduate School of **Natural and Applied Sciences** _____________________

Prof. Dr. F. Cânâ Bilsel
Head of Department, **Architecture** _____________________

Prof. Dr. Soofia Tahira Elias Ozkan
Supervisor, **Architecture Dept., METU** _____________________

Examining Committee Members:

Prof. Dr. Aydan Balamir
Architecture Dept., METU _____________________

Prof. Dr. Soofia Tahira Elias Ozkan
Architecture Dept., METU _____________________

Prof. Dr. Sevil Sarıyıldız
Architecture Dept., TU Delft, Hollanda _____________________

Asst. Prof. Dr. Fatma Korkut
Industrial Design Dept., METU _____________________

Prof. Dr. Tuğçe Kazanasmaz
Architecture Dept., IYTE _____________________

Date: 31.08.2018

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : KAMAL ELDIN MOHAMED

Signature :

ABSTRACT

INTEGRATING SUSTAINABILITY PRINCIPLES INTO ARCHITECTURAL DESIGN STUDIO

Kamal Eldin Mohamed
Ph.D., in Building Science, Department of Architecture
Supervisor: Prof. Dr. Soofia Tahira Elias Ozkan

August 2018, 336 pages

Architectural education prepares the students for their professional lives by teaching them design skills and technical knowledge. The design studio is a special course within the architectural curriculum, while design itself is a structured process or a tactical guideline to accomplish a unique expectation of a product. On the other hand, the concept of sustainability in design is meant to ensure that the product of the design is in harmony with human and nature, by taking into consideration the three aspects of sustainability, i.e. environmental, social and economic.

The objective of this research was to integrate sustainability principles into the architectural design studio in order to train future architects who will be able to design sustainable buildings. The study aimed to create an integration method that could be validated through the junior students' work in the innovative Sustainable Architecture Design Studio at Izmir Institute of Technology. Three experimental sustainable architecture studios were executed consecutively and the pedagogy and the teaching method were modified after each execution to respond to the previous experimental recommendations.

The impact of the pedagogy on the students' ability to integrate the sustainable design principles into their projects were measured through the evaluation tools formulated for this purpose by the instructors. Further, the students' feedback through course

evaluation, questionnaire and colloquium at the end of each term was used to assess and revise this method. Furthermore, the impact of this training on the professional life of the students who had taken one or more of these design studios were also tested through the post course interviews' feedback.

The findings of this research demonstrated that the innovative studio pedagogy and teaching method were successful in integrating sustainability design elements into design studio projects, and the level of sustainable elements integration was 68%. The research recommended further improvement to the studio pedagogy and teaching method as well as emphasizing the importance of embedding sustainable design in the architecture curriculum.

ÖZ

SÜRDÜRÜLEBİLİRLİK İLKELERİNİ MİMARİ TASARIM STÜDYOSU ENTEGRE ETMEK

Kamal Eldin Mohamed
Doktora, Yapı Bilimleri, Mimarlık Bölümü
Tez Yöneticisi: Prof. Dr. Soofia Tahira Elias Ozkan

Ağustos 2018, 336 sayfa

Mimarlık eğitimi, öğrencilere tasarım becerilerini ve teknik bilgilerini öğreterek profesyonel yaşamlarına hazırlar. Tasarım stüdyosu mimarlık müfredatı içerisinde özel bir ders iken tasarımın kendisi bir ürünün benzersiz bir beklentisini gerçekleştirmek için yapılandırılmış bir süreç veya taktiksel bir kılavuzdur. Öte yandan, tasarımda sürdürülebilirlik kavramı, çevre, sosyal ve ekonomik olmak üzere üç boyutu dikkate alarak tasarım ürününün insan ve doğa ile uyumlu olmasını amaçlamaktadır.

Bu araştırmanın amacı, sürdürülebilir binalar tasarlayabilecek geleceğin mimarlarını yetiştirmek için sürdürülebilirlik ilkelerini mimari tasarım stüdyosuna entegre etmektir. Çalışma, İzmir Yüksek Teknoloji Enstitüsü'deki yenilikçi Sürdürülebilir Mimari Tasarım Stüdyosunda, eğitimin başında olan öğrencilerin çalışmalarıyla doğrulanabilecek bir entegrasyon yöntemi yaratmayı amaçlamıştır. Üç deneysel sürdürülebilir mimarlık stüdyosu arka arkaya yürütülmüş ve her uygulamadan sonra pedagoji ve öğretim yöntemi, önceki deneysel önerilere verilen cevaplar üzerine değiştirilmiştir.

Pedagojinin öğrencilerin sürdürülebilir tasarım ilkelerini kendi projelerine entegre etme yetenekleri üzerindeki etkisi, bu amaçla hazırlanan eğitmenler tarafından değerlendirilen değerlendirme araçlarıyla ölçülmüştür. Ayrıca, öğrencilerin her bir

dönem sonunda ders değerlendirme, anket ve kolokyum yoluyla geri bildirimleri, bu yöntemi değerlendirmek ve revize etmek için kullanılmıştır. Ayrıca, bu eğitimin bir veya daha fazlasını bu tasarım stüdyolarını alan öğrencilerin mesleki yaşamları üzerindeki etkisi de geri bildirimleri ile test edilmiştir.

Bu araştırmanın bulguları, yenilikçi stüdyo pedagojisi ve öğretim yönteminin, sürdürülebilirlik tasarım öğelerini tasarım stüdyosu projelerine entegre etmede başarılı olduğunu ve sürdürülebilir eleman entegrasyonu düzeyinin % 68'in üzerinde olduğunu göstermiştir. Araştırma, stüdyo pedagojisi ve öğretim yöntemine daha fazla ilerleme sağlamanın yanı sıra, mimarlık müfredatında sürdürülebilir tasarımın yerleştirilmesinin önemini vurgulamıştır.

Anahtar Kelimeler: Mimari Eğitim, Tasarım stüdyosu pedagojisi, Sürdürülebilirlik.

To

My Parents

My mother Anayet Housean Mahmoud

And

My father Mohamed Mohamed Helmy

For the life, they have given me

May Allah bless their hearts

To

My family

My wife Gülşah and my son Furkan

They are my life.

ACKNOWLEDGEMENTS

Firstly, I would like to express my sincere gratitude to my supervisor Prof. Dr. Soofia Tahira Elias Ozkan for the continuous support of my Ph.D. study and related research, for her patience, motivation, and immense knowledge. Her guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better supervisor and mentor for my Ph.D. study.

Besides my supervisor, I would like to thank the rest of my thesis committee: Prof. Dr. Sevil Sarıyıldız, and Asst. Prof. Dr. Fatma Korkut for their insightful comments and encouragement, but also for the hard questions, which incented me to widen my research from various perspectives.

My sincere thanks also goes to Dr. Zeynep Durmuş Arsan for her positive support and great energy through the experimental studios' work. In addition, I would like to acknowledge my teaching assistant Mümine Gerçek for her help and hard work.

I thank my fellow great hard working students of class AR 302 spring 2015, AR 301 fall 2016, and AR 302 spring 2016 for sleepless nights we were working together, and for all the fun, we have had.

Certainly, I appreciate the support of The Rector of IYTE, The Dean of the Faculty, and the head of the Department for their support and positive attitude toward my research work.

Last but not the least; I would like to thank my family: my wife Gülşah and my son Furkan for supporting me spiritually throughout writing this thesis and my life in general. Their love, care and encouragement have given me a great inner strength to success. It is a privilege to have them in my life and a pleasure to share this with them.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

IYTE	Izmir Institute of Technology
SADS	Sustainable Architectural Design Studio

CHAPTER 1

INTRODUCTION

Architectural education aims to teach students a combination of design skills and professional knowledge. The architecture profession is an interdisciplinary practice that involves engineering, arts, environmental science, computer science, sociology, geography, culture, information technology, political science, and law disciplines (Yu 2014). Architectural education has a unique set up which is distinct from other university education programs. It has a special core subject, which is the design. The architectural curriculum consists of three main course categories. The first includes basic courses in the liberal arts such as humanities, social science and creative arts, the second includes technical courses covering important aspects of architectural design such as materials and construction, building structures and environmental control systems, and the third consists of learning through practicing design, i.e. “apprenticeship” in the architecture studio.

Design is a repetitive decision making process that involves strategies of resource use to produce a system that responds to the human needs and requirements, or solves existing problems (Bakarman 2003b). Design is a strategic plan or a roadmap to accomplish a unique expectation. Design studio is the heart of architectural curricula where students learn visualizing and representing their created design graphically; and it has a unique class format in architectural design education, in which learning is based on an informal interaction and learning by experience (Bakarman 2003a).

Design jury is the assessment tool used to evaluate the product of the design studio work. The jury system embraces the strengthening of the learning process in addition to measuring the acquisition and application of knowledge.

Sustainability has been defined as fulfilling the demands of the present without discounting the ability of future generations to fulfill their own demands. Sustainability education is an emanate imperative that requires a paradigm shift in academic and professional training (United-Nations 1987) (Altomonte et al. 2014).

Although sustainable design is very important; but as pointed out in published research as well, there are various obstacles facing its integration in architectural education as follows:

- Outdated pedagogy of architectural education that focuses mainly on the form and artistic. It does not support architecture schools to follow the current issues that are transforming the practice of architecture (Lofthouse 2013).

- Students are not trained to be professional architects. Design courses focus on creating an individual character not on collaborator individual; especially since students are generally expected to work on their own not in groups (Buchanan 2012b).

- Architectural education has two parallel axes as technical-theoretical and practical design studio. Design requires the transition of the technical and theoretical knowledge to practical cognition ideas, from passive knowledge to active knowledge. This transition is lacking in architectural schools (Heylighen, Bouwen, and Neuckermans 1999).

- Architecture students are not trained to work with other related disciplines that are mandatory in architectural practice (Yu 2014) (Lofthouse 2013).

- There is a lack of clear goals or objectives for design studio juries (Utaberta, Hassanpour, and Usman 2010).

- Architectural schools use digital technology as a CAD tool. While digital technology should be fully integrated into the whole design process (Yu 2014).

- The studio instructors do not possess the required knowledgebase nor the practical professional experience. Furthermore, the detachment of technical courses instructors in design studio and vice versa created a separation gap between the two architectural axes (Altomonte, Rutherford, and Wilson 2014).

- Ambiguous definitions of sustainable architecture are leading to confusion as to what it really is; also, there is a lack of experts in this area (Taleghani, Ansari, and Jennings 2011).

The premises of this research are that:

a) Integrating sustainability principles into design studio will help to create awareness of the subject among architecture students.

b) Integrating sustainability principles into design studio assignments will result in producing a sustainable architecture project.

1.1 Objective and Aims

The objective is to integrate the sustainability principles into design studios producing a sustainable design solution for the student's architecture project. While the study aims to:

a) Create an integration method

b) Test the integration method.

c) Test the method's impact on the student learning level and the level of integration on the designed projects.

While the goal of the research is to provide an innovative *studio structure* and a novel *Sustainable Architecture Design Studio (SADS) model* to the academics, i.e. architectural educators, planners, studio teachers, etc., that can be adopted for sustainability integration.

1.2 Research Questions

Integrating sustainability principles into design studio projects bring research questions that needed to be answered:

- How can sustainability principles be integrated into design studio?

- What should be the format of the design studio?
- How can digital technology be useful to implement this integration?
- How can design juries be employed as a tool to educate students and measure the final design product?

What could be the role of assessment in the integration method?

What are the measurement criteria of integrating sustainability principles into students' projects?

1.3 Research Methodology

The research is structured to focus on design studio principles teaching that depends on the mean of practicing rather than the mean of acquiring the information, which supported integrating sustainability in the design project. This principle reflected on the creation of the new structure of design studio pedagogy and the implementation of the digital technology. The research is a quantitative and qualitative methods type that provided various ways to evaluate and assess the new sustainable design studio pedagogy and the integration success level in students' designed projects.

The study took place at the Architecture Department in Izmir Institute of Technology, in Turkey. The research was conducted in the third year design. 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 fourteen weeks of 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.

It is essential to mention that development of the methodology was flexible because of the fact during the process the students’ opinion, feedback, and work respond were considered. Therefore, the needed modifications were done at the proper time, which will be mentioned in the chapter where is has been done. Research structure is shown in (Figure 1.1).

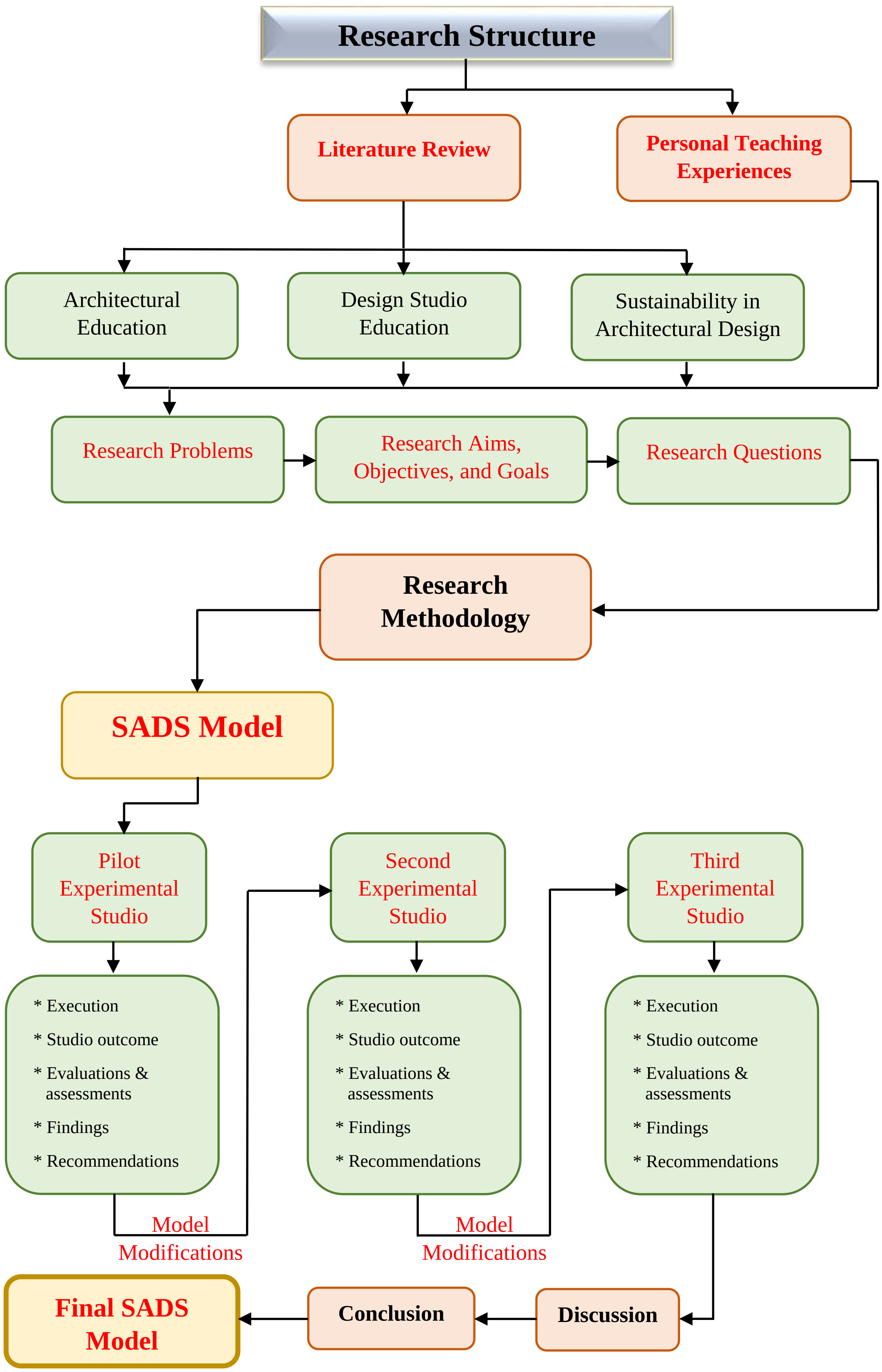


Figure 1.1: The research structure

1.4 Disposition

This work is organized in eight chapters illustrating the total research work in the following order.

The first chapter is an introduction that includes research problems, research promises, as well as research objective, aims, and goal. Further, it illustrates research questions, the research methodology, and disposition.

The second chapter illustrates a lengthy and extensive literature review of major academic works that have been done as well as clarifications to important definitions and existing problems. The chapter divided into seven major parts; architectural education, design education, integrated design education, integrating sustainability principles, problem in integrating sustainability in architectural education, studio culture and sustainability challenge, and assessing learning process.

The third chapter covers the research materials and method. The research materials section explains experimental studio, questionnaire survey, the open colloquium evaluation format, on-line course evaluation, and post students' interviews formats. Meanwhile, the research method illustrates SADS pedagogy, which includes new structure, innovative teaching method, implementation of digital technology as well as instructor attitude and jury formats.

The fourth chapter illustrates the execution of the pilot experimental studio, which includes introduction, method execution, studio outcome, evaluations and assessments as well as findings and recommendations.

The fifth chapter presents the execution of the second experimental studio after the improvement of the method. It includes the studio outcome, evaluations and assessments, together with findings and recommendations for the following experimental studio.

The sixth chapter introduces the third and final experimental studio that has the final improved pedagogy and method execution as well as the studio outcome. In addition, it presents the evaluations and the assessments along with the findings and recommendations.

The seventh chapter demonstrates the discussion, which describe the status Que in details. Further, it presents discussion of the experimental studios together with the evaluations and assessments as well as comparisons among the three experimental studios. Furthermore, it presents the post course interviews’ results and discussion.

The final chapter illustrates the thesis conclusions, which includes the findings, what has been learned as well as the obstacles along with recommendations for future research work improvement as well as suggestion for future research work. Furthermore, it illustrate the final Model diagram of SADS work that will provide the academic area a complete method that can be followed to integrate sustainability principles into design studio

CHAPTER 2

LITERATURE REVIEW

This literature review covers three main topics, which are architectural education, design studio pedagogy and teaching sustainability to architectural students.

These three topics are presented in seven sections. First, it reviews architectural education, background history, and architectural school types. It looks into architecture education programs, and architectural curricula as well as its main components, which are architectural design, architectural technology, and architectural environment. Lastly, it discusses the architectural education problems.

The second section focuses on design studio education while it explores architectural design studio and design studio pedagogy. Under design studio education, it covers design studio format, design project brief, and design juries. While beneath design studio pedagogy, it presents design studio teaching styles. Further, the section includes representational media in the design studio. Lastly, it demonstrates design studio education problems.

Third in the review, it presents integrated design education in a relation to sustainability teaching; meanwhile it covers background, concept of sustainability, and the reason for it. Moreover, it illustrated sustainability in architecture and architecture education and sustainability.

Fifth part, explains the problems in integrating sustainability in architectural education. While six section discusses the studio culture and sustainability challenges.

The last part of the literature review covers the assessing the learning process. It presents Bloom’s taxonomy method, checklist method. In addition, it illustrates the building performance simulation for integrated design.

2.1 Architectural Education

The philosophy of architectural education defines architecture as a conceptual problem solving discipline; its goal produces conceptual thinkers who are knowledgeable 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 University 2015).

Architectural education intends to teach students a collection of design skills and professional knowledge. Architecture is an interdisciplinary field that binds engineering, arts, environmental science, computer science, sociology, geography, culture, information technology, political science, and law disciplines. Thus, architectural education requires a process that provides special learning environment to combine all disciplines (Yu 2014).

Generally, the architectural education model underlines three main themes; first theme concerns the behavior aspect where building the personality and the character of an architect takes place, second theme focuses on acquiring the knowledge, and third concentrates on the skills and skills types that student needs to master to be a good architect (Bakarman 2003b).

The architecture curriculum has been established and monitored by national organizations in different countries such as; National Council of Architectural Registration Boards in USA, Royal Institute of British Architects in UK, COA Council of Architecture in India (Manu et al. 2012). In Turkey, the curriculum has been developed by the universities and approved by the Council of Higher Education *(Yüksek Öğretim Kurumu).*

Architectural education is one of the few disciplines that has a unique set up which is distinct from other university education disciplines. It has a unique instructional format of a core subject, which is design of the built environment (Bakarman 2003a).

2.1.1 History of architectural education

Architecture is one of the most ancient professions. In ancient Egypt, it was a prestigious profession that used to be taught in the scribes school under the supervision of clerics and priests to members of nobility who usually learned the craft from the family. Architectural knowledge, skills, and methods were devolved from generation to generation (Salama 1995).

In ancient Greece from fifth to second B.C., there were small private schools where an experienced master architect trained and guided the students. In ancient Rome, the ten books on architecture written by Vitruvius were the starting point for formal architectural education; which included the knowledge of construction trade, building materials, astronomy, history, philosophy, constructional elements, and geometry (Salama 1995). In the first section of the first chapter (Education of the architect) in his first book Vitruvius stated that:

> *"The architect should be equipped with knowledge of many branches of study and varied kinds of learning, for it is by his judgement that all work done by the other arts is put to test. This knowledge is the child of practice and theory. Practice is the continuous and regular exercise of employment where manual work is done with any necessary material according to the design of a drawing. Theory, on the other hand, is the ability to demonstrate and explain the productions of dexterity on the principles of proportion" (Vitruvius 1914).*

The Byzantine used the Romans' experience to establish better organized architectural training schools (The Great Soviet Encyclopedia 1979).

In the Ottoman era, an organization by the name of "Imperial Architects' Society" was responsible for handling the architectural education of the government and military. It included masters and laymen under the supervision of the chief architect. The first formal school for the public was called The High School of Fine Arts *"Sanayi Nefise*

Mektebi Aali". It was established in the 19th century by Osman Hamdi Bey (Dizdar 2014).

In the Renaissance period, Vasari established the Fine Arts Academy in Florence. In 1671, the special Royal Academy of Architecture was established in France, followed by The Ecole des Beaux-Arts (the School of Fine Arts) that experienced many changes to its education identity through the industrial revolution (Salama 1995).

2.1.2 Contemporary schools of architecture

In mid-19th century, many engineering technical schools in Germany, France, and UK offered various architectural education programs, which lead to the division of the architectural profession into two specialties: engineer-architect and artist-architect. Architectural school division into art and technical departments still exist in many countries until now. In 1950's and 1960's, the construction and reconstruction of European cities required an increase in architectural schools; for instance in the UK 20 departments of architecture were established 70 were opened in the USA and many more were started in the rest of Europe (The Great Soviet Encyclopedia 1979).

The most two famous architectural school models are The Ecole des Beaux-Arts and The Bauhaus.

The Ecole des Beaux-Arts

The Ecole des Beaux-Arts was originally conceived to inculcate three spirits: Freedom, Competition, and Variety (Carlhian 1979, Chafee 1983).

Freedom: The Ecole was established on the most precise and rigid unique approach of architectural education that included its structure, selection of teachers, courses types, number and kind of exercises, and the quality and the size of the student body. The students enjoyed total freedom with no academic prerequisites in term of nationality, age, race, diploma study period, choice of design teacher, classes' admission order, and tuition fees (Carlhian 1979).

Competition*:* Developing a competitive spirit started with admission to The Ecole. The student had to prepare for the entrance competition by passing twelve various exam each one had points to collect and The Ecole admitted the best forty. Education time included a numerous of assignments, exercises, and tests built on competition spirt (Carlhian 1979, Drexler 1977).

Variety in assignments: The Ecole offered courses to satisfy the intimacy and casualness of atelier life. Technical courses blended with studio practices. Quick sketch problems intermingled with the long duration architectural projects (Carlhian 1979).

Variety in atelier: The Ecole offered various atelier types where each was grouping 50 to 100 students aged from 15 to 30 who were coming from different kinds of economic, cultural, or political backgrounds. Lectures attendance was optional. Grades were given by professors based on the papers submitted or the correctness of answers of oral examination (Carlhian 1979).

The curriculum

At the Ecole des Beaux Arts, at first, student joined the atelier of his/her choice out of more than dozen ateliers available. The student's choice depended on the atelier: type, subject, teacher, etc. the school permitted changing atelier. Atelier was not only a place of education but also a home for the student (Carlhian 1979).

The Ecole diploma required minimum five years of study. These five years program made up of two cycles. The first cycle was three years where student learned to master the fundamental theoretical and technical tools of artistic creation and to define an individual long-term artistic undertaking and project. The second cycle was two years where student prepared for the diploma. The cycle included a move into the outside world in 4^{th} year, either in the form of a professional internship or participation in a study abroad program, and a seminar in 5^{th} year. During these 2 years, students further developed their theoretical knowledge by developing a research project and writing it up as a research paper, which they defended to a jury in their 5th year. Students took a yearlong seminar in their 5th year that complemented their own artistic work. The

2nd cycle culminates in the degree examination for the Diploma National Supérieur d'Arts Plastiques (DNSAP) (Ministry of culture and communication 2018).

The Bauhaus

The Bauhaus in Germany was an art school which included fine arts, and craft. It existed from 1919 to 1933 then the Nazis forced to close. Bauhaus literally means house of construction, which was understood as School of Building. The founder of Bauhaus was the architect Walter Gropius in Weimar. The Bauhaus did not have architecture department at first year, the spirit of the school based on creating a total work of art that included architecture. The Bauhaus had significant influence on art, architecture, interior design, industrial design, graphic design, and typography (Whitford 1992).

The Bauhaus depended on educational foundation, which included all fields of architectural creativity. Students-teacher (master-apprentice) was the teaching method. The curriculum developed with the theory of Gestalt perception, the learner advances though the apprentice, journeyman and master levels throughout the educational process, which included all the needed applications for creative work and scientific fields (Dizdar 2014).

The Bauhaus influenced the design education profoundly. One of the prime education objective of the Bauhaus was unifying craft, art, and technology so that this approach combined into the curriculum. The Bauhaus *"Vorkurs"* preliminary course structured echoed the pragmatic approach of integrating theory and application. First year education reflected the Bauhaus approach where students studied basic elements and principles of design and color theory while experimented with various range of materials and processes (Whitford 1992).

The Bachelor of Architecture study was three years. The study at the starting year included presentation skills and basic design in addition to the fundamental architectural design principles, followed by two years of the basic theoretical lectures. The concentration of studies on second year were on the design, construction, and urban design issues. First semester of third year, students had the option to spend it abroad or in university in Germany, or in professional practice. Last semester, students fulfilled the graduation requirements by presenting a bachelor thesis with seminars and lectures supporting the project and offered related background on the subjects of their thesis. At the end, the student was awarded degree in Bachelor of Science (B. Sc.) (The Bauhaus-Universität Weimar 2018).

Architecture programs

Architectural schools can generally be categorized into two types; those that focus on technology and those that focus on fine arts.

- **Technology oriented programs:** put their emphasis on an integrated design approach, which combines technology, theory and design. The undergraduate programs in such schools focus on technical architectural issues and the integration of technology into design project and design studio. Some examples of such schools are Massachusetts Institute of technology (MIT), Delft University of Technology (TU Delft), Swiss Federal Institute of Technology Zurich (ETH), etc. After five years of study program, in most cases, student receives a professional degree in architecture. This degree has alternative names but at the end, it carries the same meaning, for example Bachelor of Science in Architecture (BSc), The Bachelor of Science in Architecture (BSA), and Bachelor of Science in Architecture (BSc Arch).

  In some cases, architectural department is founded under Engineering faculty where mostly called architectural engineering department. The department usually has the same program and objectives of the above mentioned school category. It is five years study program emphasizing on technical and engineering issues, which integrated into design studio. Student receives a professional degree in architectural engineering that it is called Bachelor of Science in Architectural Engineering (BSc Arch Eng.) or (BSc. AE) (Bakarman 2003b).

- **Fine Arts oriented programs:** that concentrates on the design project and theory. In general, there are two different programs. Four years program (preprofessional degree) which leads to a Bachelor of Arts in Architecture (BA) or Bachelor of Design in Architecture (B Des Arch) that requires one or two extra year(s) to be considered a professional degree holder. That program could be found in UK education system, some European countries, and USA. The second program is five-years system, which lead to a professional degree is called Bachelor of Architecture (B.Arch.) such as University of Texas (UT), and Carnegie Mellon University (CMU) (Bakarman 2003b).

Architectural curricula

The architectural curricula varies among countries. Generally, the core subjects are shared by most countries. For instance, in UK architectural curricula includes five categories: design, technology and environment, cultural context, communication and management, practice and legal (Fan and Xueqiang Wang 2014).

The needs of the professionals and industry can be observed from the requirement established by the accreditation bodies and the state of architectural practices that receive the students. While in Malaysia architectural curricula consists of four major fields of study: history/theory, technology, design and professional practice (Ibrahim 2008). However, in most counties the architectural curricula consists of three main academic categories. The first category includes basic courses in the Liberal arts, the second includes professional courses covering important aspects of professional practice such as materials and construction, building structures and environmental control systems, and the third group is full of learning experiences “apprenticeship” that occurs in the architecture studio. Students undertake a design project under the guidance of a leading designer or professor of design studio, which is traditional in all schools of architecture. The design studio is of great importance in architectural education (Fan and Xueqiang Wang 2014).

In UK, a full teaching plan consists of an academic education and professional practice; it requires total of seven years. The five years of university academic education has two parts; part 1 leads to middle degree, and part 2 advances to a degree in education. Part 1 and 2 the program specifies five topics: design, technology and environment, cultural context, communication and management, practice and legal. The two years of professional practice, part 3, is a test to examine the graduates as a professional architect to employers, clients, professional, the construction team, and understanding of obligation and social responsibility (Fan and Xueqiang Wang 2014).

In Turkey, The Turkish Architectural Accrediting Board *"Mimarlık Akreditasyon Kurulu (MIAK)"* reviews, supervises, and accepts the education curriculum under the umbrella of The Council of Higher Education *"Yükseköğretim Kurulu, or YÖK".* The architecture education curriculum requires minimum four academic years to obtain a bachelor degree in architecture (B. Arch). There is no professional exam required after graduation. Any architecture degree holder can practice as a professional architect i.e. design and sign an architecture project (The Chamber of Architects of Turkey 2015).

2.1.3. Architectural education problems

Architectural education has been heavily criticized because of its outdated pedagogy. Education, patterns, and the basic process have not changed very much over the last 20 years and this is its biggest weakness. Architecture schools are struggling to follow the current issues that are transforming the practice of architecture (Lofthouse 2013).

In recent times, the demand for architects still exist but with special qualification requirements. The existing architectural education does not produce a professionally qualified architect who is able to think and act outside the box to keep up with the discipline (Brown 2011).

Environment, up to date new technology, and materials are lacking issues in the architectural education. The students are not educated nor trained to stand on the first step of the architecture profession career. They should be trained to meet the community and culture requirements, and their level of education should elevate the life quality. Generally, courses concentrate on producing individual genius rather than collaborator individual (Buchanan 2012b).

A survey study uncovered the major characteristic problems of the culture of architectural education due to highly advocacy and low inquiry, ambiguous criteria for students' performance and success. Architectural education focuses mainly on the form and artistic, it always aims to develop the skills and superficial adoption of disparate and scrappy pieces of knowledge of technology, ecology, socio-political and socio-economic (Ibrahim 2008).

In most architectural schools, the education program has two parallel axes. The first axis includes the technical and theoretical lectures. Technical includes materials sciences, building physics, economics, mechanics, etc. Theoretical includes architectural history, design methodology, and theory. The second axis is the design studio, which helps the students to experience the real life project, allowing them to walk on the rope without facing the risk of falling. Design requires the transition of the technical and theoretical knowledge to practical cognition ideas, from passive knowledge to active knowledge. This transition is lacking in most architectural education (Heylighen, Bouwen, and Neuckermans 1999).

The discourse and practice of architecture are highly dominated by global transitions. In architecture schools students may be educated under teachers coming from other countries, using global published books, refereeing to some international iconic building, and using the global internet as a first sources of their knowledge (Williamson, Radford, and Bennetts 2003). Globalization is an unavoidable phenomena yet architectural education has no clear vision of dealing with it. Globalization made all countries' culture heritage become human been common wealth. It promotes building technology by cross-cultural. On the other hand, there are big worries about the melting identities of each individual culture around the globe which starts to reflect on each region architectural identity (Zhao and Tao 2014, Bakarman 2003a). There are demands for international architectural education standards to equip students with new international cutting-edge architectural design concept (Fan and Xueqiang Wang 2014).

In most countries, architectural students are chosen by special exams after they have gone through special training during high school time. In Turkey, architectural students are accepted in architectural departments by the choice and placement tests after high school. Generally, students start their architectural education without any basic background knowledge about architecture. They begin the education process without any accumulation of professional knowledge (Dizdar 2014).

Numerous of disciplines operate and work in extreme isolated worlds. That is the case with architectural education. Architecture students are not trained to work with other related department disciplines in order to grasp the required experiences needed for profession practice. One of the biggest separation between education and practice is the lack of business and technical skills. It is essential to integrate the architectural practice within the architectural education (Lofthouse 2013).

James Brown in his statement criticizing the architectural education in UK stated:

> *"Although there is tremendous innovation in teaching and research in the institutions themselves, every course in the country is beholden to the RIBA validation criteria. Despite a significant and worthy attempt to rewrite these over the last few years, the revised documentation is simultaneously too vague and too constraining to be of any use. We should look to America, for instance, where there is a much greater diversity of approaches to architectural education. Students should be able to choose between schools that are genuinely different." (Brown 2011) (James Benedict Brown, Lecturer at Norwich University of the Arts, 2013).*

Architectural education remains in the theoretical rather than practical, therefor there is a great gap between what tutors are teaching and the expectation of future employers. Furthermore, changes in the architectural education require an innovation from the teachers to establish new ways of thinking instead of being bounded to the existing education curriculum (Wainwright 2012).

2.2 Design Education

Design is a strategic tactic of someone to accomplish a unique expectation. It defines the plans, parameters, specifications, processes, costs, and activities. Normally, it is accomplished under social, legal, environmental, political, economic, and safety limitations. Architectural design is the melting pot to these disciplines combination with all of its knowledge and skills and design studio is the place of the special learning environment. During the design process, students have to respond to wide array of references, which put the design comprehensive condition situation. Therefore, the design is acknowledged as part of complex context, which included material, social and cultural conditions, technology, and economy (Bakarman 2003a).

In other words, design can be define as a process of something being drawn and/or built as a whole with its mass and its surroundings following criticism and documentation of the theoretical, functional, spatial, structural and actual characteristics of the whole building to meet the requirements. Design involves innovation and creative concept which is not only about making something out of nothing but also it should be evaluated as the vehicle and method used so this thing can exist (Dizdar 2014).

Creativity means seeing a relation between new information and a previous experience and developing a fresh combination out of this perspective (Kahvecioglu 2007). Furthermore, creative individuals who are successful in making new associations from unrelated elements tend to have unusual access to the potential in new input (Canaan 2003).

Successful and good architectural design would have one or few ideas that different aspects of the project organized around it, which generate and produce a coherent and meaningful whole. The implicit ideas that can range from images to site characters, etc. are well known among architect as design concept (Heylighen, Bouwen, and Neuckermans 1999).

It is well known that design is a complex and multi-dimensional activity that embody various skills and tendency such as communication, interpretation, research, knowledge integration, and problem-framing (Kahvecioglu 2007). On the other hand, Power and Koolhaas stated that design is an “experience-machine” that needs to be self-organized rather than operational (Power 2002; Koolhaas 2004).

2.2.1 Architectural design studio

Design studio has been widely adopted for architectural design education. It 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. Students learn to design where design is considered the key activity for an architect. They rely on the principle of developing skills and sharing ideas. Successful architecture studio courses is the one that integrate the practice of design activity with all other coursework and educational experiences. Therefore, students learn critical thinking and question all things in order to create and improve their designs (Kurt 2012).

Oxman defines the studio as a place for making designs under the periodic guidance of the design instructor who intervenes in the student's designing, generally in reaction to the student's explicit design (Oxman 1999).

Design studios tend to focus on learning by mean of practicing rather than by mean of the acquiring the information. This principal could illustrate the difference between lecture/seminar learning and studio learning. Design studio instructor shall have four essential criteria; be available to students, respect diverse talents, provide visions that include a respect for diverse views, and provide clear and real evidence that students have learned. Design studio has eight to sixteen hours weekly so that it is structured to allow instructor and students spending time together (Attoe and Mugerauer 1991).

Good instructor talks and repeats the talk all the time, during group meetings, panel reviews, desk critiques, etc. to make sure the message reached the students. The chemistry between the instructor and the group of students and between the instructor and each individual students is essential for a successful studio work (Kurt 2012).

Design studio is the heart of architectural curricula where students learn visualizing and representing phenomena graphically. They learn how to think architecturally, practice-making decisions, design process, and synthesis, which required identifying what information needed to accomplish the design. Design studio as a special working place requires a space that has good light quality, natural ventilation, drawing tables with flexible movable chairs, tables for model making, group meeting area, panels, lecture space, and space for rest and beverages (Attoe and Mugerauer 1991).

Design studio format

There are five common classifications of design studio practice depending on the supervision style, critique format, and the freedom that is given to the student to be creative and productive (Kurt 2009) (Utaberta, Hassanpour, and Usman 2010). Each class has its advantages and disadvantages, which will be explained as follow:

- Groups of eight to twelve students are under the supervision of an instructor. They are obligated to have critique of their design work, which prepared out of the studio. Students sit in a round format table while instructor handle the discussion, which has limited controlled participation by the students. Students have chance to listen to other critiques with some possible discussion participation. It is teaching/learning action, which limits student creativity.

- Group of eight to twelve students are under the supervision of an instructor. They are obligated to have critique for their work inside and outside the studio. The instructor gives the critique to each student individually on his/her desk. Positively, each student has to work on the design project during the studio hours. Negatively, no group discussion takes place, which leads to lack of collaboration and participation in the studio practice.

- Group of students are working under the supervision of group of instructors. Each student has the opportunity to take individual desk critique from more than one instructor. Student has to construct the project solution and make individual decision according to the given advices. The student has the advantage of the exposure to more than one point of design view. On the other hand, there is no class discussion, which cause the absence of collaboration and participation in the studio practice.

- There are different groups of students. Each group works with one instructor. Instructors of all groups meet frequently to conduct common jury for all groups. It is called “***frequent jury system***”. This system present the chance of possible discussion and participation in the studio during the juries. However, this system is instructor-centered and student is supposed to study individually during the desk critique.

- There are 2-3 instructors supervising group of students. This group of students are from same academic level responsible for the same design project or from different academic level responsible for different design projects. There are a constant juries applied in the studio teaching. This is called “***constant jury system***”. This system allow for collaboration, participation and discussion concerning assignments and design issues.

Design project brief

Architectural design project brief is the dominant part of the architectural design process. It is an information processing system, which accommodates the needs of the users, the clients, the designers, and the developers. This information contains quantitative data in addition to the requirements and constrains in term of production process (Sanoff 1992).

Design project brief initiates where architecture starts. Today’s architectural design project brief is defines as research and decision making process, which determines the work objective of the designed project. That may come under various titles such as scoping, functional and operational requirements, and facility programing. William Peña, invented a process to organize programing efforts that calls ***“Problem Seeking”*** that counseled architects and clients who looked to define the goals of a design problem before initiating the design, which is meant to unravel the design problem (Cherry and Petronis 2009). He considered that the brief concern five main principles which they are establishing goals, collecting and analyzing facts, uncovering and testing concepts, determining needs, and finally stating the problem(s) (Peäna and Parshall 2001).

The American Institute of Architects (AIA) standard stated that project brief is the responsibility of the owner. In the meantime, the owner's project brief can vary from ambiguous to very distinctive so that the owner should use project brief consultant in order to develop an expertise program. In most cases, architects are the project brief consultant who provide the service to the clients (Cherry and Petronis 2009).

It is common in architectural design studio that the studio's instructor develops and writes the project brief especially for first and second year design studios' projects due to the lack of students' experiences. Sometimes in third year studio, students share with instructor the project brief development. For the final year of design studio, students shall be able to write their own project brief or develop the main out line frame of it under the supervision of the studio's instructor.

Design juries

Jury evaluation system is an old traditional architectural learning appraisal tool. It is also known as a review and critique. Jury system was at first part of arts education and training development. In 1795, Ecole Des Beaux-Arts in Paris, France (School of Fine Arts) adopted the jury system, which, at first, started by evaluating students' projects behind closed doors (closed jury format). By the beginning of the 19th century, the Ecole Des Beaus-Arts determined to move from closed to open jury system where students can be part of the evaluation process (Salama and El-Attar 2010). North America embraced the jury tradition from Europe during 1980's (Kostof 1986).

Furthermore, in the USA architectural schools were including one or two French professors in the jury committee to make sure of success of the system (Esherick 1977). At the time, jury system were intend to elevate competition among students to achieve a well-drawn projects which were defensible on the base of good taste and perception (Anthony 1987). Assessment criteria were based on drawings, and presentation quality without any consideration to any other aspect that influence the architectural design (Kostof 1986) (Salama 1995).

The word "Jury" seems to have a negative impact due to the linguistic connection with the justice system. On the other hand, jury system meant to be an assessment tool for the design projects, which is reflecting, discussing ideas, learning, and elevating students' performance (Dutton 1987).

Jury format have not had any major change since it has been adopted in the architectural education of the Ecole Des Beaux-Arts. Each student presents his/her finished design project to a group of faculty, visiting professionals, classmates, and interested others (Sara and Parnell 2004).

The basic format of design jury would be that students present his/her work ideas on his/her own or in-group in a series of presentations within a limited time. The jury can take place during the design process or at the end of the design project. It could be informal or formal format of sitting way and students usually present the visual and/or verbal explanation of his/her work. The audience can be small or large group and made up of students from various years, instructors involve in teaching the project, other instructors, architects and specialist, and users and clients. The audiences discuss students' ideas and give feedback to the students. Students has the opportunities to learn from the audiences involved and he/she may receive a grade for the project and performance during the review (Parnell et al. 2007).

Roger K. Lewis a professor at University of Maryland's School of Architecture stated his thoughts of the jury:

> *"The jury system nevertheless survives because it achieves results that would be otherwise impossible to obtain. It simulates to some extent the reality of making presentations in practice, it reinforces the importance of meeting deadlines, it provides a forum for students to see each other's work and for faculty to see the work of students other than their own, and it encourages graphic quality. In addition, jury discussion raises important issues and promotes new thinking. Like it or not, the architectural jury is probably here to stay and represents one of the unique, recurring experiences in architectural education." Roger K. Lewis (Anthony 1991).*

Many scholars support the view that jury members critique projects spontaneously without set of rules and criteria that has been made clear to the students (Dutton 1987) (Anthony 1991) (Salama 1995) (Sara and Parnell 2004).

Between 1910's and 1930's, the German and Swiss models have loomed out in Europe to substitute the French model, however many of the customs , mechanisms, and traditions of the Ecole Des Beaux-Arts still exist in the US which keep on influencing architectural education around the world (Esherick 1977).

The implementation of architectural design jury system have been under debate during the last twenty years until now. Since Kathryn Anthony published "Private Reactions to Public Criticism" in 1987 followed up by her book "Design Juries on Trials: The Renaissance of the Studio" in 1991, the subject of jury system took the attention of educators. Furthermore, the jury system has been criticized heavily and analyzed in the literature (Salama and El-Attar 2010).

The main paradigm of the educational values of jury system is enabling students to obtain effectual knowledge solving architectural problems whereas providing them guidance, either to complete their projects which is the case in interim juries, or to regard such knowledge for future projects which is the case in final juries (Salama and El-Attar 2010).

The jury system should be a tool that embraces the strengthening of the learning process in addition to measuring the procuration and application of knowledge (Anthony 1987). Parnell in his book "The critic" suggested valuables tips to improve the jury review which are planning the structure of the review, structuring the feedback, organizing the location, informing every one with the roles, appointing a time keeper, organizing the special arrangement, and organizing the feedback forms (Parnell et al. 2007).

Salama argues that the goal of jury system as an education tool could be illustrated in four objectives as follow:

a) Provides students with constructive critiques by grabbing student attention to the positive and negative part of the design project.

b) Provides over all instruction on essential design issues that consider the students project.

c) Launches scholarly discussion among faculty members and students, and among students themselves to exchange design's ideas.

d) Assesses the level of which the students were able to obtain and apply the knowledge to provide design solution responding to a hypothetical or real life architectural problem (Salama and El-Attar 2010).

Alternative evaluation formats

Traditional format of jury has been under criticism for many various reasons that were mentioned earlier. Many literatures suggested varieties of alternative jury formats that may result in positive jury pedagogy (Anthony 1991) (Parnell et al. 2007), these alternative formats as follow:

Student-led review: where a group of students (8 students) manages the review process, four students present their projects to the other four students in series way; each has 10 to 15 minutes. The presenters get out of the room after they finish. The other four students discuss the projects, provide critiques, and evaluate the work. Instructor role is setting up the formats and process of the jury only.

Role-play review: where some of students present their project to a group of students who are presenting the roles of clients, owners, users, government, developers, etc. The instructor assigns the roles to various students and students prepare questions according to their role, which will be asked to the presenting students.

Introduce real clients and users review: is more exciting and challenging review for the students because they face the real questions, which they will face it in the real practice life. This review can take place by inviting the real clients, the project owners and some of the building users.

Make someone else do the work: where the basic idea is that each student presents another classmate student project that usually happen in real life when top manager presents a project produce by many other architects working under him/her command. This teaches the students that the presentation should be clear and on the point so it can be easy to present. Each student sits and watches his/her project is presented by someone else, and listening to the questions regarding the project in an audience position.

Closed review format: imitates the real practice situation where the projects in most competitions evaluated in a closed jury setup. Student learns that his/her project presentation should speak for itself while the clearness and organization of the production play an important role.

Exhibition review: can take place in the studio, school exhibit space, or exhibit space out of the school. Each student exhibits the project where instructors, outside visitors, and students from other classes are invited. Student presents their project to the visitors, gets their feedback and instructor records the feedback and hands it to each student.

Hands-free review: tests the ability of the students to communicate their ideas visually, and to what extend the reviewers would able to understand the project. The student presents his/her project without using verbal presentation tools nor techniques. Student presents the project to the reviewers, and compares their intentions with the responses.

Meeting review: where students meet in a group under the supervision of the instructor to discuss their projects. Each student has prepared agenda that has points needed it to be discussed in priority orders. Student has 3 to 5 minutes to explain the agenda to the group and listen to the group feedback.

Reverse review: teaches students how others do presentation. Students would have the chance to learn presentation techniques, styles, etc. from watching other presenting. Instructor invite professional architects to present their project to the students and students would ask question and learn from the feedback of the professions.

Different media review: where student explores the use of unusual used media such as brochures, videos, models, etc. to be able to communicate the project idea to reviewers.

Model only review: that teaches student how to communicate idea through models only. Generally, clients, users and most public do not understand and comprehend the space and the design quality from the traditional drawing techniques. Models are proven to have much better positive impact on the public understanding to the architectural projects.

Brochure format: that would be used to communicate design idea with small community or the public in the project neighborhood area.

Lecture review: which is good for the early stages of the project design process. Student presents his/her findings about project general information that would generate the project idea.

ICT (information communication technology) Review: that ranges from using slides to multimedia presentation, which may include collection of slides, film, sound, and animations. It helps to reach large audience, and makes it possible for the presenter to enlarge some particular parts of the project to present it to the reviewers.

Videoconference review: is a power technology tool for presentation and interactive discussion that requires special skills and quality of work. The presenter should have clear contrast in the drawing, avoid details drawings, avoid excessive movement, text should be large, and the sound should be quiet while someone speaking.

The web review: is a wide range of reviewers. Students can share their projects over the internet with other schools or professional architects to be reviewed by them. Student will have feedback from various reviewers (Anthony 1991) (Parnell et al. 2007).

2.2.2 Design studio pedagogy

Design pedagogy regards various contemporary issues. These contain design methods, the impact of technology, preparing students for globalization, future direction, knowledge economies, sociology, and thought processes (Hall and Barker 2010).

Design studio is a unique class format in architecture design education, in which learning is based on student-instructor interaction and learning by experiences. It is the core course in the architectural education, which all other curricula courses are built around it. Design studio space has special environment which normally a setup of ten to twelve students per professor with their own setup drawing tables, books, panels, projectors, pictures and models (Schön 1990).

Students spend much time in studio space participating in various activities in class and out of class time that includes having lectures, producing drawings, preparing models, getting desk critiques, discussing issues, presenting their projects, and sometimes resting and sleeping. It is clear that the studio space is not just a classroom space, but also it is considered an education home for the architectural students. Architectural design studio is a great provider of constructivist, cooperative, learner-centered, multi-sensory, problem-solving environment based on experimental teaching (Kurt 2009).

Students are not only anticipated to comprehend new concepts, but also they are obligated to accomplish at least two tasks simultaneously “to design and to learn to design”. On the other hand, students should learn how to present and defend their design concept graphically and verbally on the top of that, they shall know how to form trust and commitment relationship with their studio instructors (Al-Mogren 2006).

Unlike the lecture classes, in which the student’s goal is presumably to grasp the knowledge that the instructor transfers through particular instruction, design studio focus on students’ active learning and hands-on activities (Cho 2013). In the studio, student-learning process depends neither on firm instruction, nor on textbooks, and neither tests nor exams normally evaluate student-learning outcomes. Student’s design quality demonstrates the learning outcome. Gagne mentions that various internal and external conditions are necessary for different types of learning (Kearsley 1994).

One of the core-learning tool of design studio is criticism that is provided by the instructors to each students. Criticism is a private tutorial fit each individual student's stage of development of the design project. Desk critique is face-to-face criticism given at a student's desk. Design studio is a great chance for the students to learn verbal architectural language and ways of architectural thinking. The best approach to teach design is by apprenticeship environment where letting the student observes someone who master the skills (Buchanan 2012b).

Architectural design education has three variables that play significant role: studio environment, the communication method between instructor and student, and teaching approach and studio management (Al-Mogren 2006).

There have been few practices of teaching styles format of the architectural design studio. The following are the most common practice styles that has been recorded by academic research.

Traditional design studio

The architectural education curriculum has established on the design studio, which is based on an ancient model of apprenticeship. The basic format of traditional design studio is a teacher telling students what to do and students are doing what they are told. It is a teaching/learning action. At the starting of the semester, a design problem (project brief) is handed out to students to be solved, that may take all semester or part of it. Project brief includes user requirements and concerns, client objectives and goals, site conditions, and other technical information. At the early stage of the design, students maybe requested by the instructor to do some research work and present case studies related to the project program. Instructor advises, suggests, and directs students to make changes to their design throughout the semester during desk critiques. Students are expected to respond to the instructor critique (Kurt 2009).

Traditional design studio pedagogy resembles the cleric who passes on personal experiences and knowledge to the followers in formal student−teacher interaction or master−apprentice interaction (Cho 2013).

Moore established four personifications for architecture instructor, the scientist, the practitioner, the cleric, and the social activist (Moore 2001).

Cho proposed three character profiles of design studio instructor, source of expertise and authority to transfers knowledge and know-how to students, facilitator and coach to guides and manages students to develop and maximize student potential, and friend and partner to let students enjoys equal relationships and encourages students to join the professional community (Cho 2013).

Traditional design studio is the most common studio style in architectural education system, which refers to as "Paper-Based Studio". There has been many criticisms because it depends on experimental learning method only (Lofthouse 2013).

A usual design studio project is written by the instructor with a made up scenarios that explains to the students which normally has little relevance to the reality (Buchanan 2012a). While architecture embraces participative process, traditional design studio often secludes from real world, with less interaction to the real practice life. Furthermore, students normally are not urged to share the development of their ideas among themselves unless they are working in a group project (Nicol and Pilling 2000).

Constructivist design studio

Constructivism philosophy is a theory of knowledge that claims that humans generate knowledge and meaning from intercommunication between their experiences and their ideas (Jean Piaget). Constructivism is based on observation and scientific study, it considers that the knowledge constructed by the people according to their experiences and the reflection on those experiences (Kurt 2011).

Constructivists believe that our personal world is constructed in our minds. Our personal realities are defined by these personal constructions. The mind is the tool of thinking, which interprets objects, events, and perspectives instead of trying to remember and comprehend an objective knowledge. The mind filters input from the world while processing those interpretations. The essential epistemological assumption of constructivism is that knowledge is a function of how a person creates meaning from his/her experiences rather than a function of what someone else says is true. Individuals conceive the external reality somewhat differently, which is based upon the unique set of experiences with the world and the beliefs about them. Constructivists consider meaning making is the learning processes goals; it demands articulation and reflection on what we know (Jonassen et al. 1995).

In traditional learning, students get their knowledge and meaning by direct transfer from a teacher while in constructive learning students construct their own knowledge by reflecting on their own experiences then they adjust their mental models grasp new experiences. Constructivist theory focuses on learning and learner rather than teaching and teacher. In design studio, students create their own idea, expresses it in modeling, drawing etc. They reflect on this experience they construct their own knowledge and meaning from this experience, then they adjust their own knowledge then they reflect again. This situation can keep going until the student can reach the satısfaction successful point in the design project (Kurt 2012).

In the early 1990's, constructivism theory emerged. It rejected the objectivist view of reality and the concept of communicating content to the students as a way of learning (Jonassen 1994, Jonassen et al. 1995). Constructivist studio includes the following teaching labels: collaborative, cooperative learning, learning communities, problem-based, discovery, and hands-on learning. If the traditional design studio environment is transformed to the constructivist studio, the existing problems of the design studio can be reduced (Kurt 2009).

Studio objective: the studio concentrates on the design process not the finished product, new tools and skills are acquired for learning process regarding the class content, multimedia applications with computer technology are widely used. Virtual reality and simulations are embraced.

Studio structure: design studio projects are varied. Four or five projects subjects may be offered, student freely chooses a project. He/she is responsible for solving minor assignments, sketch problems, and case studies etc. During the process, **s**tudents share their design ideas, collaboration is essential in design process, open discussion sessions are practiced, and screen critiques and/or desk critiques are implemented.

Assessment of the result (Grading): Design process is evaluated, final product is recognized as representation of the process, and the student success is the result of total evaluation from starting of the process until the end (Kurt 2009).

Vertical design studio

The vertical design studio is a single studio class that combines different academic levels of students (sophomores, juniors, and seniors) in the same course of study. Social cognitive or social learning theory advocates that learning happen in a group or social context through observation, imitation, and modeling which is happing to some degree in traditional studio. Combining students from different academic levels bring varied collection of experiences that allow for more observation, imitation, and modeling (Peterson and Tober 2014).

The Ecole des Beaux-arts was first in introducing the vertical design studio (Drexler 1977). On the other hand, the vertical studio was introduced to architecture, landscape architecture, interior architecture, and industrial design programs at the Rhode Island School of Design in 1970. In addition, it has been a part of many various architecture design program in UK at the same time too. In 2004, the interior architecture and interior design program in the University of Bedfordshire, UK, has been restructured to integrate the vertical studio in it. In 2013 – 2014 academic year, the graphic design program at the School of Art and Design, The University of Illinois at Urbana-Champaign implemented the integration of vertical design studio (Peterson and Tober 2014).

Basic implementation of the vertical design studio as follow:

a) Group of combined level balanced of students from sophomores to seniors with a large wide class is formed. The wider the class the wider range of project results are expected.

b) Students learn from their peers with a team based experiences are reinforced to increase the opportunity for peer-to-peer learning. Instructors have to plan project carefully to avoid group working problem.

c) Project has to accommodate all students’ levels so that it should not include any technical expertise.

d) Instructors rotate among the students groups in order to provide equal knowledge.

e) Since all students attend vertical studio together, each student is required to attend it each academic year until the graduation (Peterson and Tober 2014).

The pedagogical benefits and advanced of vertical design studio can be concluded as follow:

a) Students’ communication from different level helps to learn from each other experiences.

b) Lower level students see what potential future for them from higher-level students and senior students have to show better performance in execution and articulation, which create positive learning environment.

c) The challenges facing the instructors create a positive innovation environment that would not exist in normal situation.

d) Placing the instructors at the same teaching time and space allow them to collaborate pedagogically (Peterson and Tober 2014).

Integrated public interest design studio

This design studio focus on engaging the students in the public demands while they are designing any project. Effectively, the interest of public in the design can achieve most of the existing goals of architectural education while it addresses preventively issues such as socio-economic, environmental justice, etc. Engaging the student with a public creates great communication skills, builds the leadership character, and acknowledges the community problems (Anderson 2012). Unlike any typical standard architectural education methods, it involves experimentation, and testing as a preparation way of the students to enter the architectural practice. In these contexts, students are typically passive, learning facts, and techniques from lectures. Students learn everything about users' needs from the clients, which is the public. In addition, while students working with the communities they learn the importance value of collaborative work.

Charrette design studio

A charrette is the intense final effort made by architectural students in order to complete the solution of the given architectural problem in an exhorted time or the period in which such an effort is made. (Merriam-Webster 2015a).

Charrette can take a format of a public meeting that devoted workshop for exhorted effort to problem solving or plan the design of something (Oxford-Dictionaries 2015a).

Design charrettes hint ideas and motivate design sketches, involve many people in the design process. It explores, exams, and exposes objectives and goals of colleagues in varied functional roles, and chase away designer's block (Pernice 2013).

What are design charrettes?

A design charrette is a short collaborative gathering effort during which group of people collaborate to sketch designs to share and explore wide diversity of design ideas in quick process. The original idea of the design charrettes came from the French word charrette, which means "chariot" or "cart", which was derived from stories of architectural students in the Ecole des Beaux Art of Paris in the 1980's. Professors used to pass in the studio to collect students' exams or design drawings in a charrette for evaluation while some of these students continued intensely sketch together. Therefore, design charrette is an intense and extreme period of design and planning (Pernice 2013, Walker and Seymour 2008).

In today's studios, charrette term can be associated with developing a creative design solution, mostly in an intensive shared or group format within one day to two weeks' time frame (Walker and Seymour 2008).

Benefits and goals of charrette design

There are positive outcomes and benefits of the charrette design. Some of these benefits are:

- **a)** The exposer and inspiration by others various design ideas.
- **b)** Helps to take away the fear of design starting point, which exists for some people.
- **c)** Hearing about project's priorities views from others, which help to build consensus.
- **d)** Each person is listened to, which bring equality.
- **e)** Fast process and inexpensive.

How to conduct a charrette design

Charrette design is fast and easy. Students are grouped in as many as twenty and as few as two instructors write down the goals, the objectives, and design challenge on the whiteboard or hand them to the students. Each student has sketch and drawing tools, and sketches his/her own ideas for 15 minutes (or any set of limited time). The tempo should be fast. Students may draw one or many sketches ideas, until one of those ends: time, paper, or inspiration. Each student works individually, no discussion or talk once the sketching time starts. Once the 15 minutes are up, each student has 2 minutes (or very short time) to show, explain his/her ideas and the reason behind then.

After each student presentation is up, the group may ask questions within one minute to the student. Time keeping is very essential in this process otherwise; the process can go forever, the students will get bored and will lose concentration (Pernice 2013).

Using charrette design helps student to generate design ideas fast, brain storming, take away the paralyzing of staring design point, and better assessment of their work and others too. It helps instructors to test the studio tempo, and understands the kind of problems students facing (Walker and Seymour 2008).

2.2.3 Representational media in the design studio

The architectural students work through design project problem and communicate their outcome result by design descriptions or design representations. These means allow architectural students to test the design solution to the design problem and present them in the following media:

- **Drawings** have been initial and dominate mean of communication since the invention of paper in 16th century. Drawings were in 2D, axonometric, and perspective. Drawings can be in loose free hand or scaled ruled line. Tools used in drawings include pens, pencils, paints, set squares, rulers, and computers (Ham 2013).

- **Physical model** is a scaled 3D representation, which exploits various material to express and present the characteristic of the design. Physical model has emerged with hand-built model at first then evolved to include CNC-routed, laser cut or 3D printed models derived directly from 2D or 3D computer models.

- **3D CAD** incorporates the use of computer programs to generate virtual solid and surface materials. 3D CAD operates in a 3D environment where the model can be viewed from any location. Mostly, architectural students utilize the use of the three media during their design process simultaneously.

2.2.4 Design studio problems

Since the teaching of architecture has been carried into the studios of architecture on beaux-art, teaching of design is realized in many different ways, with the critique session as the backbone of its assessment, in spite of this the assessment system has rarely been subjected to serious critical analysis. Many architectural schools do not establish clear goals or objectives for design juries (Utaberta, Hassanpour, and Usman 2010). Studio teachers receive no training for this work; they only rely on what they learned as students in design studios, and on intuition (Attoe and Mugerauer 1991).

At present, most of the colleges in Architectural Education, still work digital technology as a tool for CAD tools or design, the real distance use digital technology into the architectural design, or use digital technology to integrate the whole design process is still a certain gap (Yu 2014).

The architects are becoming more accustomed with social change, however students are generally taught to work on their own, develop their own ideas and believe that collaboration dilutes their special vision. All of these ideas are unsustainable as we move into the future (Chris Livingston, Lecturer at Montana University, 2013).

Wilkin briefs the problems of design jury/review in three categories: large student numbers that architectural school admits made the material discussion hard, long review hours creates mental exertion where students feel that they had unfair review, and finally cultural traditions of the review process which imposes constraints on learning (Wilkin 2005).

Jurors provide an undue emphasis upon what they perceive to be weaknesses and deficiencies in students' work, rather debates about studio culture have highlighted some of its inadequacies (Ilozor 2006).

The set-up of jurors as attackers and students as defenders, which is in itself can bring out the worst in both jurors and students (Parnell et al. 2007).

The educational value of the jury/review system has an essential situation in the learning process in design studio (Salama 1995). On the other hand, it has been heavily criticized on many grounds. Many students believe that they have not learned much from any juror comments, they even indicate that they cannot recall anything about their classmates' projects that are presented before or after their own due to exhaustion because they were worry about their performance and grades (Anthony 1991) (Sara and Parnell 2004).

Cuff illustrates a fine acknowledged description of the essentiality of the studio in architectural design education. She defines the foundation of the patterns of studio education as derived from the Ecole des Beaux Arts. These patterns have various unique units. The setting of problems are the starting of the educational process. The studio is as a simulation of the professional environment. The substance of studio methodology is as a series of formulated steps of design process, which may include sketch stage, or the graphic model of the conceptual design. The relation with the studio instructor is as a tutorial relation instituted on design documents, and the demonstration is as a medium of communication. The jury system is as the forum for assessment and evaluation of the final finished product of design (Oxman 1999). The main concept built on experienced-based learning while the assessment based on final product rather than measuring the increments of acquired knowledge during the studio work (Oxman 1999).

2.3 Integrated Design Education

Integrated design education is meant to create a design education pedagogy that leads to teaching method that makes the maximum use of the technical and theoretical courses in the project design process. The following presents the learning process that may follow to achieve the integration.

The learning process

It is essential to learn how people learn and retain information; in addition, knowing which technique is more effective than other is. The ***"learning pyramid"*** in Figure 2.1 illustrates the consensus of effectiveness of various teaching methods. This diagram explains how effectively students are taught to retain knowledge. From learning pyramid diagram, lecture is the worst method; students' maximum effort is taking notes, and then reviewing it before exam. They handle the information for their short-term memories to be used for the exam then they forget most of what they had learned (memorized). This is maybe the ironical view, however we teach by lecture a lot and students are comfortable and familiar with this method (Wood 2004).

In general, teachers regard lectures as an efficient method to pass information to many but giving information in lecture to students just to pass the exam. Is the objective passing the exam? Does our question start with ***"Describe"*** (for memory) or start with ***"Explain" and "Compare and Contrast"*** (for using the information)? Teachers usually set the assessments for checking what the students learn but the assessment mostly concerns of what the students can remember things. Further, there is tendency encouraging surface learning especially with multiple-choice questions. The learning pyramid at (Figure 2.1), presents effective learning methods rather than lectures that depends on remembering and memorizing. These kinds of methods encourage intellectual effort at the higher level of Bloom's Taxonomy (Wood 2004, Kurt 2012).

The last three methods ***"Discussion group"***, ***"Practice by doing"***, and ***"Teach other/immediate use of learning"*** are scoring the highest among all effective methods. It is well known that the design studio occupies the most intensive study hours from instructors and students in the architectural education curriculum. If we add to that the commitment of integrating sustainability to the design studio, the teaching methods have to include discussion groups, practice by doing, and teach other technique in order to achieve the aimed outcome. This approach will give the students the critical thinking competence, which is considered the highest level of thinking (Kurt 2012, Wood 2004).

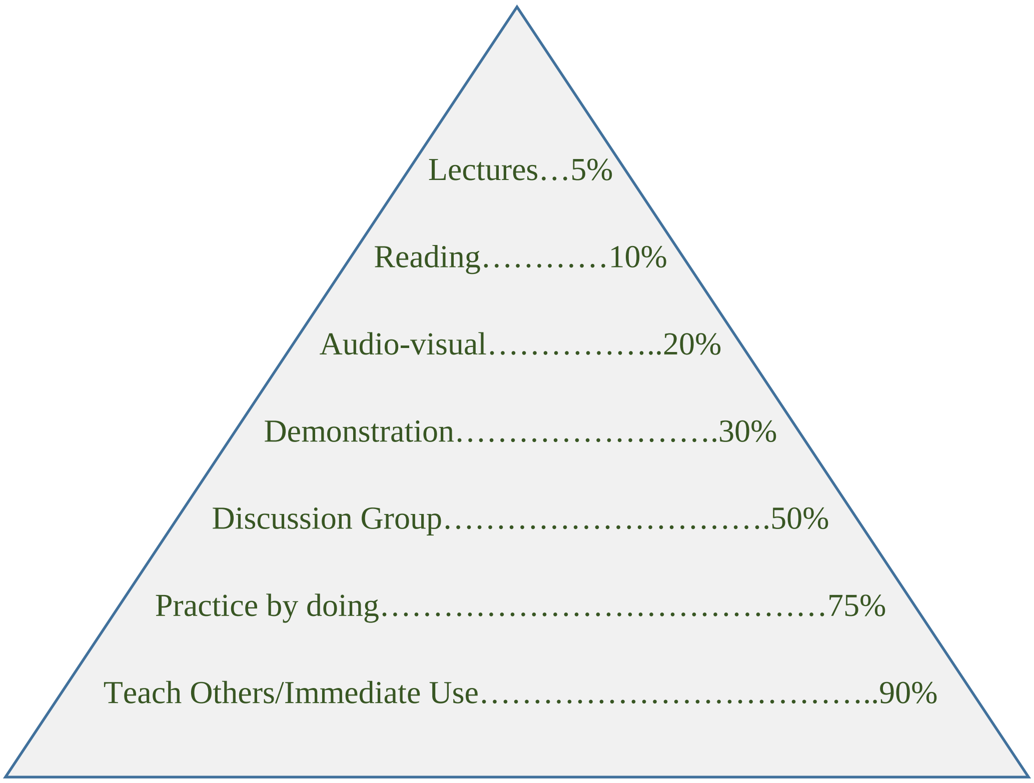


Figure 2.1: The learning pyramid

> *"The learning pyramid originates from the National Training Laboratories (NTL) for Applied Behavioral Science, 300 N. Lee Street, Suite 300, Alexander, VA 22314, USA. The percentages represent the average "retention rate" of information following teaching or activities by the method indicated. In fact, this diagram was originally developed and used by NTL in the early 1960's at NTL's Bethel, Maine campus, but the organization no longer has or can find the original research that supports the numbers given. In 1954, a similar pyramid with slightly different numbers had appeared in a book, Audio-Visual Methods in Teaching, published by the Edgar Dale Dryden Press, New York. Bligh (1998) gives some evidence for the effectiveness of different teaching methods (Wood 2004)".*

2.3.1 Teaching sustainability to architecture students

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 and 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 and Adamo-Villani 2014).

There is a unanimity among architectural schools in creating a sustainable architectural awareness and consciousness within students, who will be the future generation of architects. The National Council of Architectural Registration Boards (NCARB), the American Institute of Architects (AIA), the National Architectural Accrediting Board (NAAB), the International Union of Architects (UIA), the Architects' Council of Europe (ACE), the European Association for Architectural Education (EAAE), The Association of Collegiate Schools of Architecture (ACSA), and Young European Architects (YEA) all demand that sustainable design must be a part of an architectural educational curriculum. Furthermore, architectural education approach must be essentially based on a sustainable worldview (Bala 2010).

In Turkey, the architectural education is a combination of theoretical courses and architectural design studio courses. In theoretical course detailed technical information are usually given to support knowledge acquired in studio. On the other hand, the Turkish Architectural Education council *"Mimarlık Eğitim Kurultayı – MEK"* and the Turkish Architectural Accrediting Board *"Mimarlık Akreditasyon Kurulu – MIAK"* reported that in general students are not able to make the connection nor integrate what they learn from theoretical courses into design studio courses. In the yearly meetings of the Architectural School Department Head Communication Group *"Mimarlık Okulları Bölüm Başkanları – MOBBIG"*, the issues of ecology, sustainability, and energy efficiency were highlighted and turn into concepts presented in the latter stages of the design process. From there, the concept of sustainability evolves into part of the design rather than just theoretical knowledge or terminology (Bala 2010).

Background

The first serious international consideration on sustainable development arose when the Bruntland Commission mentioned it in 1987, World Commission on Environment and Development. The commission's issue a report called "our common future" (United-Nations 1987). The definition was frequently used in following years in various meetings and conferences one of them was the United Nations Environment and Development conference in Rio de Janeiro, June 1992. This conference is known as Agenda 21, a global action plan for sustainable development, This agenda set out a proposal of eight key objectives aimed to improve the social, economic, and environmental quality of human settlements and living and working environments (United-Nation 1992). Later on, there were two conventions established by the United Nations, the Framework Convention on Climate Change and the Framework Convention on Biological Diversity (Bodansky 1993, Ceylan 2014, Williamson, Radford, and Bennetts 2003).

The International Union of Architects "Union internationale des Architectes, or UIA" that was founded in 1948, which it is an international non-governmental organization that lays down guidelines for consideration regarding the architectural education and professional practice. On 1993, the UIA formally initiated the sustainability agenda for the architectural profession by the release of the "Declaration of Interdependence For A Sustainable Future", Chicago (Des Architectes 1993). Sustainable design considers resources and efficiency, ecologically and socially sensitive land use, healthy buildings and materials, and aesthetic sensitivity. This proclamation was renewed in 1996 with the publication of the blueprint of UIA/UNESCO "Charter for Architectural Education" (UNESCO 2011). This confirms that integration of sustainability elements in the architectural education is inevitable. Moreover, The UIA and UNESCO established a frame for the architectural education character (UIA 2005b) to be used in developing a curriculum for architectural studies worldwide (UIA

2012). This frame stated that architectural education should include acquirement of knowledge in the fields like sustainable design and low energy design along with the knowledge of core subjects like architectural design, construction techniques, building services etc.

On the other hand, there have been many talks on the issue of curriculum transformation in response to the sustainability education in the USA. A conference in August 2001, brought together the architecture schools from across the country with the main objective to plan for three to five years for a comprehensive redesign of the architectural curriculum to address sustainability agenda (Glyphis 2001). The program was started alongside on the extensive and innovative foundation developed by others over an earlier decade. These include projects such as Vital Signs at University of California, Berkeley, EASE at Ball State University, the work of the Association of Collegiate Schools of Architecture (ACSA), American Institute of Architects - Committee on the Environment (AIACOTE), and the work of the Society of Building Science Educators (SBSE). That was an important step to speed up the pace of design school in the USA that embrace sustainability. The program director had the following concluding comment on the architectural education changes:

> *"Transforming architecture education means focusing on how to teach as well as what is being taught. Teachers need to expose students to the best ideas, exemplify commitment in their own work and expand the boundaries of the discipline and the profession. A primary requirement of moving architecture education beyond architecture is an understanding of design that goes beyond buildings. Central to this new vision is the conviction that architects are generalists, although this is often masked by the necessity of specialization." (Glyphis 2001).*

The conference acknowledged that there is no one strategy toward adapting the sustainability agenda in the architectural education. The diversity of the architectural schools in terms of its philosophy, pedagogical approaches, and innovations adaptation ability contributed to this result.

The concept of sustainability

Sustainable is defined in term of continuity and maintenance of resources (Williamson, Radford, and Bennetts 2003).

In Merriam-Webster, sustainable definition is to be able to be used without being completely used up or destroyed, or to be able to last or continue for a long time. (Merriam-Webster 2015b).

Oxford dictionary definition of sustainable is to be able to be maintained at a certain rate or level (Oxford-Dictionaries 2015b).

Sustainability embodies the idea that human is able to consciously contribute to meet the needs of the present generation, while ensuring that the needs of future generations are not compromised. It is interdisciplinary concept in character, which demands participation by community from all levels, looking at maintaining a balanced ecological, economical, and social system. Furthermore, sustainability is about creating an efficient system that manage to use and distribute natural resources with a long term vision (Benkari 2013).

In addition, sustainability has been known as fulfilling the demands of the present without discounting the ability of future generations to full fill their own demands (United-Nations 1987)

Sustainable buildings widely regarded as a green building. Sustainable or green buildings are those, which minimize resources consumption whilst attempting to advance the health of building's users via better indoor environmental quality. It sound simple in concept however accomplishing these objectives can be complicated and argumentative because of the confusing claims of green washing reference (Dib and Adamo-Villani 2014).

Sustainable design components are three: passive, active, and activities-post occupancy. Passive components are location, orientation, shape, sun shading, envelope, geometry, natural ventilation, institution, community programs, policing, sustainable materials, and green roofs and landscaping. The active components are rainwater, wall, daylighting, roof, and low energy mechanical and electrical. The activities-post occupancy are low energy equipment, recycling programs, users education program (Bashir, Ahmad, and Jibril 2014).

Why sustainability?

In the second half of the 20th century, the energy problems have been risen gradually so that it became the center point of sustainable development and ecological approaches globally. After the oil crisis on 1973, the energy efficiency has been the main concern all over the world. By 1990, the ozone depletion and global warming problem took the attention and concern of the world to take serious discipline professional action (Anderson 1990).

Building energy consumption and its harmful impact on the environment have been a major concern. Energy consumption and production have the most environmental damage on earth during any peacetime (Romm and Ervin 1996). The last decade, the cost of nonrenewable energy (fossil fuel) has increased, in additional, the problems of ozone depletion and global warming continued to exist. All together directed researchers towards renewable energy explorations. That leads to new term such as “Sustainability”. Despite that, the interdisciplinary research type continued strongly in this decade, architecture discipline research explored new terms such as “Sustainable Building”, “Ecological Building”, “Green Building”, “Energy Saving Building”, “Zero Energy Building”, “Zero Carbon Building”, etc. (Jankovic 2012).

Recent researches state that construction industry consumes 35% of global energy. The goal and substances of architectural education are required to be reformulated to embrace the demands of today’s society. It is fair to say that construction industry play a significant position in growth of the economic, which makes it an essential player in energy resources problem (Ceylan 2014).

According to the USGBC report, in the USA buildings consume 36% of overall energy and 65% of electricity usage. That means sustainable construction must be taken into account because any innovation helps to provide efficient use of materials or energy saving in building would beneficial the global sustainability (Kibert 2012). The professionals has been under pressure to produce more research to create better development in the construction industry because of the increase awareness of the sustainability and sustainable design issues among academic institutes as well as the society. This awareness resulted in better development of renewable energy resources, the use of recycled materials, and the use of water and reclaim of rain and gray water (Kibert 2012).

In the world, the three main economic sectors that consume energy are transportation, industry, and buildings. Buildings have essential portion of energy consumption in our planet therefore; it needs a careful look for efficient operation (Mazria 2003b).

2.3.2 Sustainability and architecture

Sustainable architecture is a revised conceptualization of architecture to answer a numerous of contemporary concerns regarding the effects of human activity. The key to architectural sustainability is to work with, not against, nature; to comprehend, sensitively employ, and at the same time avoid damaging natural system, this called ***“The Natural Image”*** approach (Williamson, Radford, and Bennetts 2003).

There have been many approaches to define sustainable architectural through the introduction of the term sustainable development, green architecture, environmentally responsive design, and ecological design with example proposes of ***”Six Green Design Principles”*** which are conserving energy, working with climate, minimizing new resources, respect for users, and respect for site. In 1970’s, one can trace that ecological, green, and environmental are titles that embody the concept of buildings design should take essential account of their relationship with natural environment and their impact on it (Williamson, Radford, and Bennetts 2003).

“ESD” is a fuzzy term however; it is sometimes used to refer to sustainability. The letter ‘E’ stand for environmental or ecological, the letter ‘S’ stand for sustainable or sustainability, and the letter ‘D’ stand for development or design. The three elements (systems) of sustainability which are environmental, sociocultural, and economic often called ***“triple bottom line”*** by which the feasibility and success of design should be assessed (Williamson, Radford, and Bennetts 2003).

2.3.3 The role of architecture

Winston Churchill stated recognizing the built environment: “First we shape our buildings and afterwards the buildings shape us.”

The International Council of Construction (CIB) defines the objectives of the sustainable construction, which are creation and operation of a healthy built environment established on ecological design and resource efficiency (Kibert 2012).

Chris Livingston stated, “Social change reflected on the architect role where architects are no longer seen with the same reverence that they have had in last half-century”. Now days, the built environment is a huge forces that inform the final product. Architects can no longer keep believing that building form is that answer. Architects has to change naturally to be better facilitators, collaborators, negotiators, and more participatory in order to have a future. People looking for a team to work with, and if we are not changing ourselves, that may not include architect (Lofthouse 2013). That was an important wake up call for architects and the important of their roles for built environment and embracing the sustainability issues in recent and future design.

Buildings are the most heavily energy consuming sector therefore, it shall be priority for government policies makers. “The United Nations Environment Program (UNEP), 2007 reported that between 30-40% of global energy consumption is used by building sector” (John 2009). In Europe 40% of the total energy is consumed by building sector (Tommerup, Rose, and Svendsen 2007). Furthermore, in 2011, U.S. Energy Information Administration (EIA) in reported that buildings and their operation were estimated to use 41% of the United States’ annual energy consumption (EIA 2012).

“The U. N. E. Promoting Energy Efficiency in Buildings in Turkey in 2011 stated that in terms of final energy consumption, the building sector represents the second-largest energy consumer accounting for 36% of the total final energy consumption in 2008 and the building sector's emissions are 32% of the total national energy-related CO_2 emissions. However, the building sector in Turkey presents significant opportunities for cost-effective energy and CO^2 savings, estimated at some 30-50% of the current levels". Housing stock contributes about 75% of the fuel consumption and CO_2 emission of the total building sector

2.3.4 Architectural education and sustainability

"One of the keys to slowing global warming on our … planet may be educating architects and other building professionals about designing and building more efficient buildings" (Mazria 2003a).

Architectural education educates and trains future architects for professional architectural practice in governmental and private institutes as well as higher education research. The impact of construction on natural environments is essential theme that should be addresses in architectural education (Benkari 2013).

At present time, building industry demands graduates and practitioners who are able to respond to the challenges of climate change with competence of sustainable environmental design. In order for that to take place, a revision process of higher education and professional training is required (Altomonte et al. 2012).

Considering all issues that have negative impact on our environmental such as CO_2 emission, high fuel consumption, global warming, etc., the role of architectural education has to be define as a means of graduating new generations of architects who are trained to integrate principles and practices of sustainable environmental design (Bashir, Ahmad, and Jibril 2014).

Architecture is a unique human activity that blends artistic creation with scientific knowledge and technological innovation. Architecture plays a major role in providing for basic human needs for shelter, transport and commerce. Architecture has both aesthetic and utilitarian objectives and it has a vital role to play in the quest for sustainability of human civilization. The challenge for modern architects is to incorporate the principles of sustainability into their designs, without compromising their utility or style. This will require a fundamental reorientation of architectural education to emphasize the conservation of energy and natural resources in new and existing buildings and facilities (Taleghani, Ansari, and Jennings 2011).

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 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).

In response to the spirit of sustainability, many schools have begun to introduce and revise their syllabus content to include technical issues and sustainable design approaches. Hence, the terms such as environmental responsive design, energy conscious design and bioclimatic architecture has become common and form part of the courses objectives. Architecture encompasses both art and science disciplines. There is a lot of subjectivity when discussing architecture. The architectural design process is complex as it does not arise from a linear thought process or equation (Ibrahim 2008).

2.4 Integrating Sustainability Principles

The main goals of the architectural education is prepare the architecture student for the professional life. This preparation requires adaptation to the ongoing progress on our global problems. In the last five decades, the global energy and environment happened to be a big deal of problem. That required the architectural education to reflect on these issues. There have been several approaches to integrating sustainable design in architectural education. In general, there are two main approaches, which put sustainable design in two various positions and ranges in architecture practice (Wright 2003). These approaches can be concluded as follow:

2.4.1 Stand-alone studies focused on sustainable design principles

The academic institutes adopt sustainability thorough sporadic effort or separated treatment as an extension of the regular program. It develops under some existing classes concerning environmental control, which presents the technical knowledge. Instructors specialized in technical subjects mostly teach these classes. This type of approach illustrates that the institute has yet comprehensively embraces the subject of sustainability. The limitation of this approach that the instructors who have the technical knowledge has to carry out the responsibility of integrating sustainability into design studio. However, these instructors in some cases are not in a position to do so (Wright 2003).

Terenzini considered that varied experiences in diverse areas that are educationally relevant have positive impact on students learning (Terenzini, Pascarella, and Blimling 1996).

At the architectural department, Yildiz Technical University, Istanbul, Turkey the Architectural Design studio-4 is a sustainable design studio. Students are required to design energy efficient buildings using sustainable design principles. At the start, the students are introduced to the subject through lectures, case studies, and research work. Student picks up the elements and futures of sustainability that he/she will use and integrate in the design project. The evaluation of the student is based on the use of sustainability principles in the design project and the level of energy efficiency of the building. By the end of the course, the student would expected to acquire proper knowledge about the sustainability and energy efficiency and the ability to integrate this knowledge into design project. On the other hand, the studio does not continue in the following semester so that students do not have the continuation built up for the sustainability knowledge that they have had acquired. That would generally lower the expectation of using sustainable design in their professional life in the future (Ceylan 2014).

2.4.2 Embedding sustainable design into architectural education curriculum

In such model, the academic institute fully integrates sustainability into all class work by stating that in the curriculum. The integration of sustainability into the design studio projects establishes ether by setting sustainable issues as one of the design concept principals or by creating separate built environmental design studio. The advantage of this approach is that includes all academic members into sustainability subject, which guarantees the integration throughout all entire course work. It embraces sustainable design in the program by the obligation of all entire academic members (Wright 2003).

This approach is adopting the principles of energy efficiency and sustainable design straight into the pedagogy form of the architectural education. This approach became common lately in many schools around the world. For sure, this approach requires a full revision of the architectural education curriculum while radical changes of the design studio need It (Ceylan 2014). The students in the undergraduate education should be prepared to understand and deal cleverly with real modern life (Chickering and Gamson 1987).

Many distinct architecture schools around the world have modified its curriculum programs concerning sustainable design. At Cornell University, undergraduate architecture program has a "design 1" sustainable design studio, which concern about environmental design issues. This studio is supported with embedded course in the curriculum concern about sustainable landscaping and the relation to the building site. The direction in Cornell University is that the same studio continues in the following semesters with various supporting courses covering various topics of sustainability. This radical approach helps the students to apply the acquired knowledge and learned experiences in the future professional life (Cornell University 2015).

In Pratt University, department of architecture has an undergraduate program fully committed to contemporary issues such as integration of sustainable practice, materials, and technology into design studio. The goal of the design studio is sustainable design solution. There are supporting courses feeding in the design studio principles approach, which are building services, building environment, etc.

Information about professional certificates are introduced to make students aware of professional architectural world. (Pratt University 2018).

At Technical University of Delft - Architecture and the Built Environment Department, students are taught that school, home, and streets, which connects them is what architecture and built environment is all about. The program emphasize on how we modify our buildings, streets and cities to build safer environment for the users. Further, it states that the program means that students explore and design the world around them, which requires involvement in more than just architecture and design. It stated clearly that the education program is technical and scientific and the students will work in different design projects individually or in groups so that they would learn about technology, culture, and living environment acting and interacting with each other (Technical University of Delft 2015).

2.5 Problems in Integrating Sustainability in Architectural Education

Beside the architectural education problems and architectural design studio problems that has been mentioned earlier, there have been ongoing problems with integrating the sustainable education in the architectural curriculum itself. There are academic hurdles that are hindering the development of sustainable architectural education. These hurdles involve; confusion of the meaning of sustainability, ambiguous definitions about sustainable architecture, and lack of experts of this field area (Taleghani, Ansari, and Jennings 2011).

Studies show that lack of awareness of consumers (users), lack of influence by the authorities (state), lack of knowledge of building professionals (architects), lack of understanding of costs and benefits by the clients (owners), are prominent among the barriers to mainstream sustainable construction practices. All these barriers have some implications to architectural education (Ceylan 2014).

Study based on survey work affirms that, at a global level, there is increasing consciousness and concern about the themes of sustainability, as well as a consent that it provides the potential to serve as a source of creative inspiration to the design process (Altomonte, Rutherford, and Wilson 2014). However, the existing educational programs do not yet completely support the advancement of sustainable design, which suggests significant room for improvement. In addition, insufficient regulative frameworks influence the way in which sustainability is embraced by the various players of the building industry. Certainly, the professional market perception is driven by aesthetic look, reduction in investment and operation cost rather than ethical commitment to sustainable design. However, the theme that sustainable design solutions are more expensive, or can suppress good design, is still predominant among the various stakeholders of the construction sector (Altomonte et al. 2014).

The Environmental Design in University Curricula and Architectural Training in Europe (EDUCATE) reported in (EDUCATE, 2010 a) that many universities and academic institutions still have divided program between applied teachings and theoretical. During lectures' courses, students learn about principles, concept, and bodies of knowledge that supposed to supply and guide the design project in the studio. Those courses may include built environmental, building structure, building science, building physics, economic analysis, socio-cultural, etc. The essential joint problem with those type of courses that it lacks envision and connection to the studio projects (EDUCATE 2012, Altomonte, Rutherford, and Wilson 2014).

Students are seldom capable of integrating some of theoretical acquired sustainable issues into design project. Moreover, students are mostly involved in a design problem unknowing the design process of it, which results on leaving behind the sustainability issues. Generally, this problem is due to the lack of involvement of theoretical courses instructors in design studio and vice versa from the design studio instructors (Altomonte, Rutherford, and Wilson 2014).

2.6 Studio culture and the sustainability challenge

According to the earlier mentioned problems facing the sustainable architectural education, the concept of conventional teaching and learning would not be the proper approaches to address sustainability for design studio education. 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 et al. 2010, Sarhan and Rutherford 2014).

A unique approach in recent study for undergraduate students that was done in architectural, engineering, and construction disciplines. The study explains the development and initial evaluation of serious of game for learning sustainable design issues and practices. The result proves that serious games could improve students learning of sustainability issues. It shows a boost in procedural knowledge by 37% and subjects' declarative knowledge by 22% (Dib and Adamo-Villani 2014).

The Environmental Design in University Curricula and Architectural Training in Europe (EDUCATE) executed a sets of interviews with academics in over than 60 schools and faculties of build environment from about 30 countries. This study aimed to explore the potential pedagogical hurdles that prevent integrating sustainability into architectural studio. The questions were regarding sustainability in academic curriculum and pedagogical methods. Also, the respondents were able to reflect on the weak and strong parts of the educational structures in his/her institute and illustrate whether the integration of sustainability is matter of course or of force. The acquired result showed that in order to accomplish successfully the sustainability principles in architectural design pedagogy, educators have to recognize the need to address many issues such as; clear definition of learning outcomes for the academic programs and individual modules. Educators should establish qualitative and quantitative benchmarks and clear criteria for evaluation, introduce problem based learning to support delivery of knowledge, and Embrace teachers' competence and knowing the themes of sustainability. Further, they should inspire students to evaluate their work and promote the exploration of various design solutions during the development stages, encourage the invitation of external experts during design process, develop and reinforce methods for teamwork, dialogue, and collaboration among instructors and students, and embrace the ethical and socio-culture values of sustainability. (EDUCATE 2012, Altomonte, Rutherford, and Wilson 2014, Altomonte et al. 2014).

It is essential to embrace a deep learning approach for principles and practices of sustainability. Students should participate in analytic and synthetic processes, underlining reflection and serious self-evaluation techniques, imaginative reconstruction, independent thinking, and balancing design creativity with environmental, social, and economic responsibility. In achievement of that, students should be exposed to inclusive aspects of sustainability (Kevin 2003, O'Brien and Sarkis 2014). Eventually, sustainability should be seen as an essential requirement of the process itself not as a unique addition issue to the design (Altomonte et al. 2014).

Chickering and Gamson identified seven principles to improve the undergraduate education, which can be used to come over some of the integration of sustainability into design studio. These principles are; encourages contacts between students and faculty, develops reciprocity and cooperation among students, uses active learning techniques, gives prompt feedback, emphasizes time on task, communicates high expectations, and respects diverse talents and ways of learning (Chickering and Gamson 1987).

There are different certification programs that have been established by some foundations of energy building efficient in various countries. Some of these well-known certification programs are LEED, BREEAM, and DGNB. They accepted ecological design and sustainable construction as the key strategy to control the energy and resources problems. These programs established their fundamentals on integrated process of sustainable design. The main evaluation and assessment criteria of these building certification programs become the reference for many architectural design processes, which is considered to be energy efficient in the context of contemporary architecture. On the other hand, they are used for educational reasons in architecture schools. The use of these certification programs as a reference for architectural education is huge miss leading of the real education of sustainability issues and the integration of sustainability into design studio process. All these programs have a commercial image more than education values. Furthermore, some of these programs have no supervision over the designed project neither during the design process nor during the construction stages. In most cases, these programs reserve less evaluation points for the architectural design of the building and considered heavier load of points on mechanical, electrical, technological, etc. issues, which take away the important role of the architect.

2.7 Assessing Learning Process

Integrating sustainability principles into design studio required the creation a unique teaching method. However, to major the success of the created teaching method that required a special assessment process.

2.7.1 Bloom's taxonomy method

Benjamin S. Bloom (1956) has framed out a process to identify and classify educational objectives to assist instructors in the assessment of their classes' materials and exam outcomes. Bloom's taxonomy was a revolting model meant to illustrate systematic classifications of cognitive operators. His categorization had three educational activities domains for the human learning process: cognitive, affective and psychomotor (Halawi, McCarthy, and Pires 2009).

Wallschlaeger supported Bloom's taxonomy approach, which can be apply to the curriculum development and instructional goals for classroom. In addition, it can be effective by using the three learning domains. The three educational domains that can be adopted to create instruction for architecture. Design students' observations constructed their knowledge, which result in developing an understanding about the design. Students learn by experiencing the design procedure and reflecting on the design process so that their cognitive talents, emotional expression, and psychomotor skills are developed while the learning procedure take place (Wallschlaeger, Busic-Snyder, and Morgan 1992).

Furthermore, Bloom sub-categorized these domains to simple and complex classifications, which provides the instrument that researches need to determine the learning of specific behavior patterns of the students of a course. Bloom's taxonomy successfully has been employed by educators in different disciplines to develop innovative classes to accomplish learning outcomes of the classes (Halawi, McCarthy, and Pires 2009).

The cognitive learning domain concentrates on intellectual abilities and mental skills which assists the student to know, comprehend, and practice what he/she learned to a new status, analyze, and assess the value of ideas and materials (Odhabi 2007). The affective domain expresses as the changes in attitudes, interests, and values, with regard to the development gratitude and sufficient adjustment. Lastly, the psychomotor domain concerns the manipulative or motor skill area (Bloom and Krathwohl 1956).

From architecture perspective, the cognitive skills expresses the knowledge of design. The affective skills represents progressive attitude of designers. The psychomotor skills illustrates the ability of making models and drawings. Thus, it is clear that the design studio instruction covers up the three learning domains of Bloom's taxonomy (Kurt 2012).

The cognitive domain has given much concern because its relevance and applicability in secondary and post-secondary education. Bloom identified six different levels of learning under the cognitive domain (Bloom and Krathwohl 1956) is shown in (Table 2.1). He organized them on hierarchy basis as follow:

a) ***Knowledge*** that concentrates on memorization, recognition, and recall of information.

b) ***Comprehension*** that deals with organization of ideas, interpretation of information, and translation.

c) ***Application*** that centers on problem solving, use of particulars, and principles.

d) ***Analysis*** that handles detecting the implicit organization, and braking down the whole into components.

e) ***Synthesis*** that points on grouping of ideas to create something new, and innovating something unique that could be physical or verbal.

f) ***Evaluation*** that assesses making judgments on issues, and settling differences or disagreements.

Each category requires more complex thinking than the preceding one, and includes the previous levels of thought to progress to higher levels (Bloom and Krathwohl 1956, Yahya et al. 2013, Odhabi 2007).

The other two domains affective and psychomotor were also identified different levels of learning under each of them and organized on hierarchy basis (Odhabi 2007) (Table 2.1).

Table 2.1: Learning domain and their level of complexity (Odhabi 2007).

Level of Complexity			
6	Evaluation		Adaptation
5	Synthesis	Internalizing values	Complex over response
4	Analysis	Organization	Mechanism
3	Application	Valuing	Guided response
2	Comprehension	Responding to phenomena	Set
1	Knowledge	Receiving phenomena	Perception
	Cognitive	Affective	Psychomotor
		Learning Domains	

The affective domain identified five components level, which they are receiving phenomena, responding to phenomena; valuing, organization, and internalizing values (Table 2.1). This range from being able to receive phenomena to internalizing values, which means that certain values have control over a person's behavior for a sufficiently long time until the behavior becomes a lifestyle for that person.

The psychomotor domain identified six levels of learning. These levels are perception, set, guided response, mechanism, complex over response, and adaptation (Table 2.1). Perception happens at early stage of learning while the adaptation and naturalization is the most complex level, which means to be able to respond to issues automatically.

2.7.2 Checklist method

Checklist method is a simple process of testing whether or not student comprehends, integrates, and applies sustainable elements into their design project. Instructor identifies the sustainability elements that he/she wish to be considered by the students in the design project. Throughout the course, work time instructor should explain these elements using different techniques such as lectures, workshop, site visit, etc. to make sure the message reached the students. Instructor prepares a written list of the sustainability elements hands it out and explains it to the students. This is the checklist that the students’ final project would be assess by it. Instructor would check how many elements from the checklist each student project included. After collecting this data, instructor would come up with some statistic to analyze this data and understand how much overall success made, what most and less included elements, etc. (Bashir, Ahmad, and Jibril 2014).

2.7.3 Building performance simulations for integrated design

At present time most colleges in architectural education, still using digital technology as a tool for CAD in design. The integration of digital technology into the whole design process is still a certain gap (Yu 2014).

The US Department of Energy hosted a 'Building Energy Software Tools Directory' on 2011 where over 380 software packages were participated. Some of these packages were suitable for whole building analysis, and some were specialized for demonstrating compliance with codes and standards; lighting; ventilation; HVAC components and systems; and various other aspects of building energy performance (Jankovic 2012).

It is essential to involve the digital technology in the studio design process from the start to the end. Digital technology can provide support to the student during the design process stages not only as a drawing tools and presentation but also as a test and evaluation tools. It tests and evaluates the designed project during the design process starting from building orientation, form shape, material choice, façade shading, natural light, natural ventilation, etc.

The following is a survey review of the most common used digital technology in academic and commercial. The list includes the software name, the capability, the advantage, and disadvantage (Jankovic 2012).

EnergyPlus is a dynamic simulation software package developed in the US in late 1970's and early 1980's. It has the most comprehensive list of heat transfer and HVAC system models than any other building simulation software. However, it is a simulation engine only, and thus it only has a basic user interface. It will therefore not correct user input errors, although it will report them. The software is developed in FORTRAN programming language. EnergyPlus is an open system, which encourages development contributions from individuals.

DesignBuilder was launched in 2005 as the first graphical user interface to the EnergyPlus simulation engine. It is completely modular solution of a core 3-D modeller and nine modules (visualization, certification, simulation, daylighting, HVAC, cost, LEED, optimization, CFD) which work together to provide in-depth analysis of energy use, consumption and commitment for any building. Every module fully integrates with its counterparts.

IES Virtual Environment is a dynamic simulation modelling system that originated in the UK in mid-1990's, and is built around an idea of a shared content between different simulation tools. The shared database enables the model specification to be entered only once and facilitates the integration between different tools within the simulation system from which the database can be further expanded. The software has an extensive graphical user interface and a range of modules for the simulation of energy, air movement, lighting, HVAC systems, and others. Geometry can be imported from Google Sketchup or AutoDesk Revit.

TAS Building Designer has been developed in the UK. It is a commercial product, which combines a graphical user interface with dynamic simulation calculations that are carried out in hourly time steps. The software is accessed through TAS Manager, which provides access to core components: 3D modeller; building simulator; calendar database; construction database; internal conditions database; results viewer and weather database. It also enables the user to organize and access simulation projects through a directory tree structure.

TRNSYS - A TRaNsient SYstem Simulation program originated 35 years ago at the University of Wisconsin Solar Energy Lab. It has a modular structure in which the modules, called Types, each represent a specific component of the program. A particularly useful feature of TRNSYS, not available in any other simulation model described here, is the Equation editor, denoted as 'Calculator' in the Simulation window. This enables the user to modify outputs of any of the Types by applying a formula and to supply it as inputs into any other Type. Another useful feature in TRNSYS is the online plotter, which generates simulation output on the fly. This enables the user to follow the simulation as it unfolds, and to interrupt it if any modifications are required in the model.

CHAPTER 3

MATERIALS AND METHOD

This chapter presents the research materials, and method. It identifies the experimental studio, questionnaire survey, colloquium, on-line course evaluation and interviews. Further, it defines and explains the research methods out lines as well as SADS pedagogy and its structure. Furthermore, it demonstrates the role of digital technology, instructor attitude, and jury formats.

3.1 Materials of Research

The research took place at Izmir Institute of Technology (IYTE), Faculty of Architecture, Department of Architecture in the third year design course in the form of experimental studios with a novel pedagogy.

3.1.1 Experimental studio

A separate section that was to be conducted with a different approach was offered to students of the third year design studio (junior students), with the aim of integrating sustainability principles in architectural design projects; it has been called Sustainable Architecture Design Studio (SADS). Students were free to choose to attend the SADS or the conventional studio. The first attempt was the AR 302 Architectural Design V studio offered in spring of 2015. The second one was AR 301 Architectural Design IV in fall of 2015, and the third was AR 302 Architectural Design V in spring of 2016. The same materials were used in all three experimental studios but updated each time according to the feedback from the students. Details on these studios, along with the modifications or additions made in line with the feedback or to improve the pedagogical method, will be explained in the chapters devoted to these studios, i.e. Chapters 4, 5 and 6.

3.1.2 Questionnaire survey

The questionnaire survey forms were handed out to the students at the start of the colloquium or sent earlier to the students by email. It had various questions about the studio structure and its format, sustainability issues, jury style and its format, and their own comments about the studio in all aspects. In the three experimental SADSs, there were minor changes in each questionnaire form from semester to semester. These changes will be explained in the related chapters later. The forms are presented in (Appendices I, & W).

3.1.3 Colloquium

Colloquium is an open discussion forum used as an assessment tool of the SADS pedagogy structure and teaching method. The students were invited to the colloquium within ten days after final jury day as well as after the SADS grades were announced. During the open colloquium, the instructors expressed their general views about the semester and then the students were invited to ask any questions related to the SADS or make any general comments, as well as recommendations. The colloquium session was meant to be for objective questions and general comments only. Instructors informed the students that they had designated special time in their office after the colloquium session to answer any of their personal questions individually.

3.1.4 On-line course evaluation

IYTE has an on-line course evaluation system. Each student has to fill in the online course evaluation in order to learn his/her class final grade. The on-line evaluation form became accessible to the class instructor after the final grades were officially submitted on-line. The on-line course evaluation has two parts; first group of questions concern the instructors and course content evaluation, second group of questions concern the classroom and other facilities conditions. The course evaluation forms are presented in (Appendix. J)

3.1.5 Post course interviews

Personal interview is one of the qualitative research tools to investigate the participants' perspective in depth (Bryman 2012) A semi structured interview is more flexible than the conventional one. It has a flexible style format to extract the information and provide chance to elaborate on each question. In addition, it provides the interviewee with the freedom in the way he/she responds while the content is controlled by the researcher. (Edwards and Holland 2013). This type of interview was conducted with the SADS former students after two years of the third experimental studios. The interview was either face to face, or over Skype with ex-students. The questions are presented in (Appendix Y). They were semi-structured interviews type, which were planned for 50 to 60 minutes, while some of them were voice recorded.

Questions were divided into two sections. First part was concerned about their personal professional status since their graduation in a relation to sustainable design. Second, part was concerned about the SADS work evaluation from their architectural professional view not a student view. There were two questions at the end of each part for extra comments from the interviewee.

3.2 Research Method

This section illustrates the major steps of executing the experiment that was created, improved, and followed in each semester. On each of second and third semester of the SADS experiment, there were adjustments, and modifications to the results, data analysis, evaluation, and assessment methods. All adjustments and modifications in the initial method are clarified before the experimental execution.

The literature review illustrated five design studio practice formats. The created format was focused on keeping the positive and disregarding the negative aspects of all formats. That was done through the personal experience of fifteen years teaching conventional design studios. The five formats were exercised throughout this experience as well as it was discussed among teaching members, while personal notes were recorded to come up with the best format for SADS.

In the SADS, each student was guided by all instructors. The proposed objectives of the SADS practice formats were exposing the student to more than one instructor's design views, allowing the student to practice group discussions, giving the student a chance to view other students' projects and ideas, and allowing the students the time to work on their own projects during the studio hours.

3.2.1 SADS Pedagogy

The SADS experiment was proposed with a new pedagogy that lead to the establishment of novel studio structure. The new structure also supported the implementation of digital technology.

SADS new pedagogy

The proposed SADS pedagogy aimed to restructure the conventional design studio culture and modules to:

- **a)** Establish clear definition of learning outcomes of the design studio.
- **b)** Establish qualitative and quantitative benchmarks and clear criteria for evaluation.
- **c)** Introduce problem based learning to support delivering of knowledge.
- **d)** Embrace deep learning approach for principles and practice sustainability.

The proposed SADS pedagogy structure had six guideline references.

- **a)** The Ecole three principles of the Ecole des beaux art education were (Carlhian 1979):
    - i. **Freedom**: Students were informed about the differences in the studio requirements (it applied to all three SADS) and were free to select the experimental studio and the instructor (it was applied on 2nd, and 3rd SADS).

ii. **Competition:** Studio time included numerous assignments, exercises, and tests built on competition spirit. Students were exposed to previous semester(s) work performance and awards to create competitive excitement (It applies to 2nd, and 3rd SADS).

iii. **Variety**: A variety of assignments and quick sketch problems intermingled with the term-long duration architectural project.

b) The Bauhaus prime education objectives depended on integrating theory and application with focus on unifying (Whitford 1992)

- ***Craft:*** Construction materials with focus on natural, local, and sustainable materials.
- ***Art:*** Form and mass creation to support sustainable design principles.
- ***Technology***: Digital technology integrated into design process periods.

c) Constructivist design studio concepts (Kurt 2012):

- Focused on learning and learner rather than teaching and teacher (Student centered concept)
- Constructing the student knowledge by reflecting on his/her own experience and observation.

d) Integrated public interest in the design studio (Anderson 2012):

- Engage and collaborate with the public / community to respond to their needs and problems during the design process (It was applied to all SADS).

e) Charrette design studio technique (Pernice 2013):

- Group or individual assignment of specific design problem of the project in definite giving time followed up by group panel critiques or discussion (It was applied to all SADS).

f) Embracing deep learning approach for principles and practices of sustainability. Students participated in analytic and synthetic processes, serious self-evaluation techniques, independent thinking, and balancing design creativity with environmental, social, and economic responsibility. In order to apply this approach, sustainability was seen as an essential requirement of the process itself not as a unique addition issue to the design (Sarhan and Rutherford 2014).

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

- Teach others, practice by doing, and group discussion are the most techniques to retain knowledge in the student mind.
- Demonstration and audio-visual are moderate techniques.
- Readings and lectures are less tools to retain knowledge.

The SADS format was applied on all three experimental studios. Two instructors conducted the design studio working as a team supervising all students with the help of one teaching assistant. The SADS had twelve working hours per week (four hours theoretical and eight hours practical). The instructors conducted the SADS hours as follow; eight hours on Monday and four hours on Thursday. During the desk critique's scheduled time, one instructor looked after half of the class and the other instructor looked after the other half. At the following desk critique, instructors switched positions in order to make sure that each instructor overlooked all students at least once a week. The teaching assistant was available for all students who needed extra help.

SADS structure

The research proposed a new structure of SADS pedagogy and new timetable module to integrate the sustainability principles into design studio. The new proposal of implementation of digital technology supported the new pedagogy and followed the new timetable module.

The experimental course timetable

The fourteen weeks of the semester were divided into timetable modules system that allowed students to focus on the design process not only on the final design/product. The design process was divided into four periods as follow:

a) ***Four weeks for conceptual idea:*** this period focused on creating the project concept (main idea) with consideration of sustainability principles. Therefore, it included project introduction, project program, site visit, group site analysis, group site model, individual concept models, and introduction to sustainability principles, domestic technical trip, case studies presentations, panel reviews, and first midterm jury.

b) ***Four weeks for project development:*** the second module concentrated on developing the concept into developed floor plans and sections by continuous refinement to the produced work. Sustainability principles were integrated throughout the development process period. It included correction and modification of first midterm jury notes, case studies presentations, presentations by class instructors and guests instructors, panel reviews, individual study models, floor plans development and refinement, section development and refinement, sustainability strategies, site and landscape development, façade sketches ideas, and second midterm jury.

c) ***Four weeks for materials and testing:*** in this period, students were required to develop the project façades, which required materials selection. Sustainable materials choices were introduced to the students from the first week. The material selection were based on local natural and sustainable materials available in the construction field. In addition, the student ran simulation test for the project energy consumption. The studio work included responding to second midterm jury comments, presentations by class instructors and guest instructors, materials choice, façades design and refinements, system detail sections development, individual façade study models, energy consumption test and modification, and third midterm jury.

d) ***Two weeks for finishing and presentation:*** It included final project refinement, final jury presentation techniques, final presentation techniques, digital media presentation, final project models, and final drawing of the project and model making.

This timetable module system called (4+4+4+2).

Digital technology implementation

Students were required to use various software throughout the design process as design tools as well as drawing and presentation tools. Suggested softwares used during the design process:

- Conceptual design period; climate consultant and Sketchup.
- Design development period; Revit, Auto CAD, and Sketchup.
- Design evaluation period; Revit, DesignBuilder, and Sketchup.
- Final drawing and presentation; Revit, Auto CAD, 3D Max, DesignBuilder, and Sketchup.

Instructor attitude

Design studio instructors had special criteria that would help and support the new studio pedagogy structure. The following criteria supported the success of the studio:

a) Available to students during studio time and out of the studio. That was provided throughout various means of communication such as office appointment, social media communication, etc.

b) Respect diverse students' ideas and talents. Instructor tried to help to develop student idea as much as they can using their experience or inviting outsider expert. Instructor looked at the strength of talent on each students to explore it in his/her design. That leaded to diverse projects responding to variety of talents.

c) Provide vision that include a respect for diverse views. That was established throughout open discussion, panel reviews, invite outsider instructors, etc.

d) Provide clear and real evidence that students have learned. That was established by student oral presentation, follow up assignment, charrette studio work etc.

Experts' role

Experts were invited on each experimental studio to provide lectures as well as workshops demonstration. In addition, experts were invited in midterms and final juries. Four lectures and workshops were the minimum invitations number, while in some term it was more. The invited experts were varied according to the project subjects and the focus of the design work. On the other hand, there were experts who invited each experimental studio to provide basic knowledge about sustainability. Furthermore, experts were invited during the technical trips explaining each visited project in details. The expert role in general was to fulfill the unpossessed knowledge by the instructor regarding to sustainable design.

Jury formats

There were two types of juries throughout the semester; midterm's juries and final jury. Midterm's juries assessed the design process work while the final jury assessed the final project.

Various alternative jury formats are presented in the literature review, some of which were implemented as follow:

- Hands free review – 3rd SADS in first midterm juries.
- Role-play review and student-led review – 3rd semesters after third midterm juries.
- Introduce real clients and users review – all semesters in final juries.

- Make someone else do the work – 1st semester in midterm juries.
- Exhibition review – 2nd semesters by Bornova Municipality.
- Different media review (video and 3D glasses) – all semesters during final juries.
- Reverse review (invite professional architects to present their projects) – 1st, and 2nd semesters.
- Model only review – 1st semester midterm jury.
- The web review – 1st, 2nd, and 3rd semesters.

Midterm juries' grading system

Each midterm jury had 5 points value out of the total 100 class points. The evaluation was based on the following format shown in (Table 3.1).

Table 3.1: The midterm juries evaluation-grading system

Evaluation	Points
Outstanding	4.5 – 5.0
Developed	4.0 – 4.4
Promising	3.5 – 3.9
Undeveloped	3.0 – 3.4
Unpromising	2.5 – 2.9
Not attending	0.0

The six words shown in Table 3.1 were used to present real meaning to each student's performance as well as project evaluation. The use of the word has better meaning and expression than the use of the number to understand the project evaluation. This evaluation technique was created and used throughout the three experimental studios in all midterm juries.

CHAPTER 4

PILOT EXPERIMENTAL STUDIO

This chapter presents the pilot experimental studio execution of the research method. The chapter demonstrates how the method were executed, as well as the studio outcome. In addition, it presents the evaluations and assessments. Finally, it illustrates the findings and the recommendations for the following semester that led to modifications and/or changes to improve the original method.

This pilot experimental studio was published in an international conference paper (Mohamed and Ozkan 2017)

4.1 Introduction

All steps of the research's material and method, which were explained earlier in chapter 3, were executed on the third year AR 302 design studio of spring of 2015. The environmental issues aspect of the sustainability principles were the only concern for this research pilot as one of the three sustainability divisions. There was no consideration of the social and economic aspects of sustainability principles. The SADS had 22 students (13 females and 9 males).

4.2 Method Execution

The structure of SADS pedagogy guideline and timetable module structure with implementation of digital technology as well as methods' set up were incorporated into the SADS to apply the created pedagogy structure and instructor-teaching method as is shown in (Table 4.1).

The syllabus was based on the teaching pedagogy structure. It explained the objective, the rules, and the working method of the SADS to the students at first day. It is shown in (Appendix. A). The SADS project program and description is shown in (Appendix. B).

Weekly calendar of the semester work was handed out to the students, which was based on the module timetable structure and teaching pedagogy elements. The work calendar explained each class work program and homework requirements, which presented in (Appendix. C). There were two types of case studies of existing selected projects, sustainable projects, and related conventional projects, which helped to expose the students to various design ideas and techniques. The case studies name list are shown in (Appendix. D).

Table 4.1: SADS instructor teaching method of the pilot experimental studio.

No.	Learning Technique	Pilot Experimental Studio Teaching - Method AR 302 Spring 2015
1	***learning by teaching others.***	One case study was presented by each students (22 case studies). Case studies presentation had 2,5% of total class grade.
2	***practice by doing and group discussion***	Students were required to write the project program individually then in a small group of three then in a group of eight
3	***practice by doing***	Students were required to construct study models during the project design development process (4 models)
4	***deep learning***	Biweekly panel reviews were conducted (6 panel reviews) in two formats:
	group discussion	A) Group discussion of the design process and project development were conducted
	learning by demonstration	B) Students criticized each other's project by asking each student to present his/her project to the group
5		Technical trips to
	practice by doing	A) The project site and surrounding area
	learning by demonstration	B) Existing exemplary projects out of town (Istanbul, Turkey)
6	***practice by doing***	Instructors conducted biweekly charrette design assignments during the design process (4 assignments)
7	***practice by doing***	Various digital technologies were used throughout the design process
		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
8	***pubic interest/immediate use practice***	Project owner(s)/user(s) were invited to discuss the project (2 visits)
9	***learning by demonstration***	Monthly Outside expert(s) were invited for workshop (3 workshops)
	practice by doing	A) Instructors assigned homework related assignment ahead of each workshop studio
10	***learning by demonstration***	Instructors conducted individual desk critics (10 desk critics)
11	***learning by visual, audio, and lecture***	Class instructors offered lectures about the project topics that included visuals and audios materials (6 Lectures)
12		Juries
	learning by demonstration	A) Instructors conducted midterm juries (3 midterm juries)
	learning by teaching others	B) Instructors hosted a final jury that included University Rector (project owner), academic members.

4.3 Studio Outcome

The entire evaluation of the students' SADS work (100 points) was divided into two parts. First part was the students' performance evaluation throughout the semester including the design process, which embraced the sustainability integration (35% of total grade). Second was the finished product of final project submission evaluation (65% of total grade); of which 60% was dedicated purely to the design aspect and 40% for the degree of integration of the sustainability principles in the project (Table 4.2).

4.3.1 Students' performance

All along the semester, the work performance of each student was followed, evaluated, and recorded. The design and the work performance included group work, technical trip to sustainable designed projects (Figure 4.1), individual assignments in both class and home, midterm juries, and presentation (Appendix A and C).

Students' performance grades during the semester are shown in Table 4.2. The grades reflected each student effort to integrate sustainability principles into his/her project throughout the semester work.

Figure 4.1: On the left Piri Reis university, the first sustainable design campus in Turkey. On the right Erka sustainable design building.

Table 4.2: SADS's grades earned through evaluation stages of students performance.

Student NO.	First Jury 5 points	Second Jury 5 points	Third Jury 5 points	Attendance 5 points	Site / Cases 5 points	Assignments and Quizzes 5 points	Portfolio 5 points	Total 35 points
1	3,00	3,80	4,20	2,00	5,00	5,00	4,00	**27,00**
2	0,00	2,00	3,50	1,00	5,00	2,00	4,00	**17,50**
3	0,00	2,90	2,80	1,00	4,50	0,00	4,00	**15,20**
4	4,40	4,40	4,70	3,00	5,00	5,00	4,00	**30,50**
5	4,30	4,10	4,50	5,00	5,00	5,00	4,00	**31,90**
6	4,40	4,50	3,70	2,00	5,00	5,00	3,50	**28,10**
7	3,00	3,00	3,50	3,00	5,00	3,00	4,00	**24,50**
8	3,20	3,50	3,60	5,00	5,00	5,00	3,50	**28,80**
9	0,00	2,90	3,50	0,00	4,50	3,00	4,00	**17,90**
10	1,00	0,00	2,90	2,00	5,00	2,00	4,50	**17,40**
11	3,00	0,00	4,20	0,00	5,00	3,00	4,00	**19,20**
12	3,80	4,20	4,40	4,00	5,00	5,00	5,00	**31,40**
13	3,70	4,40	4,20	1,00	5,00	5,00	4,00	**27,30**
14	3,20	3,70	3,70	5,00	5,00	5,00	4,00	**29,60**
15	3,20	3,40	3,80	2,00	5,00	5,00	3,00	**25,40**
16	2,00	0,00	2,00	2,00	5,00	2,00	3,50	**16,50**
17	3,20	3,60	4,20	2,00	5,00	5,00	5,00	**28,00**
18	3,40	4,00	4,20	3,00	5,00	5,00	4,50	**29,10**
19	3,00	3,00	2,90	2,00	5,00	5,00	4,00	**24,90**
20	0,00	3,40	3,00	1,00	5,00	0,00	4,50	**16,90**
21	1,70	3,00	2,80	2,00	5,00	3,00	5,00	**22,50**
22	3,40	4,00	4,40	5,00	5,00	5,00	4,50	**31,30**

Midterm Juries: The studio instructors conducted three midterm juries throughout the design process with the possibility of one outside jury guest member. The jury guest member was project's owner, project's user, practice architect who had done similar project, or expert in the sustainable design area. The juries were open for anyone to attend (Appendix. E).

4.3.2 Finished product

Final Jury: Ten days before final jury time, SADSs' instructors explained the final jury format, style, and invited guests to the students. Instructors instructed and advised the students on what and what not to do during their jury presentation, which included how to conduct their jury in professional manner.

The studio instructors conducted one open final jury. The instructors role were to explain the overall project program, site location, design process of the project to the jury members and the guests, their position were organizing the event rather than critic the students' projects. Instructors chose the invited jury members based on three criteria, academic member, practical experience, and expert in the sustainable design subject. Jury members were handed out an explanatory brochure of all SADS work (Appendix. F). Studio instructors provided jury members with all project requirements and expectation. Jury members were instructed to be constructive in their critiques with positive attitude. Final jury requirements is shown in (Appendix. G), while Figures 4.2 & 4.3 illustrate the jury-setting environment.

Figure 4.2: Final project presentations in front of jury members.

Figure 4.3: Final project presentations in front of jury members.

All projects were carefully reviewed by the instructors after the final jury day. The projects were divided to three groups; outstanding, satisfactory, and unsatisfactory according to the number of sustainability elements integrated into each project (Table 4.4). The benchmark for each category was as follow:

- Outstanding projects were those that had 15 or more integrated elements (79% or more integrated elements); accordingly, 4 projects were considered outstanding.

- Satisfactory projects were those that had 8 to 14 integrated elements (42% to 74% of integrated elements); accordingly, there were 14 satisfactory projects.

- Unsatisfactory projects were included 7 or less integrated elements (37% or less of integrated elements); hence 4 projects were graded as unsatisfactory.

One project from each category is presented in the following paragraphs and Figures 4.4, 4.5, and 4.6.

Outstanding example

The design of the Architecture department in down town area of Izmir proposed by Eray Mustafa İnanç is shown in Figure 4.4. The presented design solution illustrated positive work of the integration of sustainability principles into the design starting from the project concept to the finished work. It incorporated 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 gray water, and solar panels. The proposed design had 56% reduction in annual energy consumption (Figure 4.4). The project integrated all 19 sustainability elements.

Project's photos: http://erayminanc.wix.com/projects

Project's video: https://www.youtube.com/watch?v=xEo6YzPm6SE

Figure 4.4: Outstanding project by Eray Mustafa İnanç.

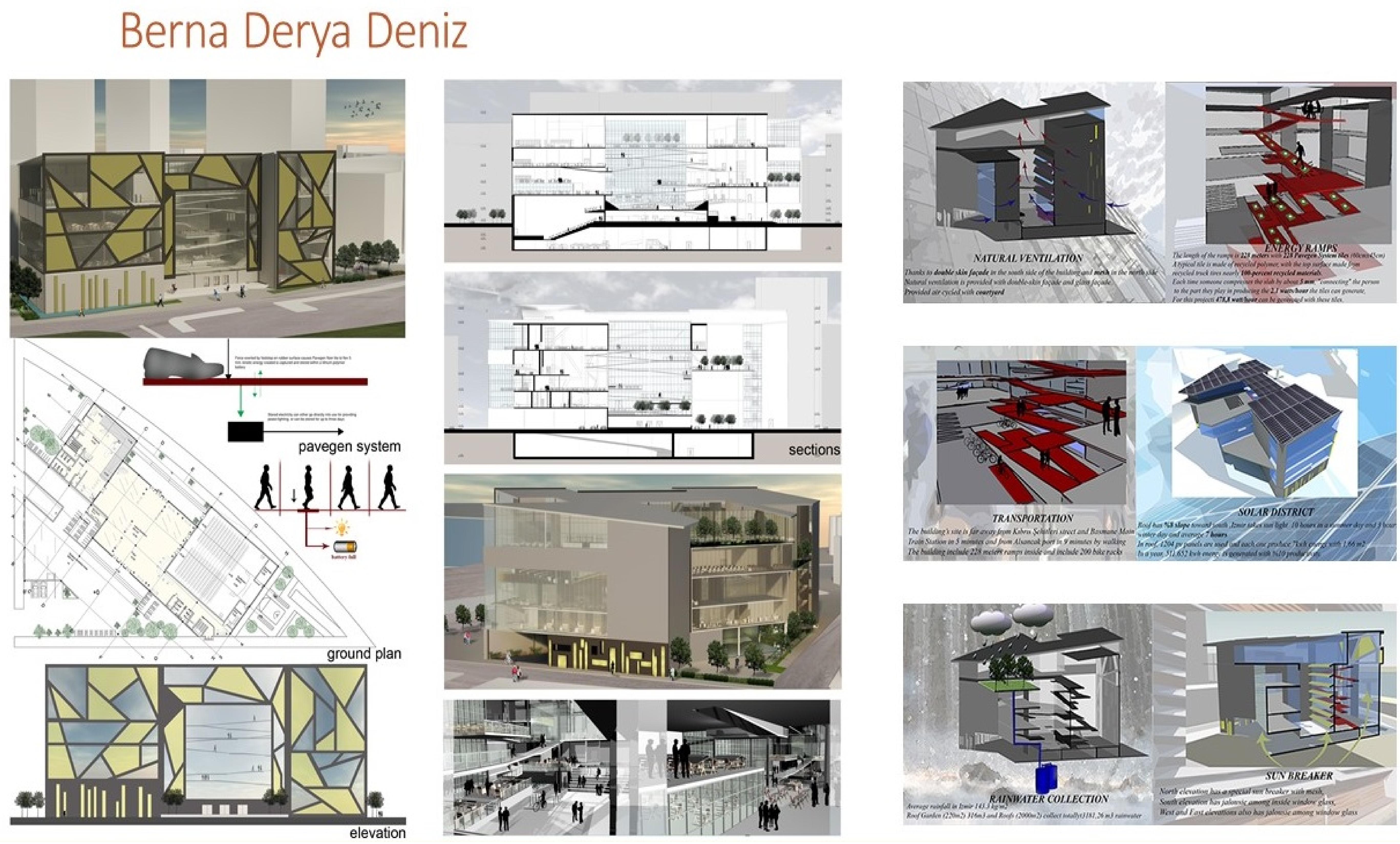


Figure 4.5: Satisfactory project by Berna Derya Deniz

Satisfactory example

The designed proposed by Berna Derya Deniz for the Architecture school project incorporate the use of; long ramps floors to convert kinetic energy to electricity as well as natural light, shading elements, natural ventilation, solar panels, green roof, and rain water collection. The design integrated 13 sustainable elements (Figure 4.5).

Unsatisfactory example

In this project, the student neglected to provide enough natural light in most working spaces as well as natural ventilation because of the wrong proportion between the building height and the space between the masses. The project did not propose any use of sustainable nor natural local materials in the construction. Moreover, student did not provide the correct energy simulation test for energy consumption and CO_2 emissions. Most of the sustainable design elements were not integrated in the design (Figure 4.6) meanwhile the project integrated 6 sustainable elements only.

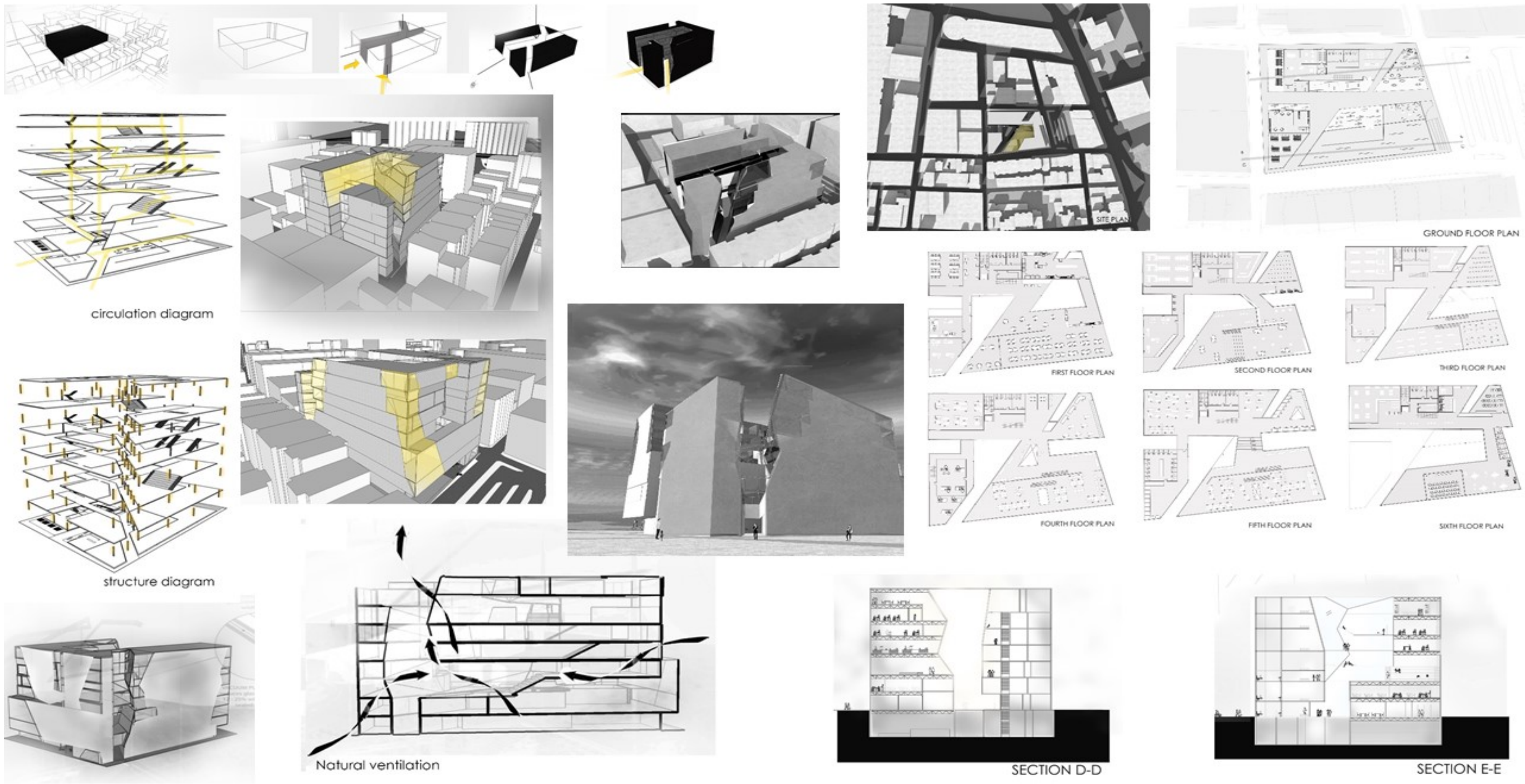


Figure 4.6: Unsatisfactory project example.

4.4 Evaluations and Assessments

This section presents the studio outcome's evaluations and assessments that were carried out with regard to the pilot experimental of SADS class. The first are evaluations by the design studio instructors of the students' work, based on the design process that they followed and the final product of their design project as well as the degree to which the sustainability principles elements were integrated into their final design. The second are assessments that were done by the students themselves for the way the studio was conducted and what their own journey was like.

4.4.1 Evaluations by 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 various alternative of 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). SADS's sustainable checklist elements is illustrated in (Appendix H), and (Table 4.3). Furthermore, the students were asked to use simulation programs (Revit or DesignBuilder) to major the building energy consumption in normal case and after applying the chosen materials. The checklist measurement and the simulation test counted for 40% of the total final project grades as was shown in (Table 4.4)

Grading system

The 40% of the total grade of final jury grade evaluation, which was designated to the checklist and simulation test was considered as 40 points. These 40 points division is shown in (Table 4.4)

Grading system was created for the major checklists' elements and the energy simulation test (Table 4.3). This points measuring system was applied to each project. The total elements were 19 sustainable elements. Each project was checked and given the elements number included in it (Table 4.4)

The average number of sustainable design elements that each students used in all projects were 11,77 of 19 elements total as is shown in (Table 4.4), while each sustainable design element integration times in the 22 projects were as is shown in (Figure 4.7).

Table 4.3: Grade system of sustainability elements and simulation test

Energy (15 points)	6 Elements or more	15
	4 or 5 Elements	10
	2 or 3 Elements	5
	One element	2
	None	0
Materials (5 Points)	One element or more	5
	None	0
Water (5 Points)	One element or more	5
	None	0
Health (5 Points)	One element or more	5
	None	0
Simulation Tests (5 Points)	Base case result	5
	Modified case with selected materials and shading elements	5
Total Points		**40**

Students were required to submit the energy consumption's simulation test for base case and modified case after applying the selected construction materials to their design. The grading points are presented in (Table 4.5). The detail grades evaluation of the final project for each student are presented in (Table 4.5).

Table 4.4: The number of sustainability elements integrated in each project of SADS

Students No.	Energy									Materials			Water			Health				Total Elements 19
	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-holes	Natural ventilation by channels (wind catcher)	reduce heating loads (high insulation glass system (low-e 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	
1	X	X	X		X	X			X	X	X		X	X	X	X		X		**13**
2	X	X			X	X				X			X	X		X	X	X		**10**
3	X	X		X		X										X		X		**6**
4	X	X	X	X	X	X		X		X	X		X	X		X		X		**13**
5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**19**
6	X	X	X	X	X	X	X	X	X	X	X		X	X		X		X		**15**
7		X		X					X			X	X			X				**6**
8	X		X	X	X	X	X			X	X	X		X	X	X	X		X	**14**
9	X	X	X	X						X		X	X		X	X		X		**10**
10	X	X		X		X			X	X		X		X		X				**9**
11	X	X	X	X	X	X			X	X			X			X		X		**11**
12	X	X	X	X	X	X	X		X	X	X		X	X		X	X		X	**15**
13	X		X	X	X	X			X	X	X		X			X	X			**11**
14	X	X	X	X	X		X	X	X		X	X	X	X		X	X	X	X	**16**
15	X	X	X	X	X	X				X	X		X	X		X	X			**12**
16		X		X					X			X	X			X				**6**
17	X	X	X		X	X	X		X	X	X		X	X		X		X		**13**
18	X	X	X		X	X	X		X	X	X		X			X	X		X	**13**
19		X		X		X			X		X			X		X		X		**8**
20	X	X	X	X	X	X			X	X		X		X		X	X	X		**13**
21	X	X	X	X	X	X			X			X	X			X		X	X	**12**
22	X	X	X		X	X	X		X	X	X		X	X	X	X	X			**14**
The use of each element in 22 projects	**19**	**20**	**16**	**17**	**16**	**18**	**8**	**4**	**16**	**16**	**13**	**9**	**17**	**14**	**5**	**22**	**10**	**13**	**6**	**11,77**

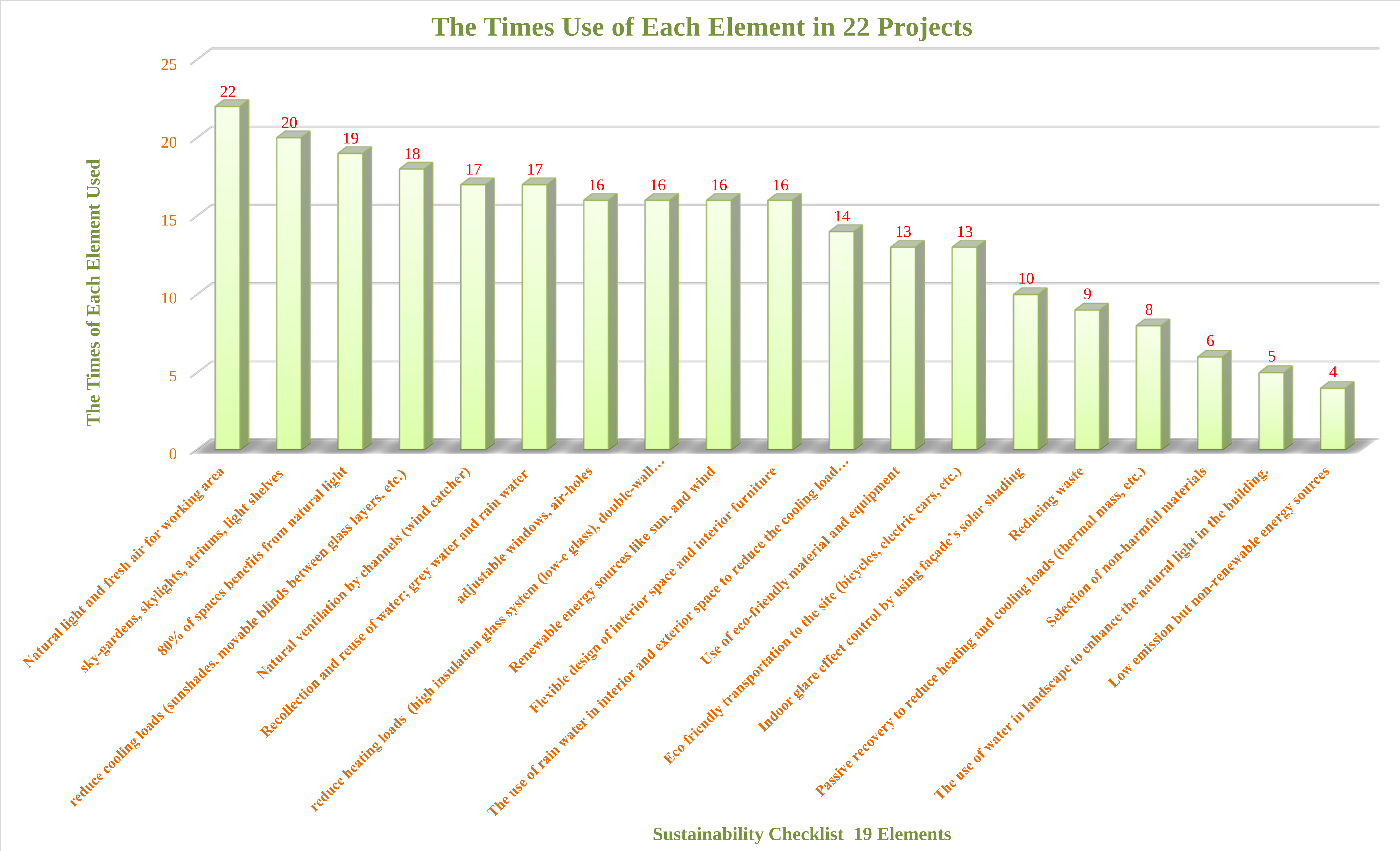


Figure 4.7: The times use of each sustainable design element in the 22 projects.

Table 4.5: SADS's final project grades

Students No	Energy 15	Material 5	Water 5	Health 5	Simulation 10	Total Sus. Checklist & Simulation 40	Design Evaluation 60	Total 100
1	15	5	5	5	10	**40**	**49**	**89**
2	10	5	5	5	5	**30**	**47**	**77**
3	10	0	0	5	5	**20**	**37**	**57**
4	15	5	5	5	5	**35**	**57**	**92**
5	15	5	5	5	10	**40**	**56**	**96**
6	15	5	5	5	5	**35**	**45**	**80**
7	5	5	5	5	0	**20**	**38**	**58**
8	15	5	5	5	10	**40**	**39**	**79**
9	10	5	5	5	10	**35**	**39**	**74**
10	10	5	5	5	0	**25**	**39**	**64**
11	15	5	5	5	5	**35**	**51**	**86**
12	15	5	5	5	10	**40**	**45**	**85**
13	15	5	5	5	5	**35**	**47**	**82**
14	15	5	5	5	10	**40**	**42**	**82**
15	15	5	5	5	10	**40**	**45**	**85**
16	5	5	5	5	0	**20**	**42**	**62**
17	15	5	5	5	10	**40**	**48**	**88**
18	15	5	5	5	10	**40**	**53**	**93**
19	10	5	5	5	5	**30**	**42**	**72**
20	15	5	5	5	5	**35**	**30**	**65**
21	15	5	5	5	5	**35**	**28**	**63**
22	15	5	5	5	10	**40**	**47**	**87**

SADS’s final grades of each student is presented in (Table 4.6). The table illustrated the instructors’ evaluation of each project throughout the semester, which included the design process work and the final project presentation.

Table 4.6: SADS's final grades of each student

Students No.	Design Process Grades	Final Jury	Final Grade	Letter Grades
1	27,00	57,85	**84,85**	**BA**
2	17,50	50,05	**67,55**	**DC**
3	15,20	37,05	**52,25**	**FD**
4	30,50	59,80	**90,30**	**AA**
5	31,90	62,40	**94,30**	**AA**
6	28,10	52,00	**80,10**	**BB**
7	24,50	37,70	**62,20**	**DD**
8	28,80	51,35	**80,15**	**BB**
9	17,90	48,10	**66,00**	**DC**
10	17,40	41,60	**59,00**	**DD**
11	19,20	55,90	**75,10**	**CB**
12	31,40	55,25	**86,65**	**BA**
13	27,30	53,30	**80,60**	**BB**
14	29,60	53,30	**82,90**	**BB**
15	25,40	55,25	**80,65**	**BB**
16	16,50	40,30	**56,80**	**FD**
17	28,00	57,20	**85,20**	**BA**
18	29,10	60,45	**89,55**	**AA**
19	24,90	46,80	**71,70**	**CC**
20	16,90	42,25	**59,15**	**DD**
21	22,50	40,95	**63,45**	**DD**
22	31,30	56,55	**87,85**	**BA**

Data analysis

After all projects had been graded by the instructors, data was analyzed to understand the positive and negative part of this experimental pilot work. The SADS pilot had nineteen sustainable design elements that were required by the students to integrate them in their project. The (Figures 4.8) illustrated the correlation between the number of sustainable design elements each student used in his/her project and the final studio grades.

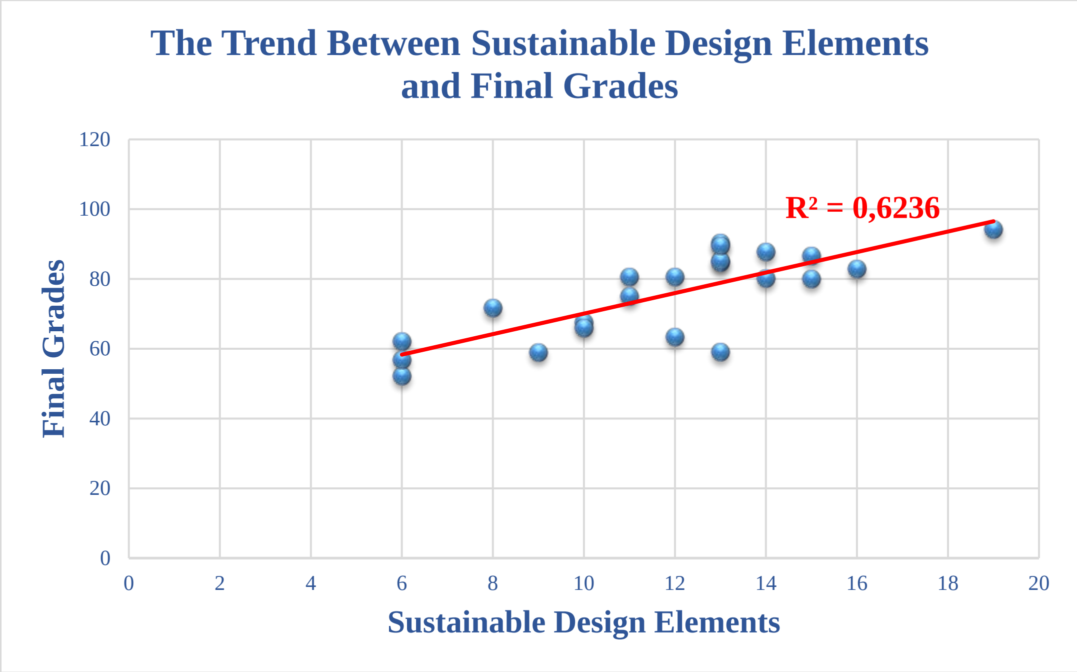


Figure 4.8: The correlation between the numbers of sustainable elements each student used in his/her project and the final SADS's grades

In additional, The trend between design process grades representing the SADS pedagogy structure and final project grade of the students show a positive result as shown in (Figure 4.9) Naturally, the same positive trend result between design process grades and final studio grades.

4.4.2 Assessment by the students

The assessment of the SADS pedagogy structure was done throughout three methods. They were as follow:

- **a)** Questionnaire form
- **b)** SADS colloquium
- **c)** IYTE's online class evaluation

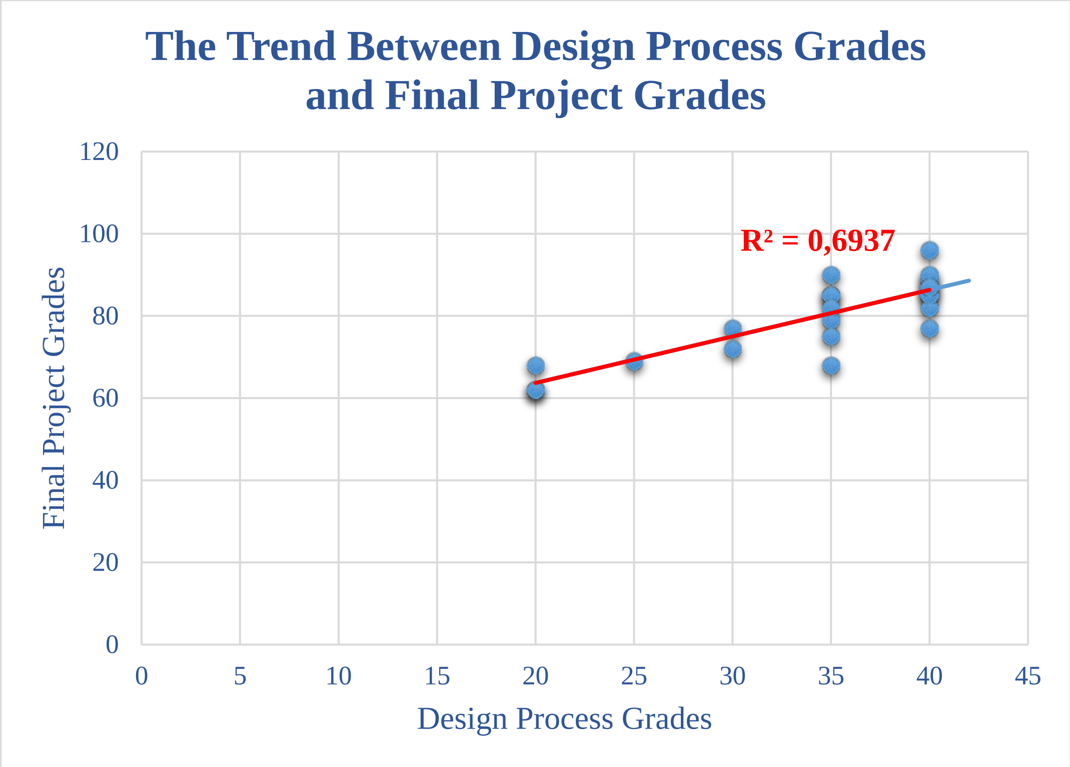


Figure 4.9: Positive trend result between design process grades and final studio grades

Questionnaire form

Nine days after the final jury, the grades (95% of the class grade) were announced, including final jury grade. Instructors invited the students for an open colloquium. The students were handed out a questionnaire form (Appendix. I) that were used as measurement tool for the SADS pedagogy and teaching method success. There were various questions about the studio structure and format, sustainability design elements, jury style and format. Students were requested to feel free to write their own comments about the studio from all aspects. Teaching assistant collected the filled form with no name on them for the integrity of the collected data as well as moving any pressure of directive answer on the form

Questionnaire forms' results

Twenty questionnaire forms were collected from the students. The following were the answers of these questions:

1) Did you have information about sustainable architectural design before this design studio?

Twelve students answered "No" while only eight had some idea. Of these, four had taken elective courses before; two had made research on their own while two had participated in an architectural competition.

2) Did you attend any related course(s) about the technical aspects of sustainable architectural design before this design studio?

Sixteen students have never attended any classes while four students attended one course only.

3) Design studio pedagogy structure included many elements during the semester. Would you put these elements in order, the most beneficial to your design project process?

This question had 15 questionnaire forms that had correct answer format of 20 forms. SADS pedagogy structure 12 elements were placed in order of priorities in the students' answers. The most beneficial was given 12 points and the least was giving one point. Each elements average from the 15 students' answer was recorded, as shown in (Table 4.7). The average order of the SADS pedagogy elements are presented in (Figure 4.10).

Table 4.7: The students' evaluation average points score of the SADS pedagogy structure elements.

	SADS Pedagogy Elements / Forms order	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	14 th	15 th	Each Element Average
a	Physical models	3	8	6	2	7	6	3	9	2	4	3	6	1	4	6	**4,67**
b	Site analysis	2	9	11	7	2	12	5	10	7	2	9	4	4	10	5	**6,60**
c	Lectures by instructors	11	11	5	8	6	7	11	7	8	11	4	10	7	12	9	**8,47**
d	Case studies	12	5	12	12	12	8	10	11	10	9	10	9	12	11	8	**10,07**
e	Site trip	6	4	4	3	1	9	4	8	9	1	11	5	3	9	7	**5,60**
f	Technical trip visiting sustainable building	10	12	10	10	3	10	12	12	12	12	12	11	8	8	2	**9,60**
g	Lectures by expert visitors	9	10	9	4	5	11	6	6	1	7	5	7	11	7	1	**6,60**
h	Panel reviews	4	6		6	11	4	9	4	6	5	7	3	6	5	12	**6,29**
i	Midterm juries	5	1	7	9	10	5	7	1	11	10	6	12	2	3	4	**6,20**
j	Desk critiques	8	7	8	11	4	2	8	5	5	6	8	2	5	6	11	**6,40**
k	Assignments	7	3		5	9	1	2	3	3	3	2	1	10	2	10	**4,36**
l	Use of digital media	1	2		1	8	3	1	2	4	8	1	8	9	1	3	**3,71**

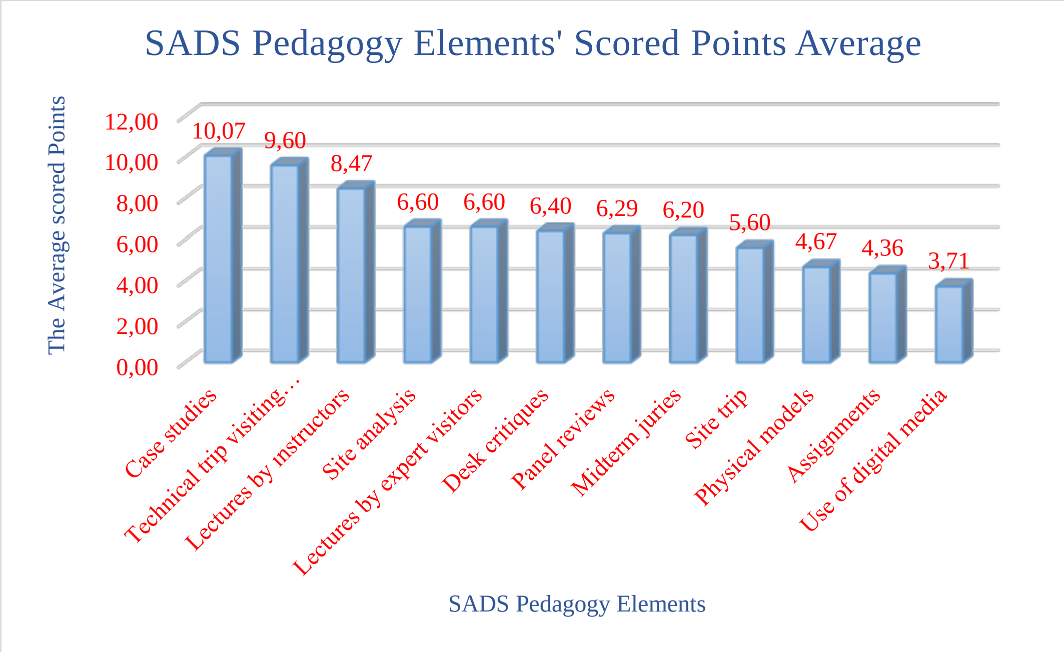


Figure 4.10: SADS pedagogy structure elements average scored points

4) Will you practice sustainable design in your profession in the future?

There were nineteen students, who answered “Yes” and one student answered “No”.

5) If you will continue your graduate study in the future, would you chose an architecture environmental subject such as sustainable design, ecological design, energy saving design, etc. as your study topic?

There were nineteen students, who answered “Yes” and one student answered “No”.

6) What are the difficulties for designing a sustainable building in the design studio course?

Majority of the students express there pleasure to attend SADS even though it was hard due to the extra effort and energy needed. They expressed their gratitude for the knowledge that they have learned which it was considered a great challenge for them. Further, students appreciated the constructed studio timetable and the clearness of the studio objective and requirements. Furthermore, most of them were thankful for the technical trip.

Some students complained about the difficulty of the energy simulation work being started late in the semester, while few said the technical implementation of the subject was hard to do but they were positive that they will do better in the following semester.

Most of the students had fear of the studio subject but the fear went away after the third week due to the clearness of the instructors' method. Further, some students expressed that the SADS teaching method was more effective than similar studios that they attended in Erasmus program.

7) Can you make an order of what you considered the most important to least important in your design in this semester?

This question had 19 questionnaire forms that had correct answer format of 20 forms. SADS principles design elements was placed in order priorities in the students' answers. The most considered element was giving 8 points and the least was giving one point. Each elements average from the 19 students' answer was recorded, as shown in. (Table 4.8). The average scored points the SADS principles design elements are presented in (Figure 4.11).

Table 4.8: The students' evaluation average of SADS principles design elements.

	Design Principles Elements / Forms Order	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	14 th	15 th	16 th	17 th	18 th	19 th	Each Element Average
a	Natural light	8	7	8	8	6	7	8	8	8	8	8	8	7	8	7	8	7	6	8	7,53
b	Eco friendly materials	3	5	2	5	7	2	4	3	4	4	5	3	3	7	3	2	5	2	6	3,95
c	Natural ventilation	7	8	7	6	8	8	7	7	7	7	4	6	8	6	6	7	8	8	7	6,95
d	Shading elements	6	6		4	3	5	2	5	6	6	7	7	4	3	1	1	2	5	1	4,11
e	Renewable energy sources	5	4	6	3	2	4	5	1	5	3	3	4	5	5	8	3	6	7	5	4,42
f	Use of thermal mass	2	1	4	7	5	6	3	2	2	1	2	5	2	4	5	4	4	4	3	3,47
g	Rain water uses	1	2	3	2	4	3	1	6	3	5	6	1	6	2	4	6	3	3	2	3,32
h	Eco friendly transportation to the site (bicycles, electric cars, etc.)	4	3	5	1	1	1	6	4	1	2	1	2	1	1	2	5	1	1	4	2,42

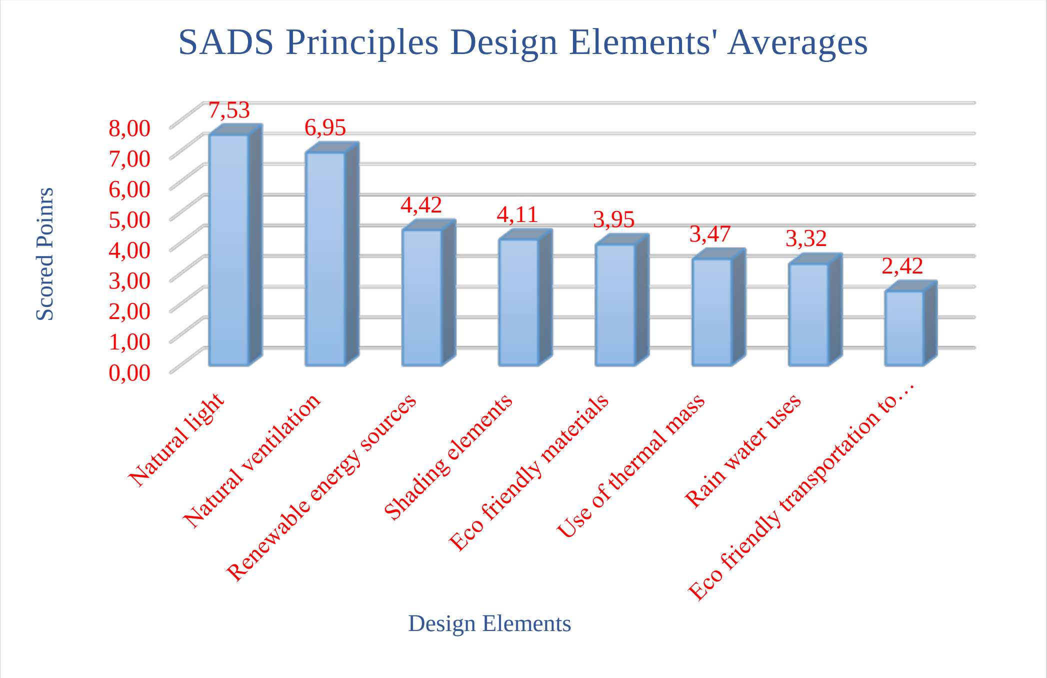


Figure 4.11: The average scored points of the SADS principles design elements.

8) Please write your personal comments about the sustainable design studio spring of 2015.

Many students were consider themselves lucky to attend the studio and they appreciated the effort of the instructors during the semester long. They also request that the studio should continue in the fourth year too.

Some considered learning then applying what you learn right away is hard thing to do, while some considered good challenge.

Several students said that they have learned many things, which they will be able to use all in their professional career. Further, they enjoyed the studio set up environment.

A student said, “I have learned in one studio what I have learned in all other studios, it opened my architecture vision, I will use all what I learned. Our teachers made the subject very interesting and enjoyable to us. Learning how to simulate and calculate the building energy consumption was interesting thing to learn. Generally, it was nice studio". Other student said, "I believe the best thing was that our teacher care about us and work with us closer". Another student said, "It is hard to be an architect, I have to work more, my teachers pushed me too much to work more by their care and attention".

SADS colloquium

The second format of assessment tools of the SADS pedagogy structure was an open colloquium for the students' discussions. After the questionnaire forms were collected each instructor expressed his/her view of SADS semester work briefly. Afterwards, the floor was giving to the students to ask questions, make general comments, and provide recommendations as well as being objective. Instructors designated special time in their office after the colloquium session to answer any student's personal questions. There were two students spoke privately to the instructor regarding the reason for their failure in the studio. They were wonder that they failed because of their design issue or the sustainability integration. The instructor explained that they failed based on their design problem related issues only as it was stated at the starting of the semester. There was no one failed based on the sustainability integration since it is not part of the department curriculum objective.

Students' comments:

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

They appreciated their attendance to the sustainable design studio and joy of learning the subject, meanwhile they requested for the continuation of the studio in their fourth year. They also appreciated the instructors' knowledge about the topic.

Few students complained about the load work difference in a relation to the conventional studio section, while some requested to schedule the technical trip earlier in the semester in addition, some requested to finish case studies review by the midterm.

IYTE's online class evaluation

By the end of the semester, students are required to fill up online class evaluation form before they can be able to learn their final grade. This online form became accessible to the class instructor to look at it. The following were the questions asked to the students and the final average answers (Appendix. J).

The students answered to all questions were above the department and the faculty average score. Students voted 93% that the lectures were understandable while 95% said that the class's requirement and timetable were clear. Furthermore, 94% said that the open discussion environment were available.

General comments by the students:

Most students expressed that it was instructive and informative tutorial studio. Others, considered the most productive and enjoyable studio, while few said that the project size was big.

4.5 Findings and Recommendations

This section derived findings points out of the founded results, data analysis, evaluations and assessments sections. These findings points had introduced various recommendations that had used to improve the SADS pedagogy structure for the following semester.

4.5.1 Findings

The findings of the pilot experimental studio presents various points that have been learned. These points were derived out from the instructors' evaluations and students' assessments of the SADS.

From instructors

Instructor evaluation showed that there was parallel trend between sustainability checklist elements used in each student project and final project grades (Figure 4.8). R-squared value of (0.6236) represented strong data that were fitted to the regression line. Moreover, most of the students managed to include many of sustainable design elements in their design project (table 4.4). In addition, students design process grades showed parallel trend with final project grade (Figure 4.9), with strong R-squared value of (0.6937).

Instructor design evaluation showed that there was lack of applying sustainable design principles on the project landscape.

From students

The students' assessments of the SADS presented various conclusion points that were derived from the questionnaire survey, colloquium, and the on-line course evaluation.

The questionnaire

The questionnaire form showed that 80% of the students had no knowledge about sustainable design and the 20% had only one elective class related to sustainable design before they attend SADS. Furthermore, 95% of the students will practice sustainable design in their professional life and will chose it as their graduate study work.

The case studies and technical trip scored the highest points among the studio tasks (SADS pedagogy structure elements) in benefitting the students design while the use of digital media and assignments scored the least points (Figure 4.10). The relative standard deviation among the pedagogy elements was high (30.07%).

The natural light and the natural ventilation scored the highest points among the sustainable design elements while the eco transportation and rainwater use scored the least within the students' design consideration (Figure 4.11). The relative standard deviation was high (39.60%) among the design elements.

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.

Colloquiums' comments

There were general appreciation of the studio's instructors, learning materials, and work environment while there were complain about the workload and intense work schedule.

There was complain about the starting time of learning the energy simulation software, which was considered late for most of the students as well as they considered project was big square meters wise. Moreover, there was request to apply the SADS to fourth year studio too.

Technical trip was scheduled after the first midterm review, which minimized the benefit of it.

Students claimed that case studies presented by them were big help to achieve their project. However, the presentations took long time along the semester to be finished.

IYTE's online evaluation

The SADS class evaluation scored above 90% in all questions. Furthermore, the SADS average score answers was higher than the department and faculty averages.

4.5.2 Recommendations

The above findings introduced some recommendations points that had proposed changes and modifications in the following experimental SADS semester's pedagogy structure (AR 301 SADS-Fall of 2015). These recommendations were:

Survey should be done at the start of semester to learn the students' knowledge of sustainable design level.

Only, Revit software would be used for simulation to measure energy consumption and CO_2 emissions.

Design process grade distribution should be increased to match the workload and emphasize on its important.

The grade distribution of sustainability checklist elements and energy simulation should be modified according to the workload, and energy saving effort.

More attention should be given to the low scores elements of SADS pedagogy structure and sustainable design by providing more lectures and inviting external experts. Same strategies could be applied to sustainable landscape design.

The project size (meter square) shall be reduced so that the students could pay more attention to the sustainable design issues.

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

All case studies would be presented by the students within the first six weeks of the design process to get the maximum benefits of it. Design studio students of spring 2015 are in (Figure 4.12).

Figure 4.12: The Students of SADS class of AR 302 spring of 2015

CHAPTER 5

SECOND EXPERIMENTAL STUDIO

This chapter presents the second experimental SADS work process along the semester. The chapter demonstrates how the modified method were executed as well as the studio outcome, which includes the students' performance, and the finished product. On the other hand, it presents the evaluations and assessments of the experiment including its improvements and modifications. At the end, the findings introduces new recommendations for the following final experimental SADS that will lead to modifications and/or changes to improve the original method for final test.

5.1 Introduction

All of the research's materials that were explained on chapter-3 were applied. The major steps of research method from chapter-3 as well as the modified method and teaching techniques, and the restructured class calendar were executed. The experimental work was executed on the third year AR 301 design studio of fall of 2015. These students were coming off second year where they had less design experiences comparing to the students of first pilot experimental studio. Similar to the first pilot, the environmental issues aspect of the sustainability principles was the only concern for the second SADS experimental as one of the three sustainability divisions. There was no consideration of the social and economic aspects of sustainability principles. The SADS had 25 students (16 females and 9 males).

5.2 Improved Method Execution

The SADS pedagogy guideline and the timetable module structure with implementation of digital technology as well as the first research pilot experimental recommendations were implemented into the SADS to create the modified pedagogy structure and improved instructor-teaching method (Table 5.1).

The modified syllabus (Appendix K) was based on the modified teaching pedagogy structure. At the first day, instructors explained the objective, the rules, new grades system distribution, and the working method of the SADS to the students. The SADS project program and description is shown in (Appendix L). The total project size was reduced by 30% comparing with first pilot's experimental studio project.

The SADS weekly calendar had been modified to respond to the modified teaching method and the SADS pilot experimental studio's recommendations (Appendix M).

There were 25 of two types of case studies of existing selected projects, first were sustainable projects, and second were related conventional projects. Those cases were assigned study work to the students to expose them to various design ideas and techniques. The case studies name list are shown in (Appendix N).

Table 5.1: SADS's instructor teaching method of pilot experimental studio, and second experimental studio modified elements that are shown in red.

No.	Learning Technique	Pilot Experimental Studio Teaching Method of SADS Spring 2015	Second Experimental Studio Teaching Method of SADS Fall 2015
1	*learning by teaching others.*	One case study was presented by each students (22 case studies)	One case study was presented by each students (25 case studies). Finished in the first 6 weeks. Case studies presentation had 5% of total class grade.
2	*practice by doing and group discussion*	Students were required to write the project program individually then in a small group of three then in a group of eight	Students were required to write the project program individually then in a small group of three then in a group of eight. The project size was reduced by 30%.
3	*practice by doing*	Students were required to construct study models during the project design development process (4 models)	Students were required to construct study models during the project design development process (6 models) with various scales.
4	*deep learning*	Biweekly panel reviews were conducted (6 panel reviews) in two formats:	Weekly panel reviews were conducted (9 panel reviews) in two formats:
	group discussion	A) Group discussion of the design process and project development were conducted	A) Group discussion of the design process and project development were conducted
	learning by demonstration	B) Students criticized each other's project by asking each student to present his/her project to the group	B) Students criticized each other's project by asking each student to present his/her project to the group
5		Technical trips to	Technical trips to
	practice by doing	A) The project site and surrounding area	A) The project site and surrounding area. Existing exemplary project owned by the client.
	learning by demonstration	B) Existing exemplary projects	B) Existing exemplary projects
6	*practice by doing*	Instructors conducted biweekly charrette design assignments during the design process (4 assignments)	Instructors conducted weekly charrette design assignments during the design process (6 assignments)
7	*practice by doing*	Various digital technologies were used throughout the design process	Various digital technologies were used throughout the design process
		A) Conceptual design period; climate consultant and Sketchup	A) Conceptual design period; climate consultant and Sketchup
		B) Design development period; Revit, Auto CAD, and Sketchup	B) Design development period; Revit, Auto CAD, and Sketchup
		C) Design evaluation period; Rivet, DesignBuilder, and Sketchup	C) Design evaluation period; Rivet only
		D) Final drawing and presentation; Rivet, Auto CAD, 3D Max, DesignBuilder, and Sketchup	D) Final drawing and presentation; Rivet, Auto CAD, 3D Max, DesignBuilder, and Sketchup
8	*pubic interest/immediate use practice*	Project owner(s)/user(s) were invited to discuss the project (2 visits)	Project owner/user(s) were invited to discuss the project and provide presentation & workshop (2 visits)
9	*learning by demonstration*	Monthly Outside expert(s) were invited for workshop (3 workshops)	Monthly Outside expert(s) were invited for workshop (3 workshops)
	practice by doing	A) Instructors assigned homework related assignment ahead of each workshop studio	A) Instructors assigned homework related assignment ahead of each workshop studio
10	*learning by demonstration*	Instructors conducted individual desk critics (10 desk critics)	Instructors conducted individual and small group desk critics (8 desk critics)
11	*learning by visual, audio, and lecture*	Class instructors offered lectures about the project topics that included visuals and audios materials (6 Lectures)	Class instructors offered lectures about the project topics that included visuals and audios materials focusing on the low score elements from first pilot recommendation (6 Lectures)
12		Juries	Juries
	learning by demonstration	A) Instructors conducted midterm juries (3 midterm juries)	A) Instructors conducted midterm juries (3 midterm juries)
	learning by teaching others	B) Instructors hosted a final jury that included University Rector (project owner), academic members.	B) Instructors hosted a final jury that included Bornova Municipality president, University rector, experts, and academic members. The grade distribution was modified.

5.3 Studio Outcome

The grades distribution had been revised to respond to the workload and emphasize on the importance of students performance during the semester including the design process, which was recommended by SADS pilot experimental studio. The entire evaluation of the students' SADS work (100 points) was divided into two parts. First part was the evaluation of the workload performance through the semester (40% of total grade). Second was the evaluation of the finished product of the final project submission (60% of total grade); of which 60% was dedicated purely to the design aspect and 40% for the degree of integration of the sustainability principles in the project (Table 5.2).

5.3.1 Students' performance

All along the semester, the students' performance of were monitored, evaluated, and recorded. The work performance included group work, case studies, technical trip to sustainable designed projects (Figure 5.1), presentation, panel reviews, individual assignment in both class and home, midterm juries, and presentation as shown in (Appendices K and M). Design process grades are shown on (Table 5.2).

Figure 5.1: Technical trip, visiting sustainable architecture projects in Istanbul.

The three midterms' juries were conducted as it had been done for the pilot experimental studio with the same requirements without any major changes (Appendix E).

Table 5.2: SADS's grades earned through evaluation stages of students performance.

Students No.	Attendance (5)	Case Study (5)	Site Analysis (5)	Homework (5)	1st Midterm (5)	2nd Midterm (5)	3rd Midterm (5)	Portfolio (5)	Total (40 Points)
1	5,00	5,00	5,00	5,00	2,70	3,00	4,15	3,00	**32,85**
2	0,00	5,00	5,00	5,00	0,00	3,65	3,30	5,00	**26,95**
3	2,00	3,00	5,00	1,00	3,00	3,75	3,25	3,50	**24,50**
4	4,00	3,50	5,00	5,00	2,90	3,00	3,55	4,50	**31,45**
5	0,00	5,00	5,00	5,00	2,50	2,50	3,50	3,50	**27,00**
6	3,00	5,00	5,00	5,00	3,90	4,35	4,00	4,50	**34,75**
7	5,00	5,00	5,00	5,00	3,70	3,90	3,90	5,00	**36,50**
8	5,00	3,50	5,00	5,00	3,30	4,00	4,20	4,50	**34,50**
9	5,00	4,50	5,00	5,00	4,00	4,20	4,75	5,00	**37,45**
10	4,00	5,00	5,00	5,00	4,20	4,85	4,75	5,00	**37,80**
11	3,00	4,50	5,00	5,00	4,00	4,50	4,95	4,50	**35,45**
12	0,00	3,00	5,00	5,00	2,90	3,00	3,00	3,50	**25,40**
13	4,00	5,00	5,00	5,00	3,70	4,15	4,25	5,00	**36,10**
14	5,00	4,00	5,00	5,00	3,00	3,50	3,95	4,50	**33,95**
15	3,00	4,50	5,00	5,00	3,40	3,95	3,45	4,50	**32,80**
16	4,00	5,00	5,00	5,00	3,10	3,45	3,65	4,50	**33,70**
17	0,00	4,50	5,00	5,00	3,70	4,55	3,85	4,50	**31,10**
18	4,00	4,50	5,00	5,00	3,30	3,50	4,65	4,00	**33,95**
19	5,00	4,50	5,00	5,00	3,00	3,50	2,50	3,00	**31,50**
20	5,00	4,50	5,00	5,00	3,30	3,25	3,65	4,50	**34,20**
21	0,00	2,50	5,00	0,00	3,40	3,00	3,50	3,50	**20,90**
22	0,00	4,50	5,00	0,00	2,70	0,00	3,85	4,50	**20,55**
23	5,00	5,00	5,00	5,00	3,40	4,65	4,25	5,00	**37,30**
24	5,00	5,00	5,00	5,00	3,70	4,45	4,35	5,00	**37,50**
25	2,00	4,50	5,00	5,00	3,10	3,95	3,75	4,50	**31,80**

5.3.2 Finished product

SADS instructors explained the final jury format, style, and rules two weeks earlier. Instructors coached the students on how to conduct a professional presentation and how to deal with the jury event. The invited guests were Bornova Municipality president and his administrations (project owner), IYTE Rector, academic members, and Experts in sustainable design. The jury was open Jury welcoming everyone. Instructors role were an intermediators of the event, explaining SADS pedagogy, project outline subjects, and final jury requirements. Instructors prepared a brochure of all SADS work explaining to jury members all aspects of SADS (Appendix. P), and (Figures 5.2 & 5.3).

Figure 5.2: The SADS final project presentation to the jury members.

Figure 5.3: The SADS final project presentation to the jury members.

Instructors reviewed all projects after the final jury. Similar to pilot experimental studio, the projects were divided to three groups; outstanding, satisfactory, and unsatisfactory according to the sustainable elements number integrated into the each project (Table 5.3). The benchmark evaluation for each category was as follow:

- Outstanding projects were those that had 15 or more integrated elements (79% or more integrated elements); there were 10 such projects.

- Satisfactory projects that had 8 to 14 integrated elements (42% to 74% of integrated elements); there were 13 satisfactory projects.

- Unsatisfactory projects were included 7 or less integrated elements (37% or less of integrated elements); there were 2 unsatisfactory projects.

The following three projects demonstrate one project of each category.

Outstanding example

The following presents the final proposed design work of Bornova Municipality culture center by Funda Koltka that was created on the concept of sustainable design principles. On the other hand, the project was tested using energy simulation program to evaluate the building energy consumption and CO_2 emission. Moreover, the project were published (Mohamed and Durmuş Arsan 2016)

The form shape and orientation was created to offer various open, semi-open, and close space with full transparency to provide enough natural light and natural ventilation (Figures 5.4 & 5.5). Spaces transparency created better communication among various age generation users and flexible spaces utilization of the culture center. The designed project incorporate the use of sustainable materials, transparent shaded facades, inner courtyard and sloped green roof were used to support the project main concept. Moreover, the project included collecting rainwater, reuse of gray water, and solar panels. The proposed design had 18% reduction in annual energy consumption and 19% in CO_2 emissions. In additions, the project included 19 sustainable elements (Mohamed and Durmuş Arsan 2016).

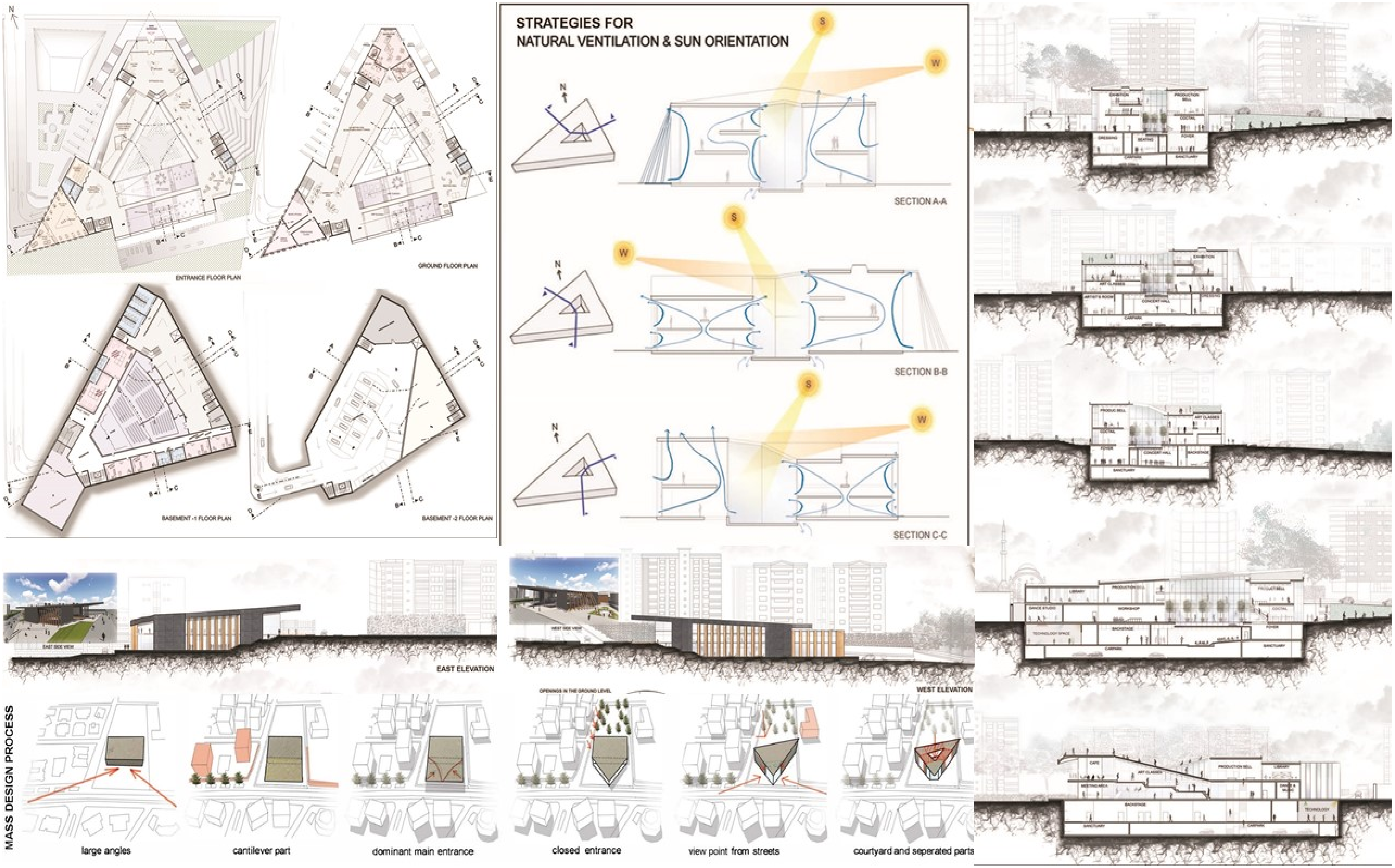


Figure 5.4: Transparent Culture Center, Bornova, Izmir. By “Funda Koltka” -1 (Mohamed and Durmuş Arsan 2016)

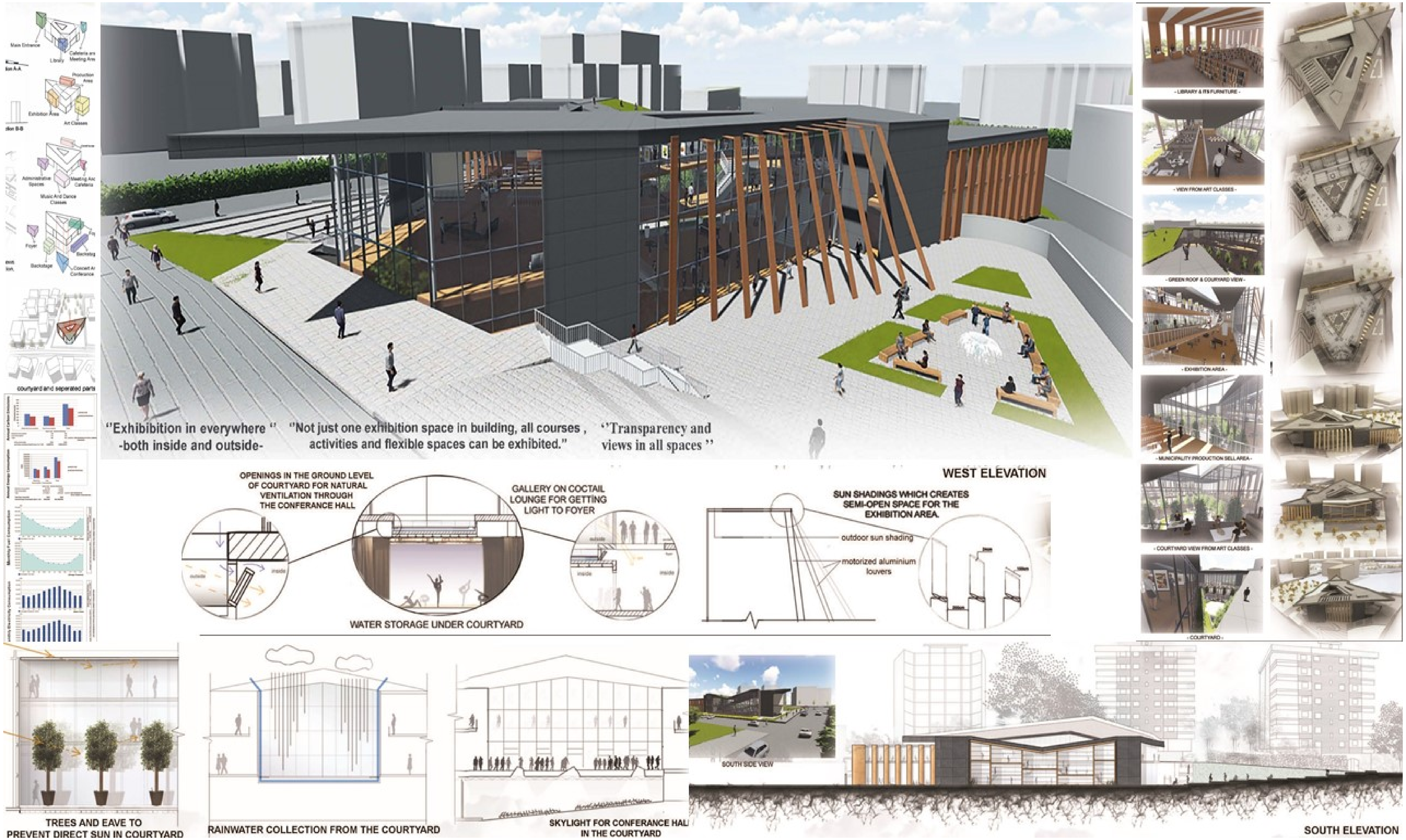


Figure 5.5: Transparent Culture Center, Bornova, Izmir. By “Funda Koltka” -2 (Mohamed and Durmuş Arsan 2016)

Satisfactory example

The proposed Cultural Center project by Tuğçe Zeynep Bacanak, was divided into four shells while each one included one of the project's main functions. The building orientation considered the sun path and prevailing wind direction. The long façade faced the south while the mass rotation was toward the northeast wind direction. The project included double skin facades and sky light to maximize the use of daylight into spaces and control the heat transfer in and out the building as well as the use of heat pump to back up the natural heating cooling system in the building. The sloped roof helped for the collection of rainwater as well. The project integrated 13 sustainable elements (Figure 5.6 & Figure 5.7).

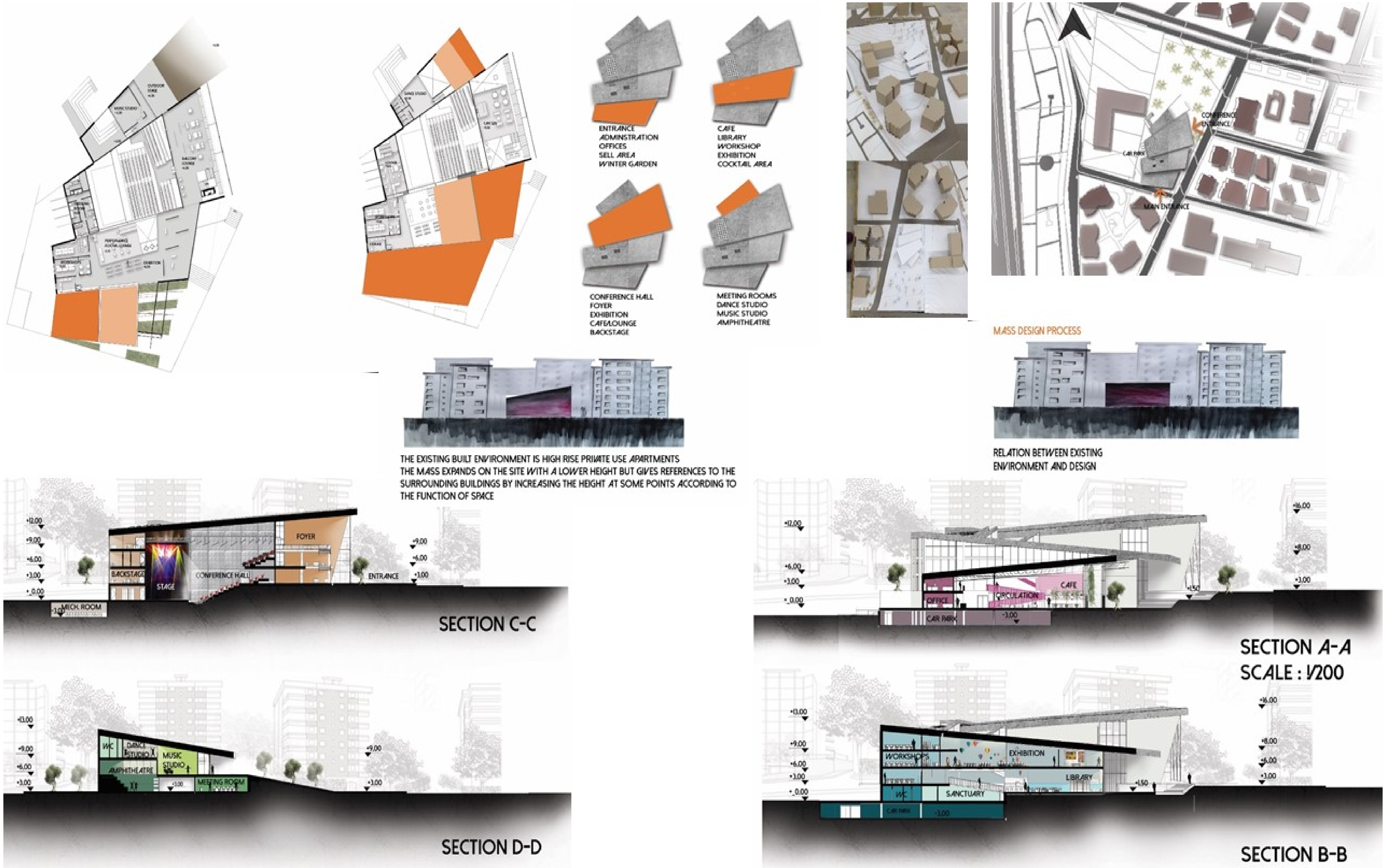


Figure 5.6: Culture Center, Bornova, Izmir. By "Tuğçe Zeynep Baçanak" - 1

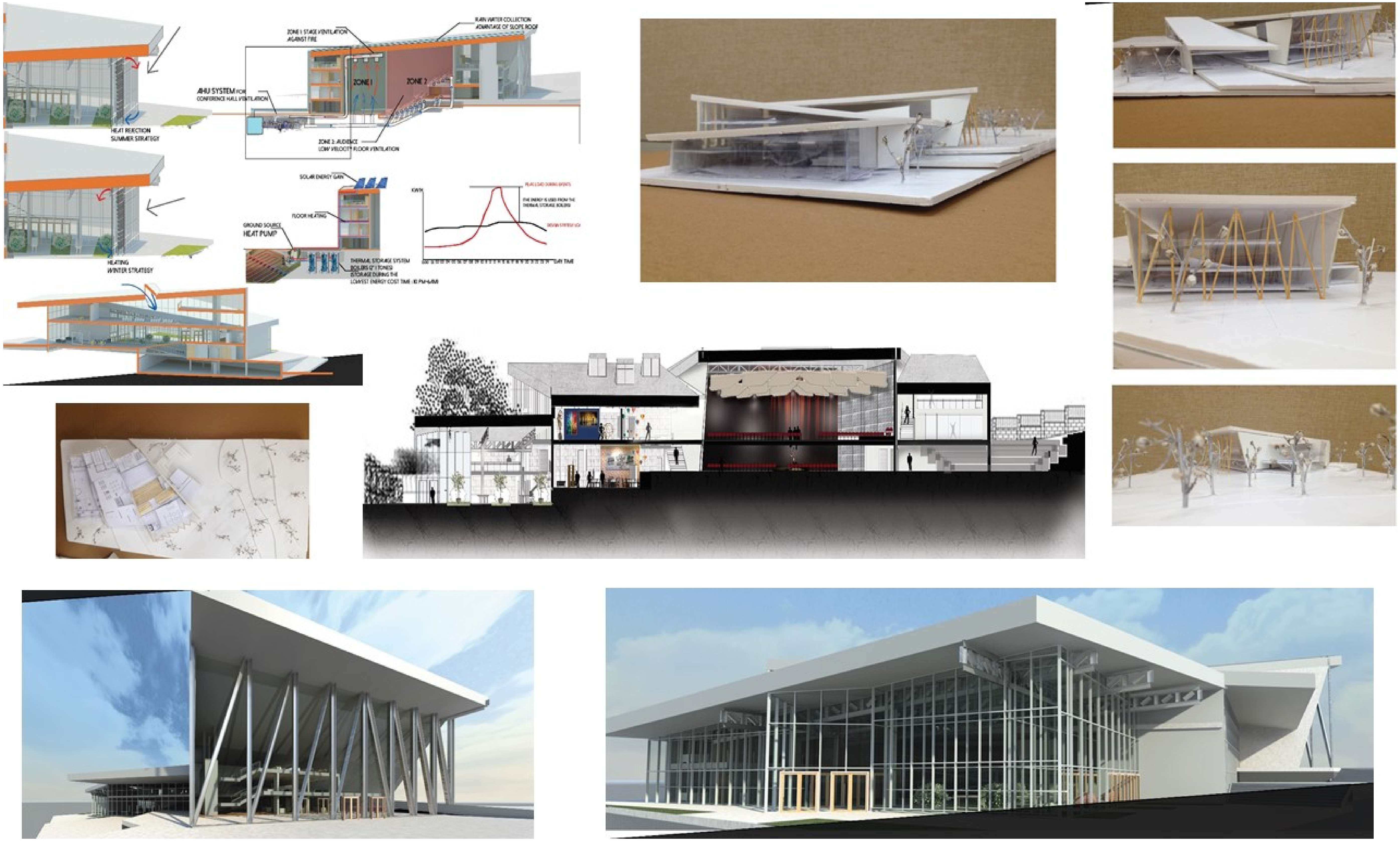


Figure 5.7: Culture Center, Bornova, Izmir. By “Tuğçe Zeynep Baçanak” - 2

Unsatisfactory example

In this project, the student managed to collect seven points of the total 19 points from the sustainability checklist elements. The project did not consider natural air ventilation, shading façade elements, sustainable material and local material, rainwater collection as well as the lack of use heat insulation. There were spaces that did not have natural light. The project did not have the correct test for energy consumption nor CO_2 emission. (Figure 5.8)

Figure 5.8: Unsatisfactory project example

5.4 Evaluations and Assessments

Similar to SADS pilot experimental studio, two types of evaluations and assessments accomplished regarding the second experimental of SADS. First was SADS instructors' evaluations of the students' works, which was based on the design process they followed and the final product of design project, as well as the degree to which the sustainability principles were integrated into their final design. The second were students' assessments of the improved SADS pedagogy and instructors teaching method that was conducted on them as well as their own SADS experience journey.

5.4.1 Evaluation by instructors

The Environmental sustainability principles checklist evaluation (Appendix H) and (Table 5.3) were introduced to the students earlier in the semester. The checklist elements where explained to the students throughout lectures, workshops, technical trips, and case studies presentations. Furthermore, it was clarified to the students that their projects will be evaluated against this list to measure their project success (Table 5.2)

Grading system

Sustainability checklist elements and Revit energy simulation result were increased up to for 40 points (Table 5.2), while the distribution points were as shown in (Table 5.3).

Grading system was created for the major checklists' elements and the energy simulation test (Table 5.3). The point's distributions were modified comparing to the pilot experimental studio system to respond to the student effort of the integration elements' numbers as well as the amount of energy and CO_2 reductions. The measuring system was applied to each project. Each project was given the number of elements included in it; while (Table 5.3) presents the checklist-collected data.

The average number of sustainable design elements used all over the projects were 12.48 of 19 elements total.

The (Figure 5.9) presents each sustainable design element integration times in all students' projects. The average use of each element was 16.42 in 25 projects.

Table 5.3: The grading system of sustainability elements energy simulation and the numbers of sustainability elements integrated in each project as well as the evaluation of simulation work.

Main Elements / points	**Energy (10 Points)**									**Materials (5 Points)**			**Water (5 Points)**			**Health (5 Points)**				**Total 25 Points**	**Energy Simulation Tests (15 Points)**		
Points distribution	**6 Elements or more (10)** **4 to 5 Elements (7)** **2 to 3 Elements (5)** **One element (2)** **None (0)**									**2 to 3 Elements (5)** **One element (2)** **None (0)**			**2 to 3 Elements (5)** **One element (2)** **None (0)**			**4 Elements (5)** **2 to 3 Elements (4)** **One element (2)** **None (0)**					**(5 Points)**	**(6 Points)**	**(10 Points)**
Elements	**Reducing the energy used for lighting**		**Reducing the energy used for ventilation**		**Reducing energy used for heating and cooling**			**Use of renewable energy sources**															
Students No.	80% of spaces benefits from natural light	Sky-gardens, skylights, atriums, light shelves	Adjustable windows, air-holes	Natural ventilation by channels (wind catcher)	Reduce heating loads (high insulation glass system (low-e 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	**Total Elements 19**	Base case result	Modified case with selected materials and shading elements, Reduction of 10% or less in Energy and CO_2 emission	Modified case with selected materials and shading elements, Reduction of more than 10% in Energy and CO_2 emission
1		X			X	X			X	X					X	X	X	X		**9**	5		10
2	X	X		X				X		X				X	X	X				**8**	0		
3		X		X	X	X		X	X						X	X				**9**	5	6	
4	X	X			X					X	X	X		X				X	X	**9**	5		10
5	X	X			X	X			X			X		X		X		X		**9**	5	6	
6	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	**17**	5	6	
7	X	X			X	X			X				X	X		X		X		**9**	5		10
8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**19**	5		10
9	X	X		X	X	X			X	X	X		X	X	X	X	X	X	X	**15**	5		10
10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**19**	5		10
11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**19**	5		10
12		X			X	X			X				X			X		X		**7**	5	6	
13	X	X	X	X	X	X			X	X	X	X	X	X		X	X	X	X	**15**	5	6	
14	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	**17**	5		10
15		X	X	X		X			X						X	X		X		**8**	5	6	
16	X	X	X		X	X			X	X	X					X	X	X		**11**	5	6	
17	X	X	X		X	X			X	X	X			X	X	X	X	X		**13**	5	6	
18	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**19**	5		10
19	X	X			X				X	X				X		X	X	X		**9**	5	6	
20		X			X				X	X			X		X					**6**	5	6	
21	X	X			X				X	X			X			X		X		**8**	0		
22	X	X	X		X	X			X	X						X				**8**	5	6	
23	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**19**	5		10
24	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	**17**	5		10
25	X	X	X		X	X			X	X	X		X		X	X	X	X		**13**	5	6	
The use of each element in 25 projects	**20**	**25**	**14**	**12**	**23**	**20**	**6**	**8**	**23**	**21**	**14**	**11**	**15**	**14**	**16**	**23**	**15**	**21**	**11**	**The Avarage element number used in the SADS 12,48**			

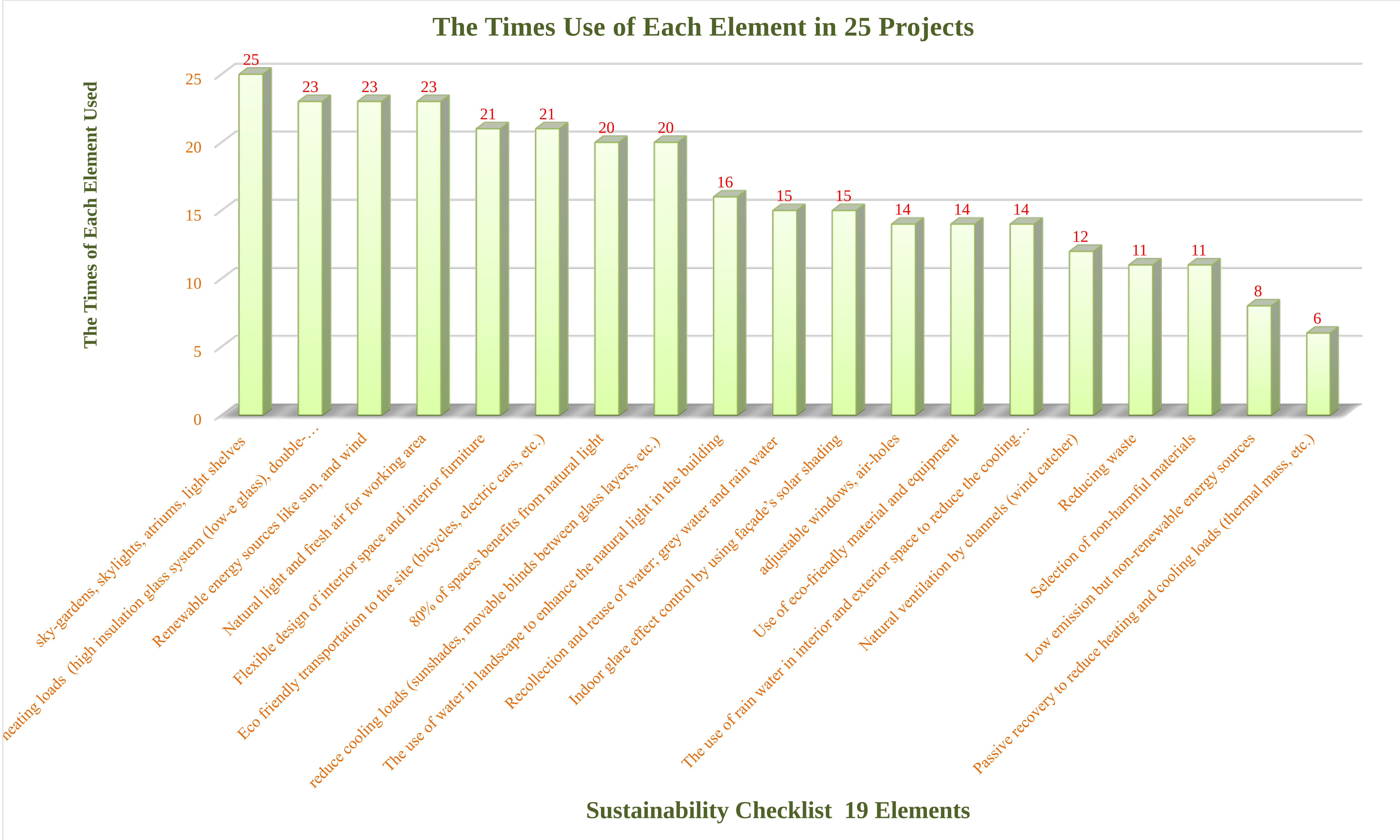


Figure 5.9: The times use of each sustainable design element in the 25 projects.

Table 5.4: The second experimental SADS's final project grades

Students No	Energy 10	Material 5	Water 5	Health 5	Simulation Bas case 5	Simulation modified case 10	Total Sus. Checklist & Simulation 40	Design Evaluation 60	Final Jury Total 100
1	7	2	2	4	5	10	**30**	48	**78**
2	7	2	5	2	0	0	**16**	49	**65**
3	10	2	2	2	5	6	**27**	48	**75**
4	5	5	2	4	5	10	**31**	41	**72**
5	7	2	2	4	5	6	**26**	41	**67**
6	10	5	5	5	5	6	**36**	51	**87**
7	7	0	5	4	5	10	**31**	49	**80**
8	10	5	5	5	5	10	**40**	54	**94**
9	10	5	5	5	5	10	**40**	49	**89**
10	10	5	5	5	5	10	**40**	55	**95**
11	10	5	5	5	5	10	**40**	55	**95**
12	7	0	2	4	5	6	**24**	46	**70**
13	10	5	2	5	5	6	**33**	51	**84**
14	10	5	5	5	5	10	**40**	45	**85**
15	7	0	2	4	5	6	**24**	46	**70**
16	10	5	0	5	5	6	**31**	46	**77**
17	10	5	5	5	5	6	**36**	51	**87**
18	10	5	5	5	5	10	**40**	55	**95**
19	7	2	2	5	5	6	**27**	53	**80**
20	5	2	5	0	5	6	**23**	47	**70**
21	7	2	2	4	0	0	**15**	50	**65**
22	10	2	0	2	5	6	**25**	47	**72**
23	10	5	5	5	5	10	**40**	49	**89**
24	10	5	5	5	5	10	**40**	47	**87**
25	10	5	2	4	5	6	**32**	48	**80**

Instructors graded the final projects of SADS as it is shown in (Table 5.4) as well as the final semester grades work that is presented in (Table 5.5).

Table 5.5: The second experimental of SADS students' final grades.

Students No.	Design Process Grades (40)	Final Jury (60)	Final Grade (100)	Letter Grades
1	32,85	46,80	**79,65**	**BB**
2	26,95	39,00	**65,95**	**DC**
3	24,50	45,00	**69,50**	**CC**
4	31,45	43,20	**74,65**	**CB**
5	27,00	40,20	**67,20**	**DC**
6	34,75	52,20	**86,95**	**BA**
7	36,50	48,00	**84,50**	**BB**
8	34,50	56,40	**90,90**	**AA**
9	37,45	53,40	**90,85**	**AA**
10	37,80	57,00	**94,80**	**AA**
11	35,45	57,00	**92,45**	**AA**
12	25,40	42,00	**67,40**	**DC**
13	36,10	50,40	**86,50**	**BA**
14	33,95	51,00	**84,95**	**BA**
15	32,80	42,00	**74,80**	**CB**
16	33,70	46,20	**79,90**	**BB**
17	31,10	52,20	**83,30**	**BB**
18	33,95	57,00	**90,95**	**AA**
19	31,50	48,00	**79,50**	**BB**
20	34,20	42,00	**76,20**	**CB**
21	20,90	39,00	**59,90**	**DD**
22	20,55	43,20	**63,75**	**DD**
23	37,30	53,40	**90,70**	**AA**
24	37,50	52,20	**89,70**	**AA**
25	31,80	48,00	**79,80**	**BB**

Data analysis

All evaluation grades of design process, sustainable design elements integration, and final project work were analyzed to assess the modified SADS pedagogy and teaching method of second experimental studio. Data analysis illustrated in (Figure 5.10) positive trend correlation between the number of sustainable design elements and final grades.

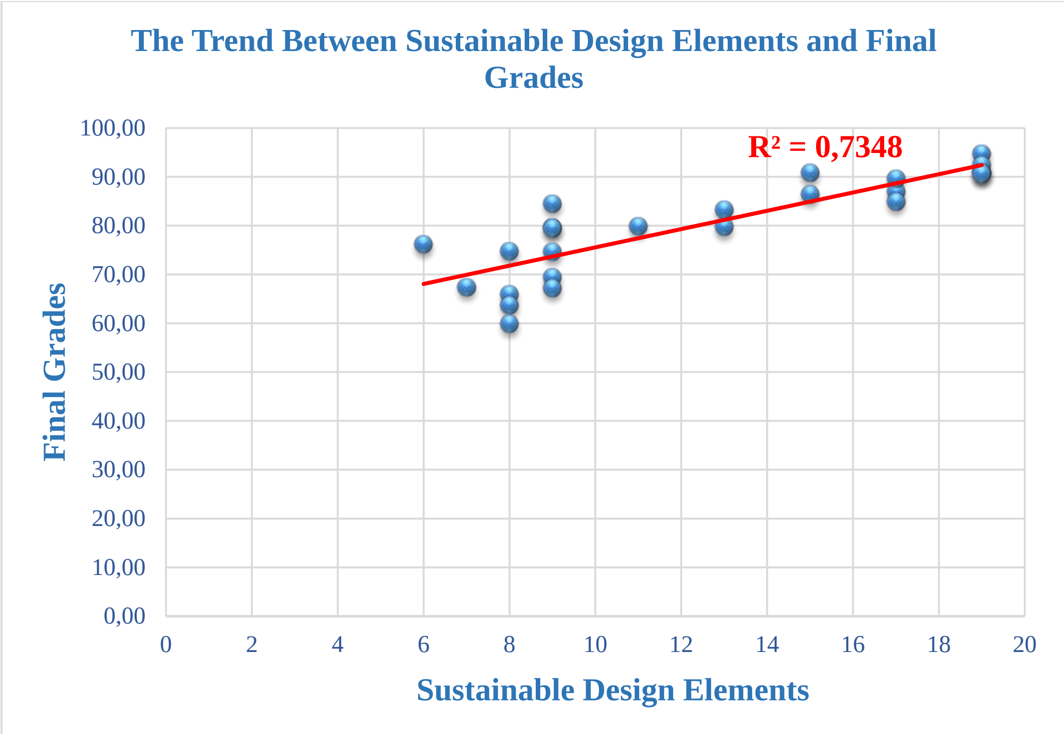


Figure 5.10: The correlation between the numbers of sustainable elements each student used in their projects and the final SADS grades.

In additional, there was a positive trend between design process grades (representing the modified SADS pedagogy structure) and final project grade of the students as is shown in (Figure 5.11). In addition, there was positive trend result correlation between the total grades of sustainable checklist elements and energy simulation test of each project and the final SADS grade, which is shown in (Figure 5.12).

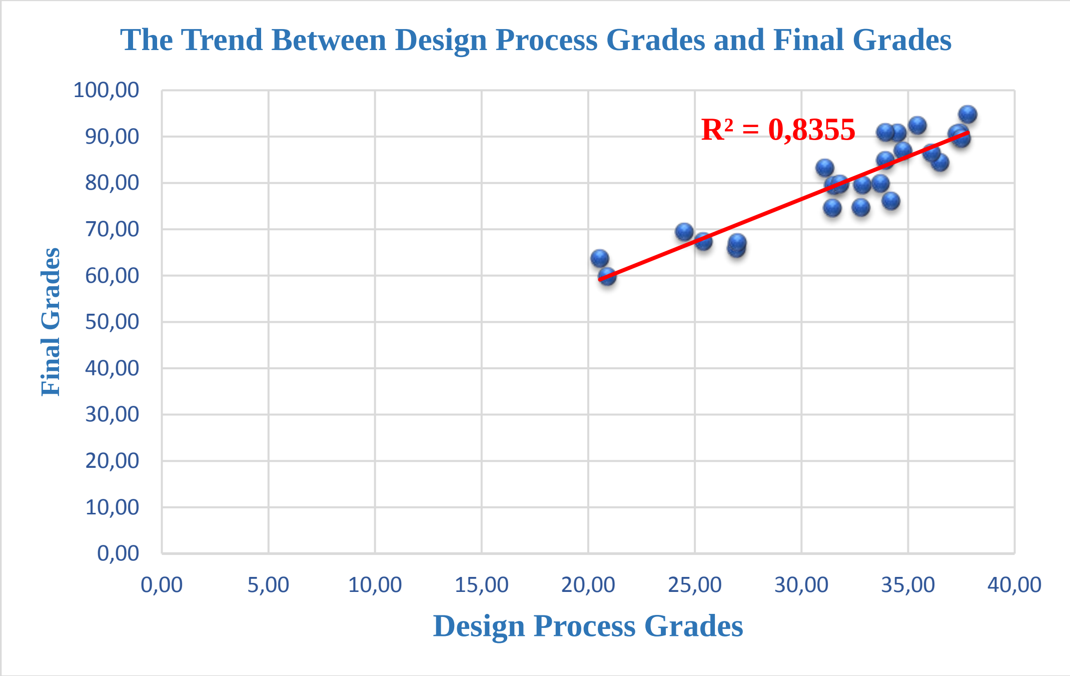


Figure 5.11: Positive trend between each student's design process grade and final SADS grades.

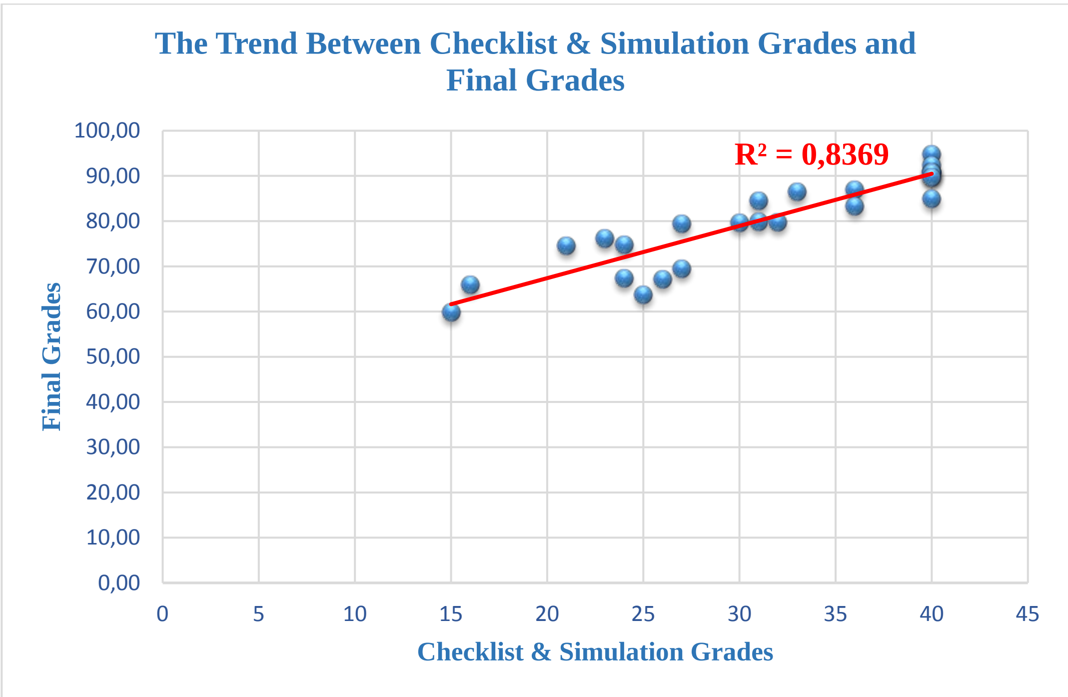


Figure 5.12: The correlation trend between the total grades of sustainable checklist elements and energy simulation of each project and the final SADS grades.

5.4.2 Assessments by students

Students' assessments to the SADS modified pedagogy structure and instructors teaching methods were done by the following steps, which is similar to the pilot experimental studio:

a) Questionnaire forms

b) SADS colloquium

c) IYTE's online class evaluation

Questionnaire form

At the final jury day, instructors called for an open colloquium nine days later. Two days before the colloquium date, the questionnaire form were sent by email to all students to be filled, giving them longer and comfortable time to answer all questions ahead of the meeting (Appendix I). The grades of the students were announced three days before the colloquium time. At the beginning of the colloquium, students handed the forms to the teaching assistant.

Questionnaire forms answers

Twenty forms were collected with no names on them. The following presents the answer of each question:

1) Did you have information about sustainable architectural design before this design studio?

There were 10 students answered "No" while only 10 had some idea of sustainable architectural design. Of these, three had the SADS pilot experimental studio; three had taken elective courses before, while two had made research on their own

2) Did you attend any related course(s) about the technical aspects of sustainable architectural design before this design studio?

Fourteen students have never attended any classes while one student attended two courses and five students attended one course only.

3) Design studio pedagogy structure included many elements during the semester. Would you put these elements in order, the most beneficial to your design project process?

This question had 18 correct format answers of 20 forms. The SADS pedagogy structure elements that were presented during the semester were placed in order beneficial priorities in the students' answers. The most beneficial was giving number (12) and the least was giving number (1). The average scored points of each element by the 18 students' order was calculated, as is shown in (Table 5.6). Element with the highest average points was set on the top order of the SADS pedagogy structure elements, the final order is presented in (Figure 5.13).

Table 5.6: The students' evaluation points average score of the SADS pedagogy structure elements.

	SADS Pedagogy Elements / Students Order	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	14 th	15 th	16 th	17 th	18th	Each Element Average
a	Physical models	9	10	4	1	9	4	4	4	6	2	2	4	12	2	4	1	1	1	**4,44**
b	Site analysis	4	11	6	6	8	9	5	12	5	3	4	5	9	12	12	3	2	5	**6,72**
c	Lectures by instructors	6	9	8	10	10	8	11	2	12	6	5	3	11	4	9	10	11	10	**8,06**
d	Case studies	7	6	10	11	12	11	10	11	11	7	6	9	8	6	7	6	8	4	**8,33**
e	Site trip	1	12	5	7	7	10	6	5	1	4	3	2	2	11	3	2	10	8	**5,50**
f	Technical trip visiting sustainable building	10	8	12	12	6	12	12	10	10	10	9	6	3	5	10	11	12	9	**9,28**
g	Lectures by expert visitors	11	7	11	4	3	7	1	6	9	11	8	10	4	10	8	12	3	3	**7,11**
h	Panel reviews	12	1	2	8	1	2	7	9	7	5	7	11	1	7	5	7	6	12	**6,11**
i	Midterm juries	5	5	3	5	5	1	8	7	8	8	11	12	7	8	6	8	5	7	**6,61**
j	Desk critiques	8	4	1	9	11	6	9	8	4	12	12	7	10	9	11	9	7	11	**8,22**
k	Assignments	2	2	9	2	4	5	3	1	2	9	10	8	6	1	2	5	4	6	**4,50**
l	Use of digital media	3	3	7	3	2	3	2	3	3	1	1	1	5	3	1	4	9	2	**3,11**

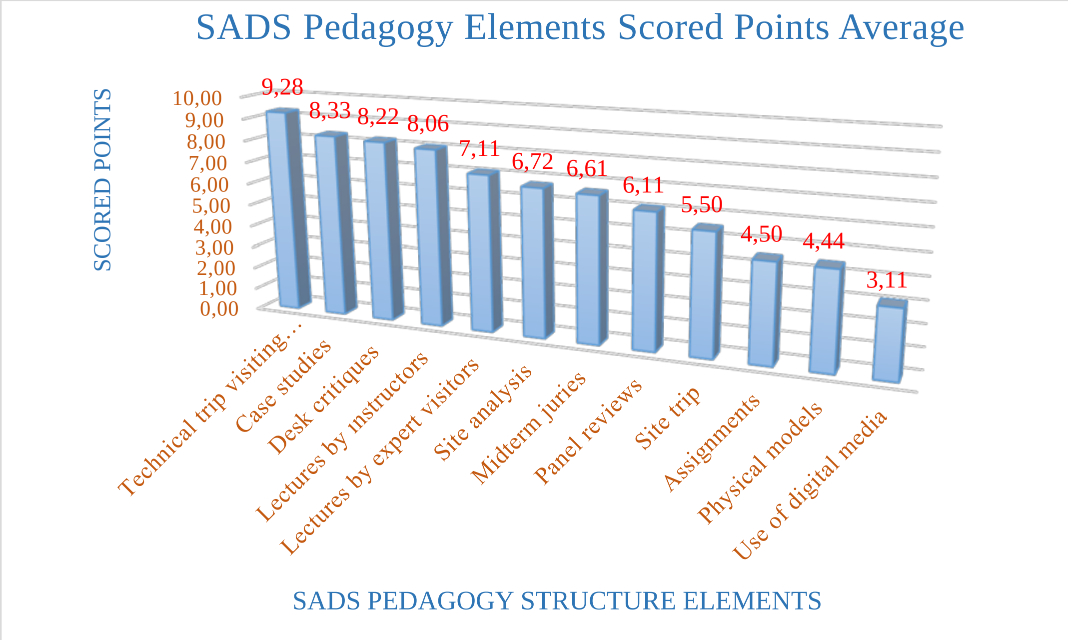


Figure 5.13: The scored points average of SADS pedagogy structure elements.

4) Will you practice sustainable design in your profession in the future?

There were nineteen students, who answered “Yes” and one answered “No”.

5) If you will continue your graduate study in the future, would you chose an architecture environmental subject such as sustainable design, ecological design, energy saving design, etc. as your study topic?

There were nineteen students answered “Yes” and one answered “No”.

6) What are the difficulties for designing a sustainable building in the design studio course?

Vast majority of students expressed that sustainable design is hard due to its requirements of learning technical issues, research for materials, façade design and shading elements, and solving construction problem meanwhile it requires comprehensive knowledge on various topics. Furthermore, they mentioned that they had to put more time and energy in SADS compare to other conventional studios. On the other hand, they were happy with the positive result due to this extra effort.

Some students considered that the complexity of the project program and the size of the project was hard to handle while they have to learn and design a sustainable building. In addition, energy simulation with Revit was hard due to the size of the project.

Number of students said that they had fear at the start because of the topics but things became better step by step with the help and positive attitude of SADS instructors, they believe that it was positive for their architecture education.

7) Can you make an order of what you considered the most important to least important in your design in this semester?

There were 20 forms for this question. SADS principles design elements was placed in order priorities in the students' answers. The most considered element was giving number (1) and the least was giving number (8). Each elements' points' average from the 20 students' answer was calculated. It is shown in (Table 5.7). The average scored points order of the SADS principles design elements are presented in (Figure 5.14).

Table 5.7: The students evaluation average of SADS principles design elements

	Design Principles Elements / Students Order	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	14 th	15 th	16 th	17 th	18 th	19 th	20 th	Each Element Average
a	Natural light	8	8	8	8	8	8	8	8	7	5	7	6	7	3	8	8	5	8	3	8	6,95
b	Eco friendly materials	6	5	5	2	4	6	5	3	2	4	4	4	8	6	5	5	8	5	8	6	5,05
c	Natural ventilation	7	7	7	7	7	7	6	4	4	6	5	7	6	7	6	3	4	7	7	7	6,05
d	Shading elements	4	6	6	6	6	5	7	2	3	2	6	8	5	2	7	7	6	6	2	5	5,05
e	Renewable energy sources	1	3	1	3	3	3	3	5	8	3	3	2	2	8	3	4	2	1	6	1	3,25
f	Use of thermal mass	3	1	4	5	5	1	1	6	6	7	2	1	4	4	2	2	7	3	5	2	3,55
g	Rain water uses	2	2	2	1	1	4	2	7	5	8	8	3	1	5	1	6	1	2	4	4	3,45
h	Eco friendly transportation to the site (bicycles, electric cars, etc.)	5	4	3	4	2	2	4	1	1	1	1	5	3	1	4	1	3	4	1	3	2,65

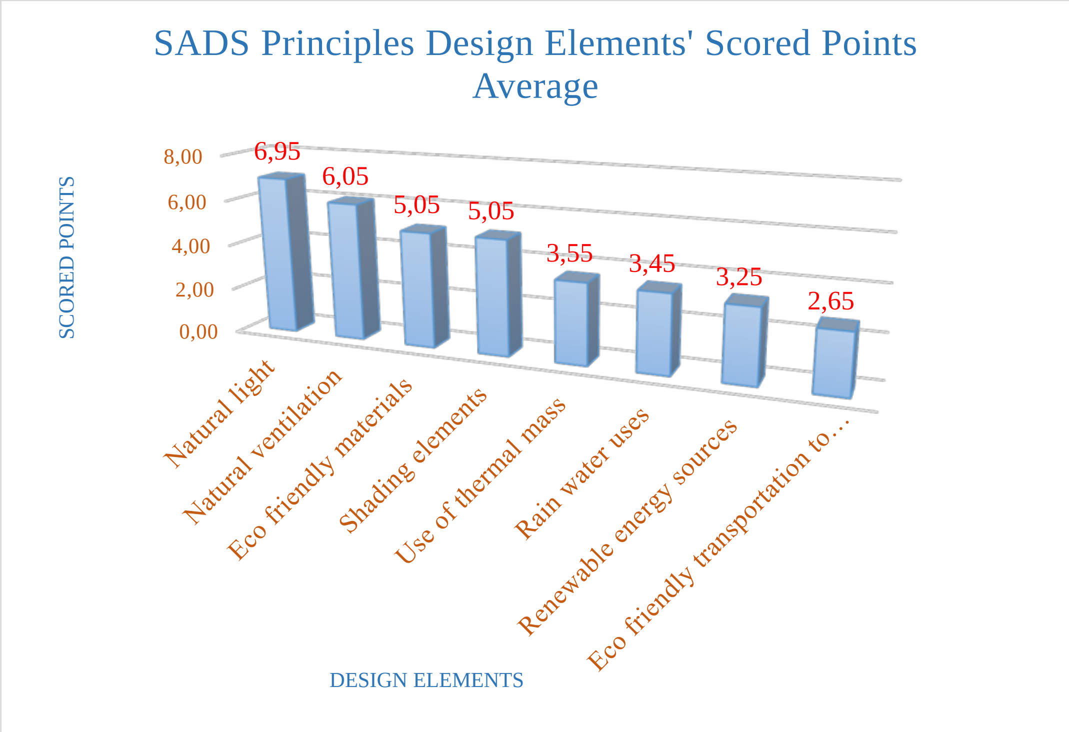


Figure 5.14: The scored points average of SADS principles design elements.

8) Would you write your personal comments about the sustainable design studio fall of 2015?

Majority of students were glad that they learn the design process not only for sustainable design but also for any architecture project while they can be an independent designer. They were pleased of the instructors in all aspect in technical trip organization, selection of case studies, inviting outside expert, etc., which all contributed to their success. Furthermore, they considered that the studio were great preparation for their professional life.

Some said it was a challenging period to work under pressure to catch up with the studio program, which was scheduled and planed clearly meanwhile jurıes requirements were well defined and the projects were graded accordingly.

Number of students appreciated the peaceful and dynamic environment of the studio that it help them to produce without feeling bored at any time. In addition, they appreciated the fairness of the instructors among all students in all aspects.

SADS colloquium

The students' second format of assessments type of the modified SADS pedagogy structure and teaching method was an open colloquium discussions. In short, the instructors explained what they have done during the semester long, the work objective, the work differences between last semester and this semester, and their general personal evaluation of the semester work. Afterwards, the students invited to express their thought objectively not subjectively regarding SADS. Students discussed issues such as workload relative to the other parallel conventional studio, teaching methods, elements of teaching pedagogy, juries, etc. Instructors allocated time after the colloquium for private interview to answer any of the students' personal question; however, no one came forward for any personal question.

Students' comments

For the most part, students were positive about what they learn and what they produce. The four students who attended the previous semester's SADS pilot experimental studio expressed that this semester was easier due to the previous semester knowledge. Students who had sustainability related classes were more comfort during the design process period. Again, students expressed that it was hard to learn many design issues while they were required to produce a creative sustainable design solution.

Generally, the students requested that all case studies should be presented by the first midterm jury in order to get the most benefit of it during the design concept period. They appreciated weekly schedule timetable along the semester as well as the instructors' knowledge and help during the design process. The also requested that they should allowed in midterm juries to present their work in digital format, that would be easier timewise and effort.

All students expressed their appreciation of having the municipality president and the University Rector at the final jury. It made the students feel that their design is a real serious work while it taught them how to be professional.

IYTE's online class evaluation

By the end of the semester, students are required to fill up online class evaluation form in order to learn their class final grade (Appendix. J), meanwhile the online evaluation is accessible to the class instructor once the grades are posted. The following were the most relevant questions to SADS work that were asked to the students. Table 5.8 presents the average answer of each question for the SADS studio, for the department all over courses, and for the faculty all over courses. The SADS scored the highest average in all questions over the department and the faculty average.

Table 5.8: IYTE's students online evaluations of the SADS second experimental.

Questions	Studio Average	Depart. Average	Faculty Average
Were the content of the class, expectations of the students' work, and the class objectives were announced at the beginning of the semester?	4.07	3.81	3.73
Were subjects processed according to the content of the course?	4.07	3.83	3.73
Did the lecturer present the course topics in an understandable way, with effective examples?	3,93	3.80	3.71
Did the lecturer give opportunity to the discussion environment?	4.07	3.82	3.72
Were homework, projects, and practices influential and understandable?	4.07	3.82	3.70
Were the examinations accurately measured the content and skills taught?	3.86	3.76	3.66
Final Average	**4.02**	**3.81**	**3.71**

General comments by the students:

The few students who had the SADS in previous semester were comfortable working in the project. Some students said that instructors were organized and helpful in coaching us to produce the project that I want.

One students comment was that the class content has been organized efficiently. Other said that the studio were fruitful. Another said, “The instructors were well qualified. I am thankful to them, it was very good studio”.

5.5 Findings and Recommendations

This section presents the findings, which were derived out of the results, data analysis, and evaluations and assessments sections. Furthermore, the findings points initiated various recommendations that had been adopted to improve the SADS pedagogy structure for the third and final experimental studio of this research.

5.5.1 Findings

Once more, the findings had two main sources; first from the instructor’s evaluations, second from students’ assessments.

From instructors

The modified pedagogy structure and teaching method introduced new grade distribution system of sustainable checklist elements and simulation energy test (table 5.2 & 5.3). This grade system reflected positively on the integration of sustainability principles into the final project results as well as it did better evaluation work accuracy. The class average of the use of sustainable design elements in each project was 12.44 elements of 19 elements that means 65.47% (Table 5.3). Furthermore, each sustainable design element’s average use in the 25 projects was 16.42 that means 65.68% (Figure 5.9). This was higher result comparing to pilot experimental studio.

The use of one software program (Revit) reflected positively to achieve the energy simulation test of the project. Only two students were not able to complete the simulation test due to their slow design progress (Table 5.4). Moreover, 50% of the students managed to design a project that reduce more than 10% in energy consumption and CO_2 emission reduction (Table 5.4).

There was a parallel trend result between students design process grades and final SADS grades (Figure 5.10) with R-squared value of (0.7348) represented strong data that were fitted to the regression line, which was stronger than the pilot experimental studio

There was positive correlation between the numbers of sustainable design elements each student use in his/her project and final SADS grades (Figure 5.11) with strong R-squared value of (0.8355).

There was a correlation between total grade of sustainable checklist elements and energy simulation test (40 points) and final SADS grades (Figure 5.12) as well as the R-squared value of (0.8369).

From students

There was general positive feedback from the students even though the workload of SADS experimental studio was more than double the workload of the conventional studio in the same department. Students recognized and accepted the heavy workload as a price of learning new knowledge. Here under the conclusion of students' questionnaire survey, open colloquium, and IYTE's on-line course evaluation.

The questionnaire

The questionnaire form presented that 70% of the students had no knowledge about sustainable design and the 30% had SADS or elective class related to sustainable design. Furthermore, 95% of the students confirmed practice sustainable design in their professional life and will chose it as their graduate education subject.

The technical trip and case studies were on the top choice students list of SADS pedagogy elements while the physical model and digital media were at the bottom list. The desk critiques by instructors was on the third position due to the difficulty of the project, students felt the need of the instructor one to one feedback. However, the standard deviation score was 1.85, which is less than the SADS pilot experimental studio score. In addition, the relative standard deviation score was 28.46%, which illustrated that the gap between top and bottom score sustainable design elements were less due to the extra effort that was given to the elements on the bottom list (Table 5.6) and (Figure 5.13).

The students who attended this SADS experimental research were coming direct off the second year with exception of four students, which might explained some of the students' comments regarding the studio workload and project size due to their lack of experience of handling big complex project. That did not mean that their final productions were not fine but it explained that there were more effort that had been done to get this positive result. On the other hand, this issue did not exist in the previous research pilot experimental studio.

Natural light and natural ventilation had the top score among students choice for SADS design principles elements while eco-friendly transportation scored the least points. However, the standard deviation between the elements was 1.51, which is less than previous pilot experimental studio. The relative standard deviation score (33.55%) was less than previous research pilot studio, which reflected that the gap was less between the top and lower elements (Table 5.7) and (Figure 5.14).

Colloquium's comments

There was positive reflection on the students while Bornova municipality president and the University Rector attended their final jury.

Students expressed that all case studies presentations were very helpful and it shall be finished in less than six weeks period, which would be more beneficial. Moreover, there was a request to have some of the midterm juries presented digitally. Once more, Revit assignments should started earlier, and study models shall be in various format and materials.

There was demand to invite more outside experts for more workshops. In addition, outside expert shall be participated in the midterm juries.

IYTE's online evaluation

The SADS scored higher points average than the Architecture Department and Architecture Faculty classes points average in IYTE online evaluation by the students. Similar result achieved on each question of the online evaluation questionnaire form (Table 5.8).

5.5.2 Recommendations

Afterwards, the conclusions led to a number of recommendations that had been applied to change or modify the SADS pedagogy structure of the third research experimental studio (AR 302 SADS-spring of 2016). These recommendations were:

The grade distribution points of sustainability design shall emphasize more on the energy consumption saving and CO_2 emission reduction.

Nevertheless, attention could be given to the low scores elements of SADS pedagogy structure as well as the sustainable design principles elements by providing more lectures and inviting outside experts.

The project size (meter square) shall be reduced in order for the students to pay more attention to the sustainable design issues.

The students would present all case studies within the first five weeks of the design process to get the most benefits of it.

Invited expert to midterm juries and permit students to present their work digitally meanwhile study models shall be in various types of materials and formats.

Simulation shall be used not only for energy test but also for the evaluation of natural light quality of the space. In additional, inviting more outside experts for presentations and workshops.

Figure 5.15: SADSs students - class of AR 301 fall 2016.

CHAPTER 6

THIRD EXPERIMENTAL STUDIO

This chapter presents the third and final SADS experimental execution of the research method. The chapter includes the modified research method execution, together with the studio outcome that included the students' performance along the semester and the finished products. In addition, it presents the evaluations and assessments of the results as well as any improvement in the results. Afterwards, the findings were presented to introduce new recommendations for future research work.

6.1 Introduction

All of the research's materials that were explained on chapter-3 were applied. The major steps of research method from chapter-3 as well as the modified method and teaching techniques that will be explained later and the restructured class calendar were executed. The third SADS experimental research work were executed on the third year AR 302 design studio of spring of 2016. Most of these students had attended SADS of second SADS experimental research with exception of eight students. Six of these eight students had technical classes related to sustainable design while they were in Erasmus program. The SADS had 25 students (12 females and 13 males).

There was a major change in the integration of sustainability principles in the design studio. In that experimental studio research, all three divisions of sustainability; environmental, economical, and social aspects were considered for the first time. There for, these change reflected on modification of the pedagogy structure, teaching methods, grade distribution, and assessments and evaluations.

6.2 Improved Research Method Implementation

The SADS pedagogy guideline and the timetable module structure with implementation of digital technology as well as the second SADS experimental studio recommendations were implemented into the SADS to create the modified pedagogy structure and improved instructor-teaching method (Table 6.1).

The modified syllabus (Appendix P) was based on the modified teaching pedagogy structure. Most students were familiar with the general outline of the SADS pedagogy however; the instructors explained that the main objective is the consideration of the three aspects of sustainability elements, which are environmental, economical, and social for this semester. Moreover, they point out the rules, new grades system distribution, and the working method of the SADS to the students. The SADS project program and description is shown in (Appendix Q). The total project size was reduced by 15% comparing with second experimental studio's project responding to the recommendations.

The SADS weekly calendar had been modified responding to the major changes mentioned earlier (Appendix R).

There were 25 case studies of selected existed projects (sustainable projects, and related conventional projects), which were assigned to the students to search them and present them to the class. The case studies name list are shown in (Appendix S).

Table 6.1: SADS's instructor teaching method of second and third experimental studios. Modified elements are shown in green

No.	Learning Technique	Second Experimental Studio Teaching - Method AR 301 Fall 2015	Third Experimental StudioTeaching - Method AR 302 Spring 2016
1	*learning by teaching others.*	One case study was presented by each students (25 case studies). Finished in the first 6 weeks. Case studies presentation had 5% of total class grade.	One case study was presented by each students (25 case studies). **Finished in the first 5 weeks.** Case studies presentation had 5% of total class grade.
2	*practice by doing and group discussion*	Students were required to write the project program individually then in a small group of three then in a group of eight. The project size was reduced by 30%.	Students were required to write the project program individually then in a small group of three then in a group of eight. **The project size was reduced by 15%.**
3	*practice by doing*	Students were required to construct study models during the project design development process (6 models) with various scales.	Students were required to construct study models during the project design development process (6 models) with various scales **and material types**
4	*deep learning*	Weekly panel reviews were conducted (9 panel reviews) in two formats:	Weekly panel reviews were conducted **(12 panel reviews)** in two formats:
	group discussion	A) Group discussion of the design process and project development were conducted	A) Group discussion of the design process and project development were conducted
	learning by demonstration	B) Students criticized each other's project by asking each student to present his/her project to the group	B) Students criticized each other's project by asking each student to present his/her project to the group
5		Technical trips to	Technical trips to
	practice by doing	A) The project site and surrounding area. Existing exemplary project owned by the client.	A) The project site and surrounding area.
	learning by demonstration	B) Existing exemplary projects out of town (Istanbul, Turkey)	B) Existing exemplary projects out of town (Bodrum, Turkey)
	learning by demonstration		**C) Existing exemplary projects in town (Izmir, Turkey)**
6	*practice by doing*	Instructors conducted weekly charrette design assignments during the design process (6 assignments)	Instructors conducted weekly charrette design assignments during the design process **(11 assignments)**
7	*practice by doing*	Various digital technologies were used throughout the design process	Various digital technologies were used throughout the design process
		A) Conceptual design period; climate consultant and Sketchup	A) Conceptual design period; climate consultant and Sketchup
		B) Design development period; Revit, Auto CAD, and Sketchup	B) Design development period; Revit, Auto CAD, and Sketchup
		C) Design evaluation period; Rivet only	C) Design evaluation period; Rivet (Energy) **and DIALux evo (Light)**
		D) Final drawing and presentation; Rivet, Auto CAD, 3D Max, and Sketchup	D) Final drawing and presentation; Rivet, Auto CAD, 3D Max, Sketchup, **and DIALux evo.**
8	*pubic interest/immediate use practice*	Project owner(s)/user(s) were invited to discuss the project and provide presentation and workshop (2 visits)	Project owner(s)/user(s) were invited to discuss the project and provide presentation and workshop (2 visits)
9	*learning by demonstration*	Monthly Outside expert(s) were invited for workshop (3 workshops)	**Biweekly** Outside expert(s) were invited for workshop **(5 workshops)**
	practice by doing	A) Instructors assigned homework related assignment ahead of each workshop studio	A) Instructors assigned homework related assignment ahead of each workshop studio
10	*learning by demonstration*	Instructors conducted individual and small group desk critics (12 desk critics)	Instructors conducted individual and small group desk critics **(15 desk critics)**
11	*learning by visual, audio, and lecture*	Class instructors offered lectures about the project topics that included visuals and audios materials focusing on the low score elements from first pilot recommendation (13 Lectures)	Class instructors offered lectures about the project topics that included visuals and audios materials focusing on the low score elements from second pilot recommendation **and economical and social aspects of sustainability (15 Lectures)**
12		Juries	Juries
	learning by demonstration	A) Instructors conducted midterm juries (3 midterm juries)	A) Instructors conducted midterm juries (3 midterm juries) **including outside guest**
	learning by teaching others	B) Instructors hosted a final jury that included Bornova Municipality president, University rector, experts, and academic members. The grade distribution was modified.	B) Instructors hosted a final jury that included Izmir Municipality represintative, the University Rector, experts, and academic members. **The grade distribution was modified.**
	learning by demonstration		**C) Instructors conducted role-play jury and student-led jury after third midterm jury**

6.3 Studio Outcome

The grading system was revised since the three branches of sustainability principles (environmental, social, and economical) were considered. There were more grade load given to the sustainability checklist, and energy simulation test while natural light simulation test was an optional as first trial for third experimental studio, as it is shown on (Table 6.2). Similar to second experimental studio, the SADS 100 points were divided into 40 point for evaluation of the semester long workload performance, which include the design process. The other 60 points were for finished project evaluation of which 50% was dedicated purely to the design aspect and 50% for the degree of integration of the sustainability principles in the project (Table 6.2), which is higher than second experimental studio.

6.3.1 Students' performance

Throughout the semester, the work performance of each student was monitored, evaluated, and recorded according to the sub items, which are shown in (Table 6.2). The workload during the semester included group work, case studies presentation, individual assignment in both class and home, technical trips to various sustainable and conventional designed projects (Figure 6.1), midterm juries, and presentation (Appendices P & R) and (Table 6.1). The final grades of the students' performance are shown on the (Table 6.2).

The three midterm's juries were conducted similar to the first and second experimental studios with the same requirements with two major changes. First was allowing the students to use both digital and manual presentation techniques in the first midterm jury only. Second was inviting outside experts to the juries (Appendix T).

Table 6.2: SADS's grades earned through evaluation stages of students performance.

No.	Attendance 5%	Site Analysis 5%	Assignments 5%	Case Study 5%	1st Jury 5%	2nd Jury 5%	3rd Jury 5%	Portfolio 5%	Design Process 40%
1	5,00	5,00	3,50	5,00	3,90	3,40	0,00	4,00	**29,80**
2	5,00	5,00	5,00	4,00	3,00	2,90	3,20	3,00	**31,10**
3	0,00	5,00	3,00	5,00	2,70	3,00	0,00	5,00	**23,70**
4	5,00	5,00	3,50	4,50	3,50	3,70	3,40	4,00	**32,60**
5	5,00	5,00	3,50	5,00	2,90	3,20	2,70	3,00	**30,30**
6	0,00	5,00	5,00	5,00	2,70	0,00	3,00	5,00	**25,70**
7	5,00	5,00	5,00	4,50	3,00	3,70	3,90	4,00	**34,10**
8	4,00	5,00	5,00	5,00	3,20	3,40	3,40	4,00	**33,00**
9	5,00	5,00	5,00	3,75	3,70	3,70	3,70	3,00	**32,85**
10	5,00	5,00	5,00	4,50	3,70	4,40	4,00	4,00	**35,60**
11	5,00	5,00	5,00	4,75	3,40	4,00	4,20	4,00	**35,35**
12	3,00	5,00	5,00	4,75	3,90	4,20	3,40	5,00	**34,25**
13	5,00	5,00	5,00	4,75	3,40	4,00	4,20	5,00	**36,35**
14	2,00	5,00	5,00	4,50	3,50	3,80	3,00	0,00	**26,80**
15	3,00	5,00	5,00	4,75	3,70	3,40	4,40	5,00	**34,25**
16	2,00	5,00	3,50	4,25	3,40	3,40	2,70	4,00	**28,25**
17	5,00	5,00	3,50	5,00	3,80	4,10	2,40	4,00	**32,80**
18	3,00	5,00	3,50	4,75	3,70	3,00	2,70	2,00	**27,65**
19	2,00	5,00	3,50	4,50	3,00	2,90	2,70	4,00	**27,60**
20	5,00	5,00	3,50	4,00	3,00	4,20	3,70	5,00	**33,40**
21	4,00	5,00	5,00	4,75	3,70	3,50	3,70	4,50	**34,15**
22	5,00	5,00	5,00	4,00	3,50	3,20	3,50	4,00	**33,20**
23	5,00	5,00	2,00	4,50	3,20	2,70	2,70	3,50	**28,60**
24	5,00	5,00	5,00	4,75	3,00	4,00	3,70	5,00	**35,45**
25	3,00	5,00	2,00	4,75	3,20	0,00	2,70	5,00	**25,65**

Figure 6.1: Technical trip; visiting sustainable and conventional architecture housing projects in Izmir and Bodrum, Turkey.

6.3.2 Finished product

SADS final jury requirements and format were announced two weeks ahead of the jury day. Students were encouraged to use both digital and manual presentation techniques. The invited guests were Izmir Municipality members (project owner), and IYTE Rector, academic members, and experts in sustainable design. Public attendance were welcomed (Figure 6.2). Instructors role were an intermediators of the event, explaining SADS pedagogy and project outline objectives. Final jury requirements are shown in (Appendix U).

Figure 6.2: SADS final project presentation to the jury members.

After final jury, instructors evaluated all projects. Similar to the two previous experimental studios, the projects were divided to three groups; outstanding, satisfactory, and unsatisfactory according to the sustainable elements number integrated into the each project, while in this experimental studio the three aspect of sustainability; environmental, social, and economic were included, therefor the total elements rose from 19 to 28 as is shown in (Table 6.3). The benchmark evaluation for each category was as the same as previous experimental studios' percentage wise but the elements number were different. The distributions were as follow:

- Outstanding projects that had 22 or more integrated elements (79% or more integrated elements); there were 11 projects.

- Satisfactory projects that had 12 to 21 integrated elements (42% to 75% of integrated elements); there were 9 satisfactory projects.

- Unsatisfactory projects were included 11 or less integrated elements (39% or less of integrated elements); there were 5 unsatisfactory projects.

The following three projects demonstrate one project of each category, where the students proposed sustainable design projects to Izmir Municipality to replace a slum residential area in Bayrakli, Izmir. The students did questionnaire survey and personal interviews to the existing residents, which helped to create responsive design to the residents.

Outstanding example

The proposed design by Okan Türkcan was called "TAM" housing responding to three words; transformability, adaptability, and maximization. These three conceptual words proposed a design responded to both urban sprawl and unvaried high-density community (Figure 6.3 & Figure 6.4). It proposed an alternative to current housing models by introducing a new modular system to achieve urban green living inside of the city, but with large and sufficient amounts of private green areas that mimic a suburban character living in the green and in the city. The private courtyard, acting as an "oasis" inside of the city. The residences are placed around the courtyard by using a modular design, in which people actually buy a module space that can be expanded later by the resident. All of the above strategies were based on environmental, economical, and social sustainable design principles. The following tools were used to reduce energy consumption and provide space living comfort for the residents:

- Solar rooftop ‘PV’ and hot water system.
- Passive overhangs and adaptable shutters.
- Ventilation openings in mass.
- Cross-ventilation in all residences (N-S)
- Water collection from porous courtyard and car park, roofs and balconies.
- Waste was separated at residential level, after which the organic one is used for fertilization of green areas. Other materials are given to the municipal system for recycling.
- Daylight performance by shallow floor plan depth (10 m. with two-sided light access), combined with glass and wood louver systems for shading or light refraction. Efficient and atomized LED lighting in all residences.
- Rainwater was collected from roof surfaces, balconies, central yard, and car park. Used in conjunction with gray water and low-usage faucets.
- Residential heating done using fan-coil systems (heating and cooling). Central tri-generation unit aided by solar hot water collectors, PV panels and ground heat exchanger combined with an adsorption cooling system. Hot water is used for domestic usage, space heating and for the adsorptive cooling system.
- Ventilation provided naturally and optionally as mechanical. Natural cross-ventilation aided by air buoyancy and louvered windows for safe ventilation and winter heat storage (double-skin window).
- Usage of steel and cross-laminated wood as main structural system. Partitions made from lightwood. When compared to a concrete building (58% lighter and 40% reduction in embodied CO_2).

The proposed design had 33% saving in energy consumption and 26% CO_2 emission reduction; meanwhile the project included the 28 elements.

Satisfactory example

The social aspect of sustainability was the leading design principles proposed by Latif Temmuz Babacan, and it was based on the “Alley infill” idea (Figure 6.5 & Figure 6.6). Streets in the existing site representing a great social activities to the residents where they meet, communicate, share, and interacting daily. Therefore, the design strategy was built on combining the residential buildings with the streets indirectly by creating a platform where the residential spaces placed on the top while the social and commercial spaces placed on the bottom. Meanwhile, the intersection between the two spaces were allowed visually and physically with respect to the pubic private design issue. Natural light and natural ventilation was accomplished by creating opening in the platform and minimizing the floor plan depth. The use of PV panels, rainwater, sustainable materials, shading elements minimized the energy consumption. The project maintain 22% saving in energy consumption and 19% CO_2 emission reduction, while the project included 21 elements.

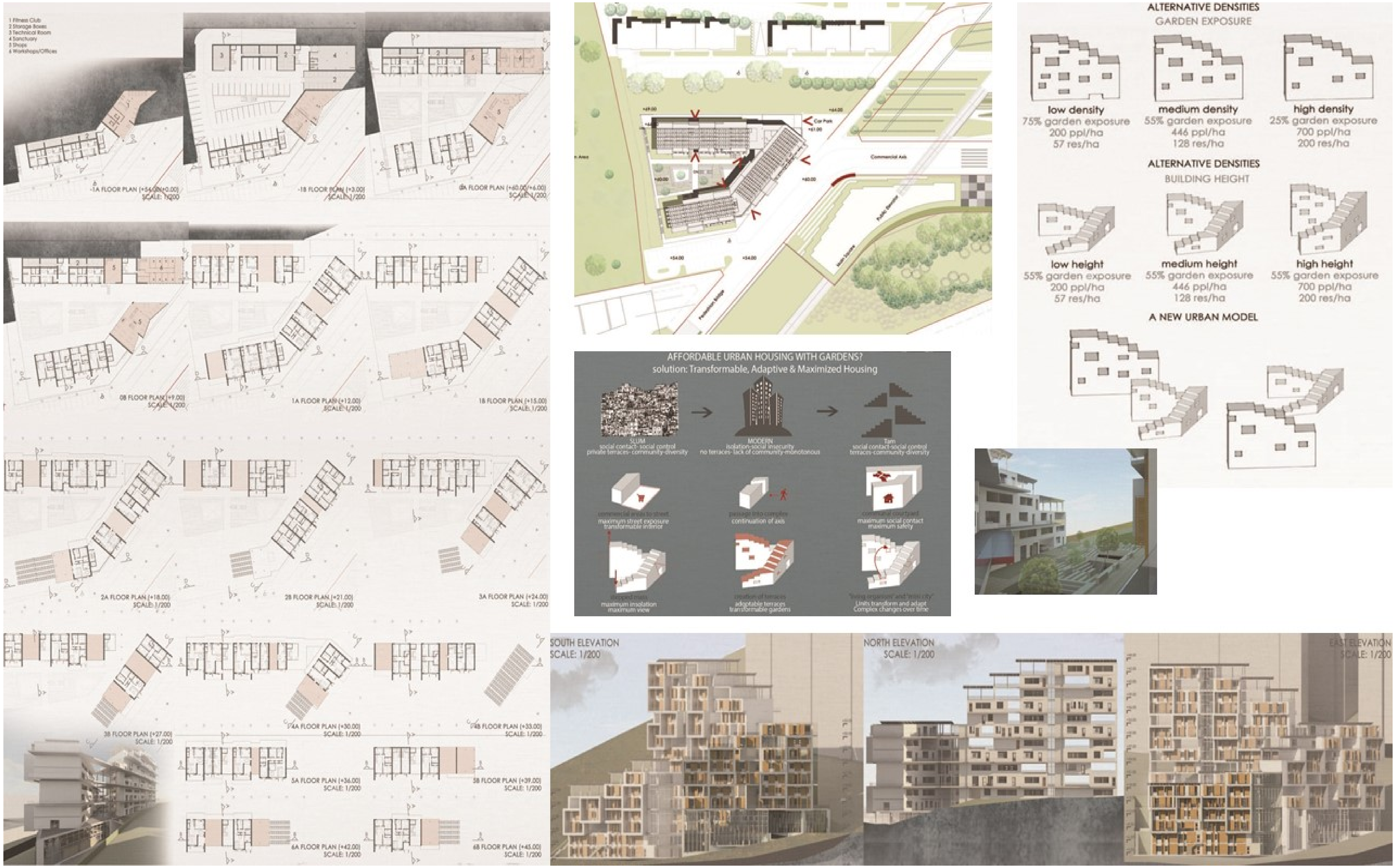


Figure 6.3: TAM Housing in Bayrakli, Izmir “Okan Türkcan” -1

Figure 6.4: TAM Housing in Bayrakli, Izmir “Okan Türkcan” -2

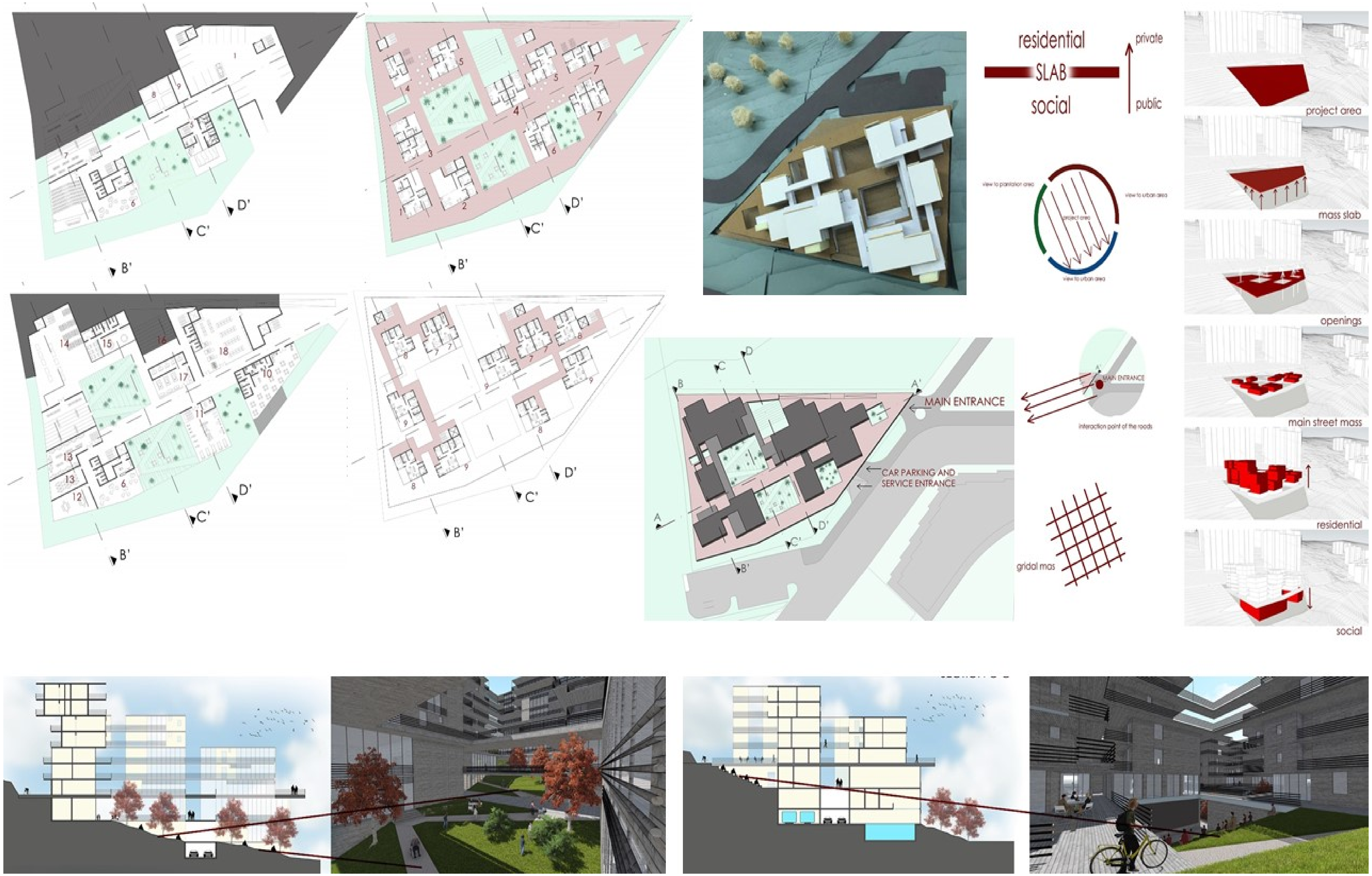


Figure 6.5: Alley infill housing, Bayrakli, Izmir “Latif Temmuz Babacan” -1

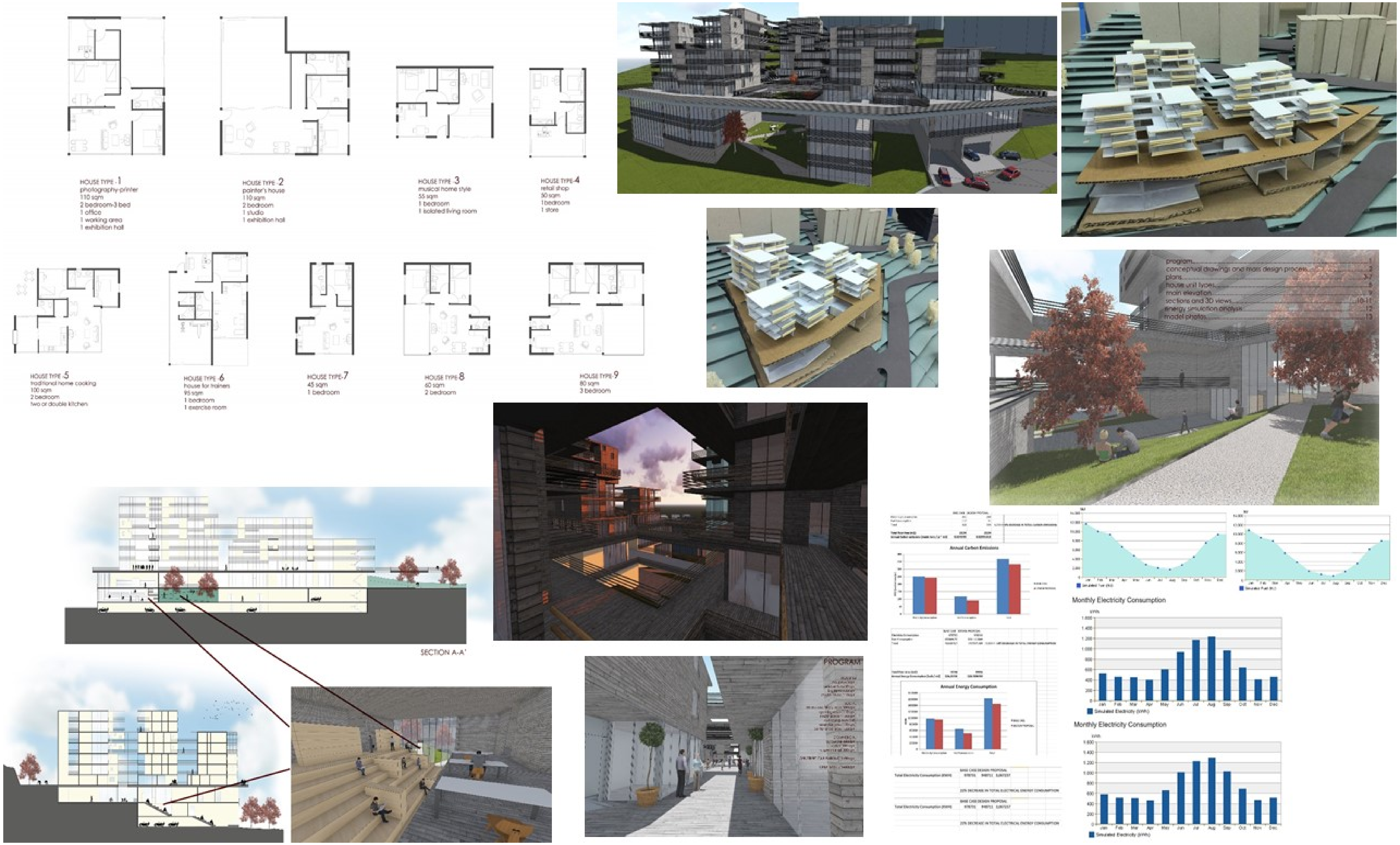


Figure 6.6: Alley infill housing, Bayrakli, Izmir “Latif Temmuz Babacan” -2

Unsatisfactory example

SADS third experimental studio had few unsatisfactory projects, which received low points on the checklist of sustainable design elements and energy simulation test. Here under is presented an example project:

The economic aspect of sustainable design was the supporting idea of this project. The project proposed an affordable housing type as shown in (Figure 6.7). The project received 8 points of the 28 checklist points. The project failed to use local natural materials and sustainable materials. It has serious problem of natural ventilation and natural light in the apartment units' spaces. There was no consideration of using rainwater and sun energy. The project did not provide correct energy simulation test.

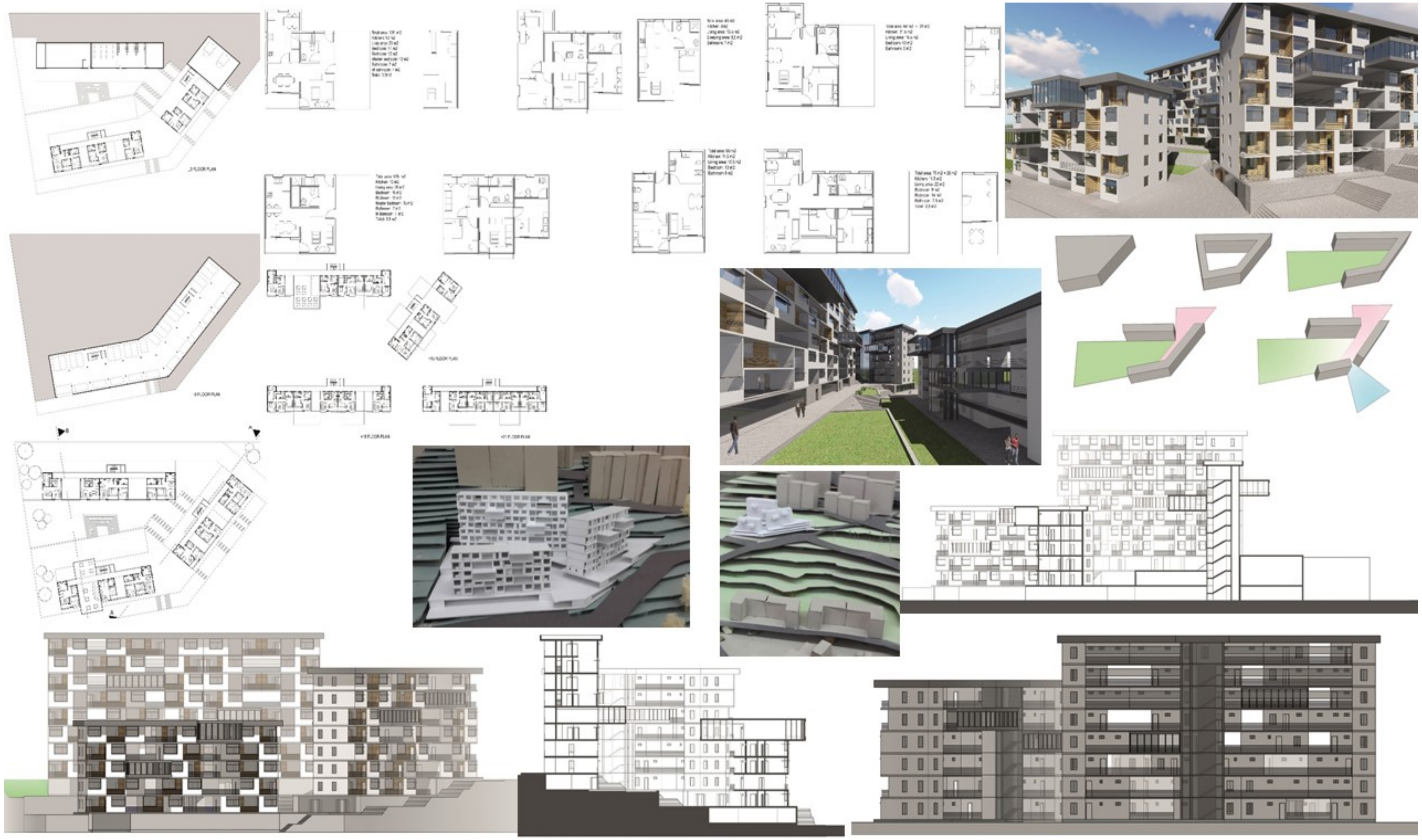


Figure 6.7: Unsatisfactory project

6.4 Evaluations and Assessments

The evaluations and assessments of SADS class were done similar to the first and second experimental studios. The SADS instructors evaluated the students' works. This evaluation was based on the design process work throughout the semester period and the final product of design project, as well as the degree to which the sustainability principles were integrated into their final design. This time, the evaluation considered the three sustainability aspects; environmental, economical, and social. Then the students assessed the SADS pedagogy and instructors teaching method that was conducted on them as well as their own SADS experience course. The assessment was applied to the final improved SADS pedagogy structure.

6.4.1 Evaluations by instructors

The new sustainability principles checklist was prepared including the three aspects of sustainability (environmental, economical, and social) (Appendix V) and (Table 6.3) were introduced to the students during the design process throughout the semester. The checklist elements were explained throughout lectures, workshops, technical trips, and case studies presentations. Furthermore, it was announced to the students that their projects will be evaluated against this list to measure their project success (Table 6.3).

Grading system

Sustainability checklist elements, Revit energy simulation test, and light simulation test (optional) results were counted for 50 points, while the distribution of these points were as shown in (Tables 6.2 & 6.3). The grades distribution were modified to include all new elements of social and economic design aspects. The energy simulation test's grade were modified to emphasize on the saving level of energy consumption and CO_2 emission reduction. The grade weight illustrated the workload, the time consumed, and integration quality to respond to each student effort during one semester period. The measuring system was applied to each project. Each project was given the number of elements included in it, while (Table 6.3) presented the checklist-collected data.

The average number of sustainable design elements used all over the projects were 18.64 of 28 elements total.

In (Figure 6.8) presents each sustainable design element integration times in all students’ projects. The average use of each element was 16.64 in 25 projects.

The light simulation test was an optional work recommended to the students who had previously the elective course of Natural Light in Architecture design. The students were requested to test some of unites’ natural light quality whether or not 60% of the unit total space has at least 300 Lux.

Table 6.3: The number of sustainability elements integrated in each project and grading system of sustainability elements, energy simulation, and daylight tests

Main Elements / points	Energy (10 Points)									Materials (4 Points)			Water (4 Points)			Health (4 Points)				Social Elements (8 Points)					Economic Elements (5 Points)				Total Elements 28	Total 35 Points	Energy Simulation Tests (15 Points)					Light Simulation Test (Optional)			Total Evaluation 50 Points
Points distribution	8 Elements or more (10) 7 Elements (8) 5 to 6 Elements (6) 3 to 4 Elements (4) 1 to 2 Elements (2) None (0)									3 Elements (4) 2 Elements (3) One element (2) None (0)			3 Elements (4) 2 Elements (3) One element (2) None (0)			4 Elements (4) 2 to 3 Elements (3) One element (2) None (0)				5 Elements (8) 4 Elements (6) 3 Element (5) 2 Elements (4) 1 Element (2) None (0)					4 Elements (5) 3 Elements (4) 2 Elements (3) 1 Element (2) None (0)						(5 Points)	(5 Points)	(8 Points)	(10 Points)	Total 15 Points	(NO)	(Good)	(Excellent)	The Integration of Sustainaplity in The Design
Elements	Reducing the energy used for lighting		Reducing the energy used for ventilation		Reducing energy used for heating and cooling			Use of renewable energy sources																															
Students No.	80% of spaces benefits from natural light	Sky-gardens, skylights, atriums, light shelves	Adjustable windows, air-holes	Natural ventilation by channels (wind catcher)	Reduce heating loads (high insulation glass system (low-e 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	Enhance awareness of available alternative options in local social structures influencing human behavior to change through collective, democratic, and sustainable ways	Design for cooperation and sustainability	Design for combating the alienation and solation that many experience today	Design for a sense of individual and collective identity	Design for an ecologically oriented society with a belief that the society alone can remove the root cause of the current ecologic crisis	Increase in the use of local available materials in construction instead of expensive imported materials	Change negative perception of low-cost housing as UGLY, NON DURABLE, LOW QUALITY, AND ONLY FOR LOW-INCOME FAMILIES by using cost-effective building technologies and materials	Decrease energy consumption	Allow self-build			Base case result	Modified case with selected materials and shading elements, Reduction of less than 10% in Energy and CO2 emission	Modified case with selected materials and shading elements, Reduction of 10% to 20% in Energy and CO2 emission	Modified case with selected materials and shading elements, Reduction of more than 20% in Energy and CO2 emission		No test	less than 60% of the unit has 300 Lux	More than 60% of the unit has 300 Lux	
1	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X			X	X	25	31	5		8		13	X			44
2	X	X			X			X	X	X			X			X	X	X			X				X		X		13	18	5	5			10		X		28
3	X								X	X				X		X		X			X						X		8	16	5				5	X			21
4	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		26	34	5		8		13			X	47
5	X		X		X		X		X	X				X		X					X						X		10	18	5	5			10	X			28
6	X	X	X			X			X	X	X			X		X	X	X			X	X				X	X	X	16	18	5	5			10	X			28
7	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X	X	X				X		X		X		20	25	5			10	15	X			40
8	X	X	X	X	X	X			X	X				X	X	X	X			X	X								14	24	5	5			10		X		34
9	X	X	X		X		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X		X	X	X		22	28	5			10	15			X	43
10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	28	35	5			10	15			X	50
11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		27	34	5			10	15			X	49
12	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	28	35	5			10	15			X	50
13	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	26	32	5			10	15			X	47
14	X		X	X					X	X	X			X		X	X	X		X	X	X	X				X		15	20	5		8		13	X			33
15	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X		X	X	X		X	X	X		23	30	5			10	15			X	45
16		X	X						X	X				X			X				X			X	X		X		10	17	5			10	15	X			32
17	X	X	X	X	X				X	X	X	X		X	X	X	X	X	X	X	X	X	X		X		X		21	26	5			10	15	X			41
18		X	X		X				X					X		X				X	X	X	X						10	18	5				5	X			23
19	X	X			X				X							X	X				X		X				X		9	13	5		8		13	X			26
20	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X			X			X	X	X		22	27	5			10	15	X			42
21	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	28	35	5			10	15			X	50
22	X	X	X	X		X		X	X	X	X					X	X	X	X			X			X		X		16	20	5			10	15			X	35
23	X	X			X	X		X	X		X	X	X			X	X	X							X		X		14	17	5			10	15	X			32
24	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X					X	X	22	28	5			10	15			X	43
25	X	X	X	X	X	X			X				X			X	X			X	X							X	13	21	5	5			10	X			31
The use of each element in 25 projects	23	22	21	15	20	16	12	15	25	21	17	13	15	18	8	24	22	19	14	13	21	16	14	7	15	10	22	8	The Avarage element number used in the SADS 18,64										37,68

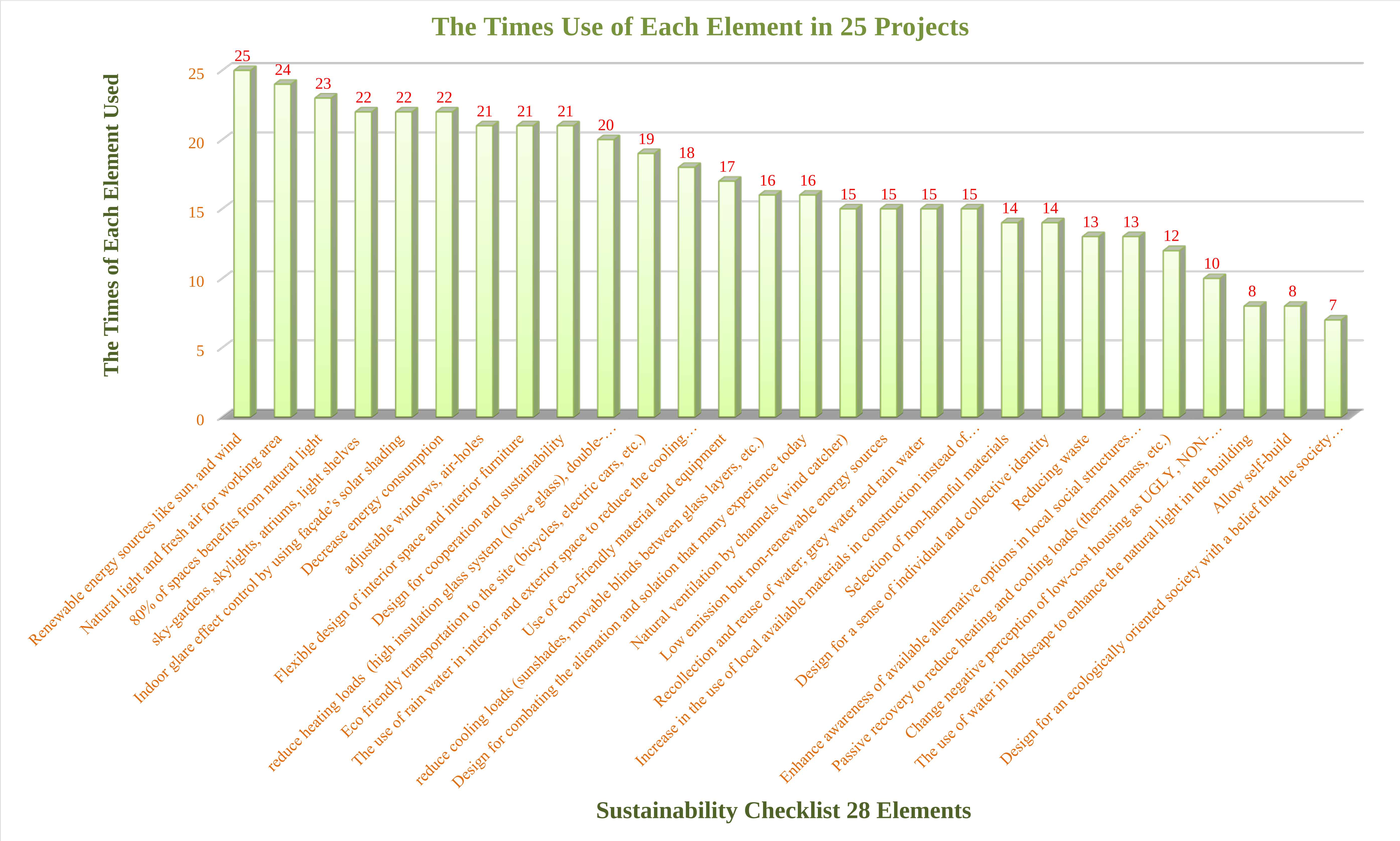


Figure 6.8: The times use of each sustainable design element in the 25 projects.

Table 6.4: Third experimental SADS's final project grades

Students No	Energy (10 Pts)	Material (4 Pts)	Water (4 Pts)	Health (4 Pts)	Social Elements (8 Pts)	Economic Elements (5 Pts)	Simulation Bas case (5 Pts)	Simulation modified case (10 Pts)	Total Sus. Checklist & Simulation (50 Pts)	Design Evaluation (50 Pts)	Final Jury Total (100 Pts)
1	10	3	3	4	8	3	5	5	**44**	**47**	**91**
2	6	2	2	3	2	3	5	5	**28**	**44**	**72**
3	2	3	2	3	4	2	5	0	**21**	**39**	**60**
4	10	4	4	4	8	4	5	8	**47**	**41**	**88**
5	6	2	2	2	4	2	5	5	**28**	**42**	**70**
6	4	3	2	3	4	2	5	5	**28**	**28**	**56**
7	10	3	3	4	2	3	5	10	**40**	**43**	**85**
8	8	3	3	3	4	3	5	5	**34**	**44**	**78**
9	8	4	3	4	5	4	5	10	**43**	**40**	**83**
10	10	4	4	4	8	5	5	10	**50**	**46**	**96**
11	10	4	4	4	8	4	5	10	**49**	**47**	**96**
12	10	4	4	4	8	5	5	10	**50**	**46**	**96**
13	10	4	3	4	6	5	5	10	**47**	**45**	**92**
14	4	3	2	3	6	2	5	8	**33**	**40**	**73**
15	10	4	3	4	5	4	5	10	**45**	**48**	**93**
16	4	2	2	2	4	3	5	10	**32**	**38**	**70**
17	6	4	3	4	6	3	5	10	**41**	**39**	**80**
18	4	2	2	2	6	2	5	0	**23**	**39**	**62**
19	4	0	0	3	4	2	5	8	**26**	**38**	**64**
20	10	4	3	4	2	4	5	10	**42**	**44**	**86**
21	10	4	4	4	8	5	5	10	**50**	**45**	**95**
22	8	3	0	4	2	3	5	10	**35**	**39**	**74**
23	6	3	2	3	0	3	5	10	**32**	**34**	**66**
24	10	4	2	4	5	3	5	10	**43**	**47**	**90**
25	8	2	2	3	4	2	5	5	**31**	**43**	**74**

Instructors graded the final submission of the project as it is shown in (Table 6.4) as well as the final semester's grades work, which is presented in (Table 6.5).

Table 6.5: Third experimental SADS's students final grades.

Students No.	Design Process Grades (40)	Final Jury (60)	Final Grade (100)	Letter Grades
1	29,80	54,60	**84,40**	**BA**
2	31,10	43,20	**74,30**	**CB**
3	23,70	36,00	**59,70**	**DD**
4	32,60	52,80	**85,40**	**BA**
5	30,30	42,00	**72,30**	**CC**
6	25,70	33,60	**59,30**	**DD**
7	34,10	51,00	**85,10**	**BA**
8	33,00	46,80	**79,80**	**BB**
9	32,85	49,80	**82,65**	**BB**
10	35,60	57,60	**93,20**	**AA**
11	35,35	57,60	**92,95**	**AA**
12	34,25	57,60	**91,85**	**AA**
13	36,35	55,20	**91,55**	**AA**
14	26,80	43,80	**70,60**	**CC**
15	34,25	55,80	**90,05**	**AA**
16	28,25	42,00	**70,25**	**CC**
17	32,80	48,00	**80,80**	**BB**
18	27,65	37,20	**64,85**	**DC**
19	27,60	38,40	**66,00**	**DC**
20	33,40	51,60	**85,00**	**BA**
21	34,15	57,00	**91,15**	**AA**
22	33,20	44,40	**77,60**	**CB**
23	28,60	39,60	**68,20**	**DC**
24	35,45	54,00	**89,45**	**AA**
25	25,65	44,40	**70,05**	**CC**

Data analysis

Afterwards, the data collected from various grade system were analyzed to assess the success of the final modification of SADS pedagogy and teaching method. The new grade system of energy simulation illustrated in (Figure 6.9) the percentage of the energy saving and CO_2 emission reduction achieved by the students.

While daylight test was an optional work, twelve students managed to achieve it and ten of them succeed to provide 300 Lux to more than 60% of the apartment unit space (Figure 6.10).

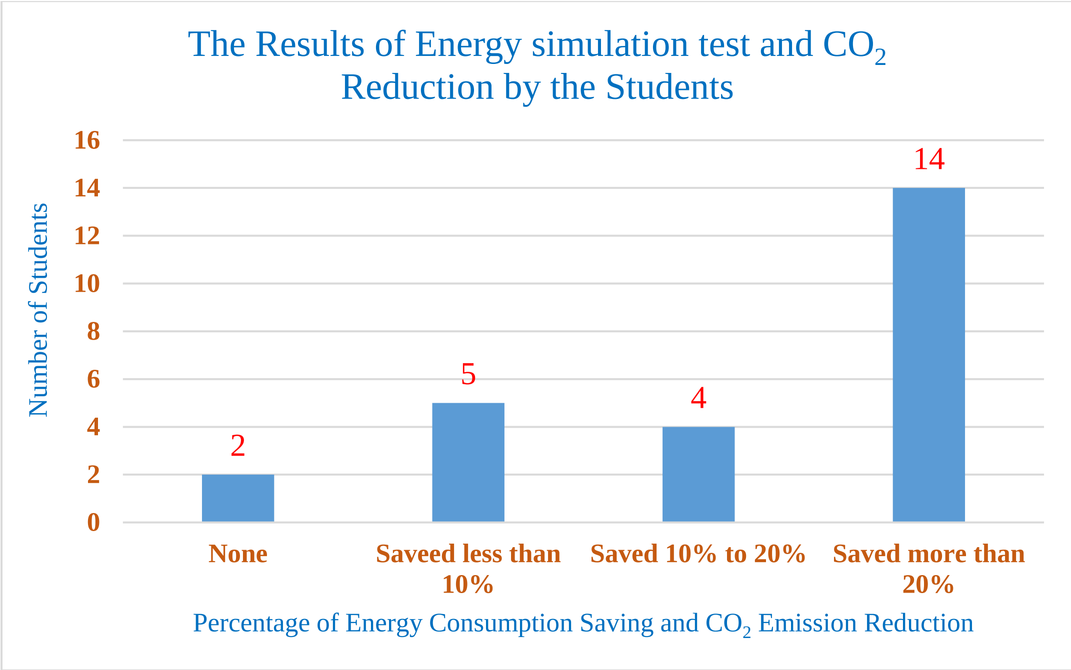


Figure 6.9: Energy saving and CO_2 emission reduction percentage achieved in students' projects.

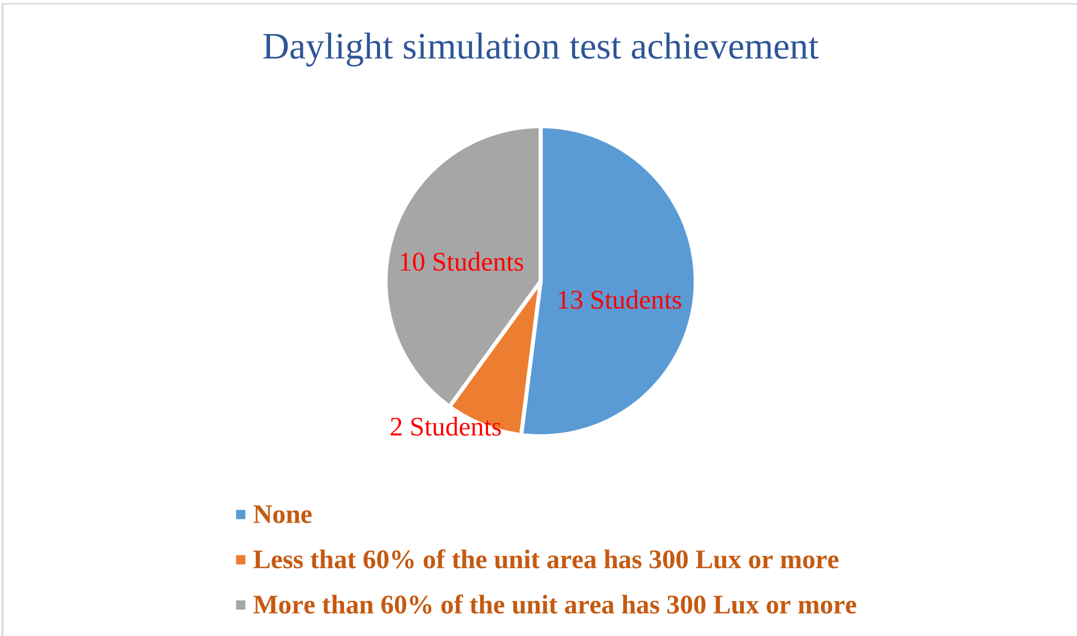


Figure 6.10: Daylight simulation test (Optional test).

Instructor’s evaluation showed a positive correlation trend between the numbers of sustainable design elements and SADS final grades (Figure 6.11). In additional, there was a positive trend between design process grades (representing the final modified SADS pedagogy structure) and final project grade of the students as shown in (Figure 6.12). Positively, the same correlation trend between the total grades of sustainable checklist elements and energy simulation test of each project and the final SADS grade shown in (Figure 6.13).

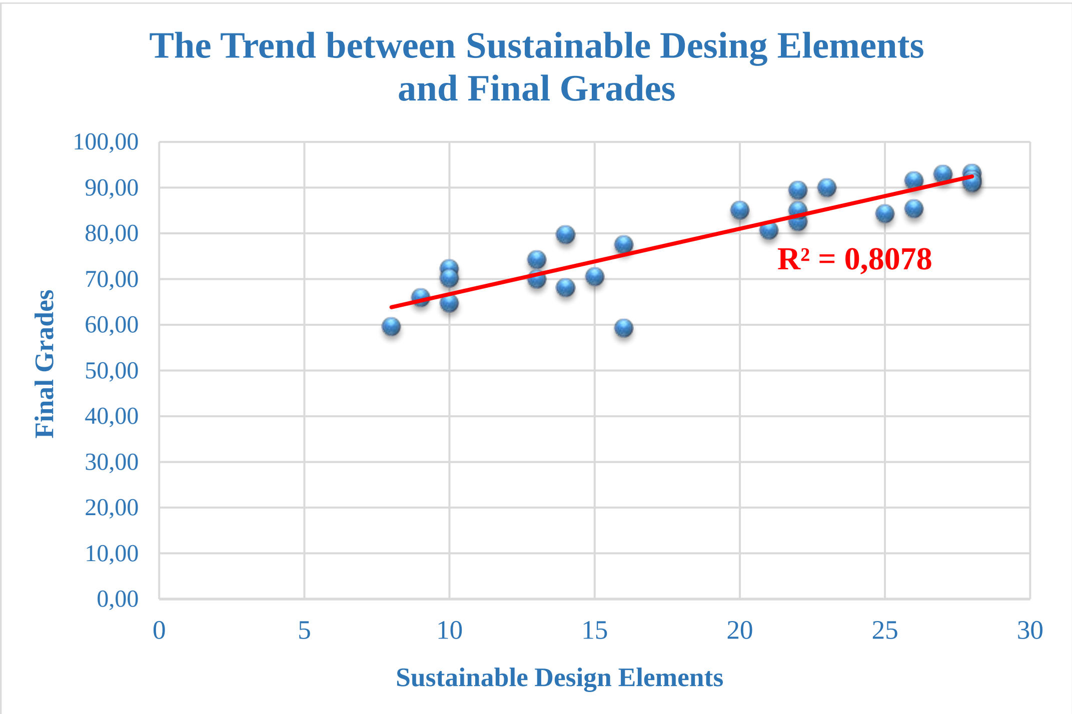


Figure 6.11: The correlation between the numbers of sustainable design elements each student used in his/her project and the SADS final grade.

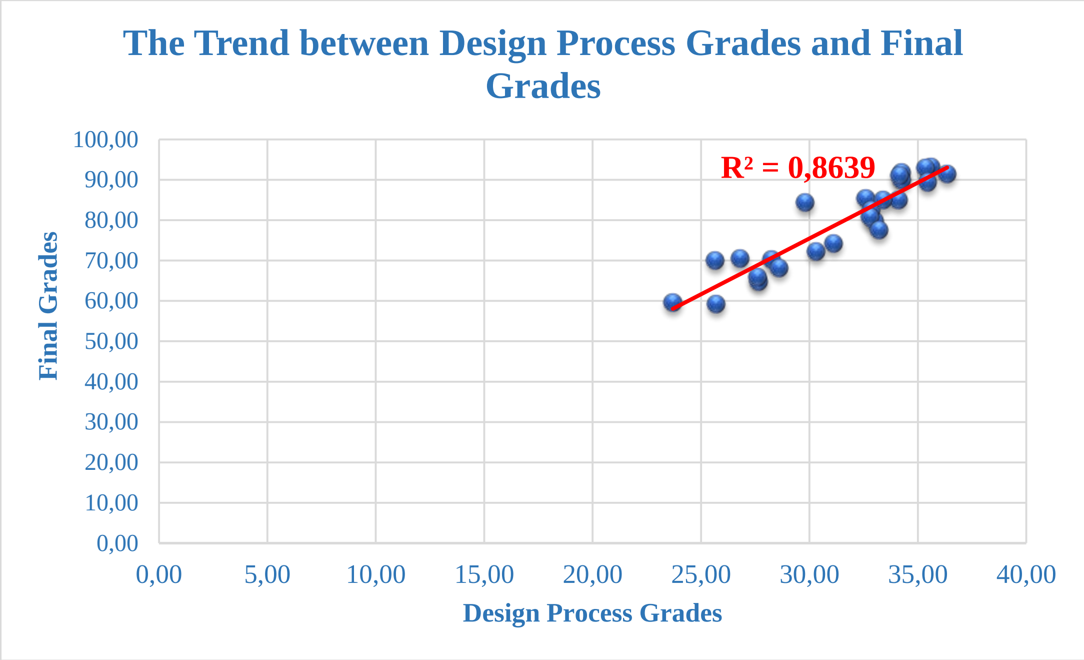


Figure 6.12: Positive trend result between student' design process grades and SADS final grades.

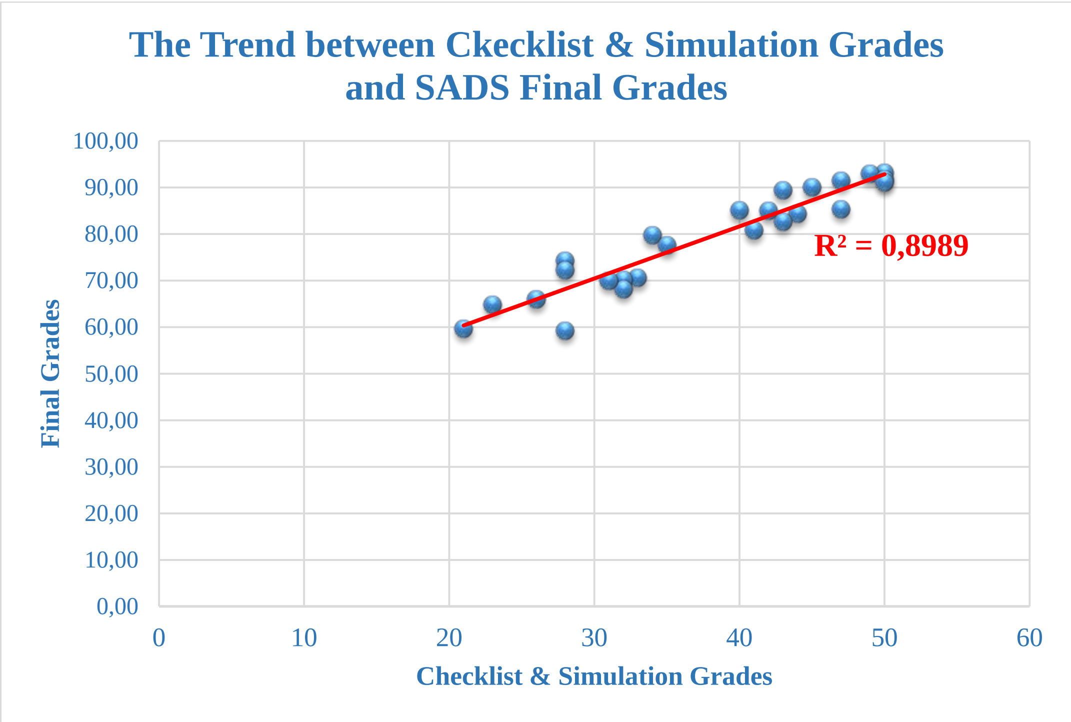


Figure 6.13: The correlation between the total grades of sustainable checklist elements and energy simulation test of the students and the SADS final grades.

6.4.2 Assessments by students

Students' assessments was similar to the previous two experimental SADS. The students' assessments used three tools that assess the SADS final modified pedagogy structure and instructors teaching methods of the final experimental research. These tools were:

a) Questionnaire forms

b) SADS colloquium

c) IYTE's online class evaluation

Questionnaire forms

The SADS instructors e-mailed the questionnaire survey form to the students after the SADS final grades were posted (95% of the final grades). Students were allowed to e-mail back the filled form or hand it in at the colloquium's day. The form had extra questions comparing to first and second experimental Studios. The new questions were related to economic and social aspects of sustainable design as it is shown in (Appendix W).

Questionnaire forms answers

Nineteen forms were collected with no names on them. The following presents the answer of each questions:

1) Did you have information about sustainable architectural design before this design studio?

There were five students answered "No" while 14 had knowledge of sustainable architectural design. Of these, 12 had the SADS second experimental studio, one had taken elective courses before, and one had taken one course during Erasmus study.

2) Did you attend any related course(s) about the technical aspects of sustainable architectural design before this design studio?

Fifteen students have never attended any classes while one student attended four courses and three students attended one course only.

3) Which one of the Sustainability aspects did you consider in your design project?

Fifteen students considered the environmental aspect while fourteen students considered the social issue and twelve students considered the economical part of sustainability. Since the SADS had 25 students, that mean some students considered two or three sustainability aspects in their projects as it is shown in (Figure 6.14).

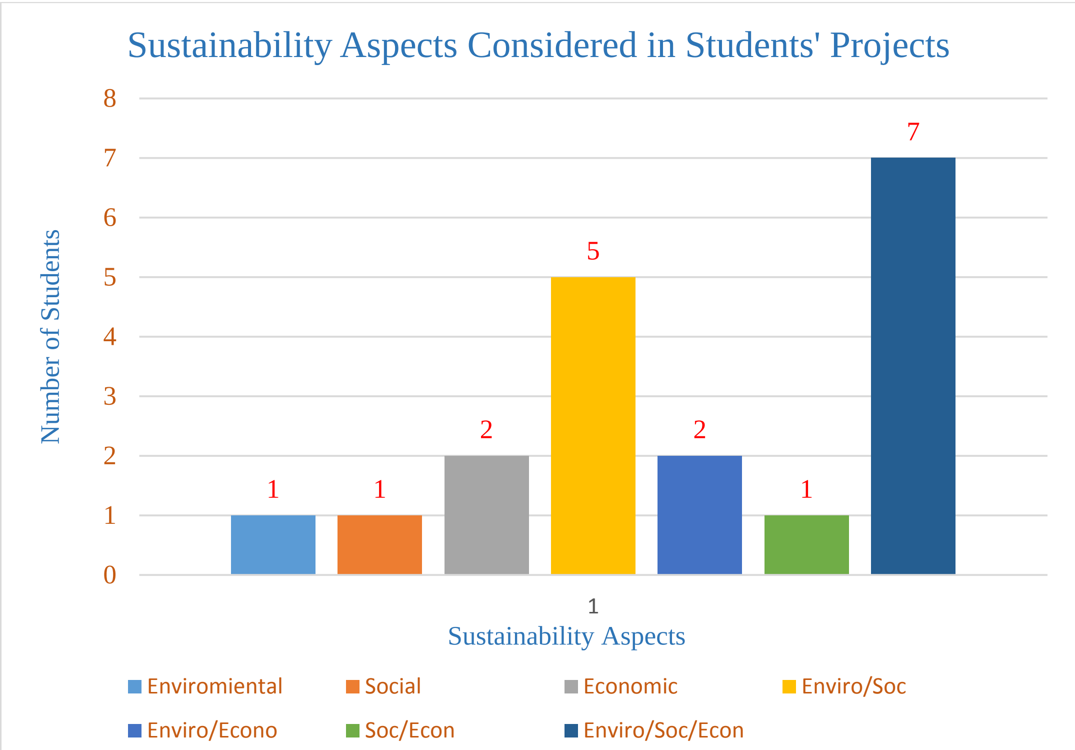


Figure 6.14: Sustainability aspects considered by the students in their design.

4) Design studio pedagogy structure included many elements during the semester. Would you put these elements in order, the most beneficial to your design project process?

There were 15 correct format answers of 19 forms. The SADS pedagogy structure elements that were presented during the semester to the students were placed in order beneficial priorities in the students' answers. The most beneficial was giving number (12) and the least was giving number (1). The average of each elements by the 15 students' order was calculated, as is shown in (Table 6.6). Element with the highest average points was set on the top order of the SADS pedagogy structure, the final order is presented in (Figure 6.15).

Table 6.6: The students' evaluation points average of the SADS pedagogy structure elements.

	SADS Pedagogy Elements / Students Order	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	14 th	15 th	Each Element Average
a	Physical models	1	8	1	1	11	2	6	5	3	2	5	5	2	1	5	3,87
b	Site analysis	12	11	11	7	4	4	9	6	1	8	12	11	4	7	8	7,67
c	Lectures by instructors	3	10	2	9	8	5	10	4	2	6	4	3	1	2	9	5,20
d	Case studies	4	9	10	12	6	6	7	7	7	10	10	10	11	6	3	7,87
e	Site trip	2	7	9	8	3	9	5	2	12	11	7	7	8	4	11	7,00
f	Technical trip visiting sustainable building	11	12	12	6	12	7	8	8	5	9	11	6	7	5	12	8,73
g	Lectures by expert visitors	5	6	8	10	7	8	4	3	11	7	3	2	3	3	4	5,60
h	Panel reviews	10	2	4	3	10	11	3	10	9	5	9	9	10	11	10	7,73
i	Midterm juries	9	1	3	2	5	10	12	11	8	4	2	8	6	10	2	6,20
j	Desk critiques	8	3	5	11	2	12	11	12	10	3	8	4	9	8	6	7,47
k	Assignments	6	5	6	4	1	3	2	9	6	1	1	1	12	12	1	4,67
l	Use of digital media	7	4	7	5	9	1	1	1	4	12	6	12	5	9	7	6,00

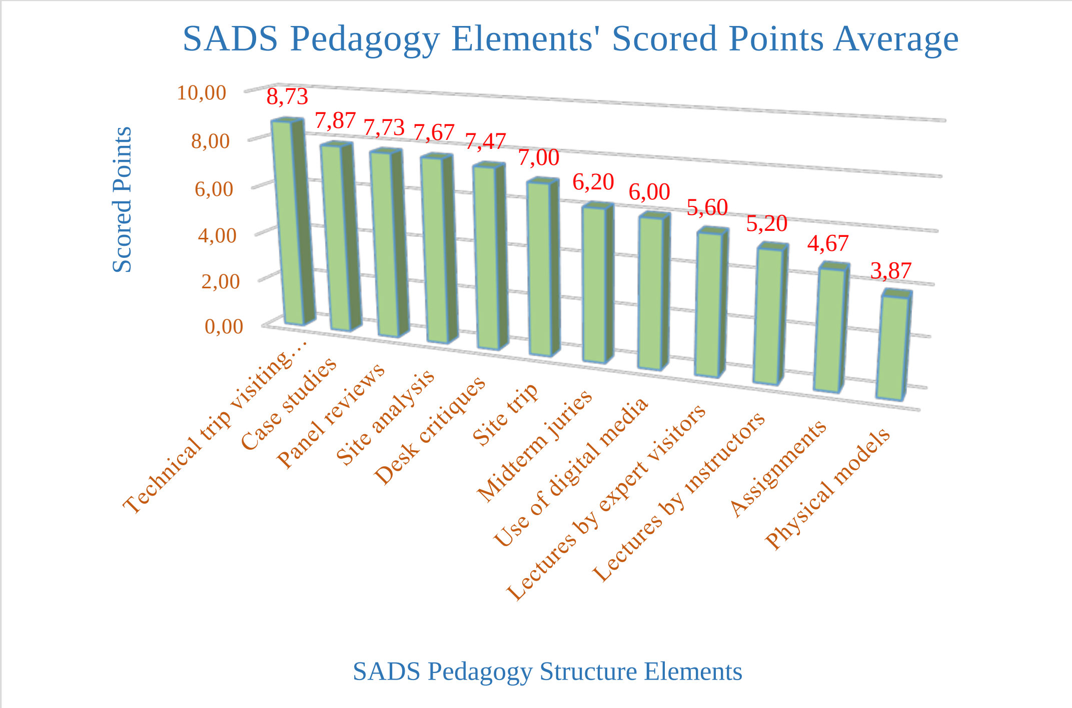


Figure 6.15: The scored pints average of SADS pedagogy structure elements.

5) Will you practice sustainable design in your profession in the future?

There were seventeen students, who answered “Yes” and two answered “No”.

6) If you will continue your graduate study in the future, would you chose an architecture environmental subject such as sustainable design, ecological design, energy saving design, etc. as your study topic?

There were fifteen answered “Yes” and four answered “No”.

7) What are the difficulties for designing a sustainable building in the design studio course?

Some of the students comments was that residential project is difficult than other building design with consideration to sustainable design. On the other hand, the consideration of all three aspects of sustainable design environmental, economical, and social made it more complex to follow up all issues in one study term. Probably, it was great challenge to learn and produce innovative solution. However, the studio was well prepared by the instructors, which brought confidence during the design process.

Many students complained about the interference of the studio work and other classes such construction documents and technical drawing class, which required many hours of work. Furthermore, few students complained about Revit performance regarding to multi-units project that is slow and hard to use.

Many others said that the subject is hard but it is important to learn it because it is connected to our future and the coming generations.

8) Can you make an order of what you considered the most important to least important in your design in this semester?

There were 18 correct format answers of 19 forms. SADS principles design elements was placed in order priorities in the students' answers. The most considered element was giving value number (8) and the least was giving value number (1). Each elements' points' average was calculated, as it is shown in (Table 6.7). The scored points average order of the SADS principles design elements are presented in (Figure 6.16).

Table 6.7: The students' evaluation points average of SADS principles design elements.

	Design Principles Elements / Students Order	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	14 th	15 th	16 th	17 th	18 th	Each Element Average
a	Natural light	8	7	7	6	8	6	8	7	8	8	8	1	6	8	2	5	8	8	6,61
b	Eco friendly materials	5	6	5	8	3	5	6	6	2	6	4	2	8	5	6	6	5	1	4,94
c	Natural ventilation	7	5	6	5	7	7	7	8	6	3	7	8	2	7	8	8	7	7	6,39
d	Shading elements	3	8	4	4	6	8	5	5	7	7	6	5	5	6	3	7	3	6	5,44
e	Renewable energy sources	1	3	2	7	5	4	1	4	4	2	5	4	4	3	5	4	4	2	3,56
f	Use of thermal mass	2	2	3	2	2	2	2	3	5	5	3	3	3	4	4	1	2	3	2,83
g	Rain water uses	4	4	8	3	4	3	4	1	3	4	2	6	1	2	1	3	6	4	3,50
h	Eco friendly transportation to the site (bicycles, electric cars, etc.)	6	1	1	1	1	1	3	2	1	1	1	7	7	1	7	2	1	5	2,72

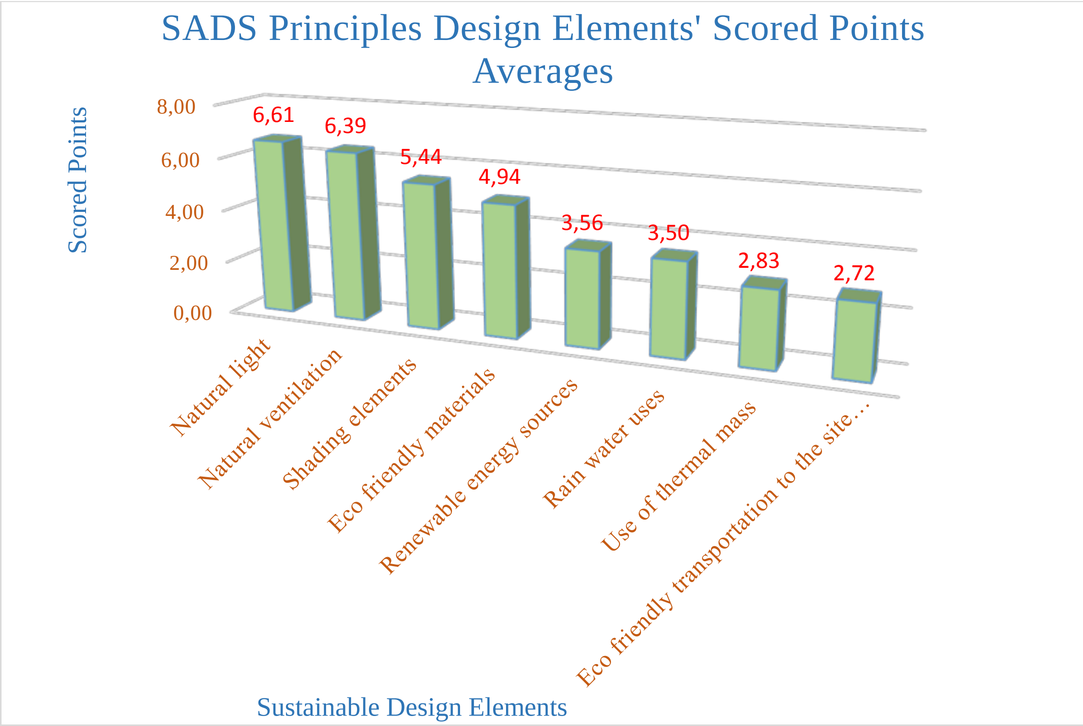


Figure 6.16: The scored points average of SADS principles design elements.

9) Please write your personal comments about the sustainable design studio Spring of 2016.

Vast majority of the students said that they found the studio efficient to learn new things related to sustainable design, which let you think of all design issues in parallel organized manner so that it was important for our education life. Furthermore, they expressed learning about permaculture cities provide them with more healthy and organic life ideas.

Individual comment complained that the motivation was not enough and it was hard, while he/she felt the need for more desk critics. Other students, said “this term project was very big and complicated for me so that I was slow with my production”. Another student said, “It was hard, I learned many things, at the end was joyful”.

Few students attended this studio only wished to attend the previous one believing that would have made things easier for them. They believe that everything in SADS were better than other conventional studio. Instructors showed us patience, positive act, and support so that it was very valuable for us.

SADS colloquium

Open colloquium was the second assessment tool by the students. Similar to first and second experimental, instructors called the students for an open colloquium after the grades were announced so that there was no pressure on free expression. At the start, the instructors explained what they have done during the semester long, the work objective, the work differences between previous two experimental studios and third experimental studio work, that changes they have done during the semester responding to their recommendation from previous semester, and their general personal evaluation of the semester work.

Afterwards, the opportunity was giving to the students to speak out freely their thought objectively not subjectively regarding the SADS. Students discussed issues such as their experience with SADS and other conventional studios as well as the workload relative to conventional studio. Furthermore, they requested to consider all this issues in their final grades. In addition, they discussed the changes between previous SADS and recent one, teaching methods, elements of teaching pedagogy, juries, instructors' performance, etc. They were positive about it as well as they felt the respect of the instructor while he responded to their previous studio's recommendations. Instructors assigned time after the colloquium for individual meetings to listen and respond to any of the students' personal questions. Three students came forward with questions to their grades, they explained that had problem dealing with big size complex project. The reason was that three students had the previous studio overseas under Erasmus program while the project size in most studios were small and less complex.

SADS comments

In general, there was positive and appreciative mood towered the materials they have learned, meanwhile there was mix feeling regarding the grades in a comparison to the other conventional studio in the department but the instructor respond to that positively in the final grades by using their incentive. Generally, most students were familiar with SADS because of their attendance to the previous SADS, their comments were objective toward the class pedagogy, teaching method, and the changes that was done. Few new students were concern about the studio workload.

There was general comment regarding housing project that students have not experienced before in earlier studios so that they had hard start, meanwhile students who attended previous semester design studio in EU countries under Erasmus program expressed that they had less design experience with big size project so that it was not easy for them.

Most of the students found the timetable module of the SADS (4+4+4+2) hard but it provided discipline to achieve the design work along the semester. While they also founded the modifications of teaching method and calendar program were very positive reflect on their design result as well as it made them feel that instructors respected their recommendations of previous semester.

Some students thought that the pressure by the instructors during the third midterm jury reflected negatively on some of them however, it was the reason to achieve better result for most of them.

There was request by the students to offer elective Revit courses in the second academic year.

Many students appreciated the outside instructors' lectures and their workshops. In addition, they were pleased to have the Izmir municipality representative and IYTE Rector in their final jury, which brought reality to the work of the design achieved.

IYTE's online course evaluation

Each semester, students are required to fill up online course evaluation form before learning their final grades (Appendix. J), while the evaluation were accessible to the class instructors. The (Table 6.8) presents the average answer of each question for the SADS studio, for the department all over courses, and for the faculty all over courses.

The SADS scored the highest average in all questions over the department and the faculty average.

Table 6.8: IYTE's students online evaluation of the SADS third experimental.

Questions	Studio Average	Depart. Average	Faculty Average
Were the content of the class, expectations of the students' work, and the class objectives were announced at the beginning of the semester?	3,77	3,70	3,69
Were subjects processed according to the content of the course?	3,92	3,72	3,70
Was the lecturer on time and ready?	4,08	3,80	3,75
Did the lecturer present the course topics in an understandable way, with effective examples?	3,85	3,70	3,65
Did the lecturer give opportunity to the discussion environment?	3,92	3,70	3,66
Were homework, projects, and practices influential and understandable?	3,77	3,66	3,64
Were the examinations accurately measured the content and skills taught?	3,69	3,62	3,61
Final Average	**3,86**	**3,70**	**3,67**

General comments by the students:

Group of comments were an expression about their pleasant of attending the studio and how much was it a positive learning productive one. Other were about how much topics they had to learn which were hard. While some expressed the conflict between the studio work and technical drawing course.

Some students mentioned that SADS studio was different from other studios in the department and it was very good.

6.5 Findings and Recommendations

This segment introduced the findings and the recommendations. The findings extracted off the results, data analysis, and evaluations and assessments sections. Moreover, the findings points were resulted in various recommendations, which may help in further research studies.

6.5.1 Findings

The SADS final experimental acquired various findings points due to the modification of its original pedagogy and teaching method. The conclusion were divided into two sources; first from the instructor's evaluations, second from students' assessments.

From instructors

The third experimental studio modified pedagogy structure and teaching method proposed a new grade system for sustainable checklist elements and energy simulation test (Table 6.3). The total grade had been increased from 40 to 50 points, which reflected positively on the integration of sustainability principles into the final project resuls where most projects included high numbers of sustainable design elements comparing to previous experimental studio. The class average of the use of sustainable design elements in each project was 18.64 elements of total of 28 elements, which is 66.57% (Table 6.3). Furthermore, each sustainable design element average use in the total of 25 projects was 16.65 (66.60%), which was higher than previous experimental studios too (Figure 6.8).

The social and economical asspects of sustainability enriched the final produced design. It made more sustaianable design elements available for the students to integrate in the design as well as it made the intigration process easier (Figure 6.14).

Although there were no grades assigned for the daylight simulation test, more than half of the students managed to achieve it. The sudents were incouraged to integrate what they have learned in other elective courses into SADS (Figure 6.10).

The early start of (Revit) workshop made it easier for the students to handle the energy simulation test. All students have done the basic part of energy simulation test while only two students were not able to complete the modified materials' simulation test (Table 6.4). Moreover, emphasizing on the level of energy saving and CO_2 emission reduction resulted in 56% of the students managed to design a project that reduced more than 20% in energy consumption and CO_2 emission reduction (Figure 6.9).

There was positive correlation between the number of sustainable elements each student use in his/her project and final SADS grade (Figure 6.11), with R-squared value of (0.8078) represented strong data that were fitted to the regression line, which was very strong in a comparison to previous experimental studio.

There was a positive parallel trend result between students design process grade and final SADS grade (Figure 6.12), with stronger R-squared value of (0.8639) than previous experimental studios.

There was a correlation between the total grades of sustainable checklist elements and energy simulation test (50 points), and final SADS grades (Figure 13), which had R-squared value of (0.8989), which represented stronger data that fitted to the regression line.

From students

The third experimental studio workload was heavier than previous experimental studio due to two reasons; the project type (housing project) and the inclusion of the three aspects of sustainability (environmental, social, and economic). There was general comparison of the workload and final grades between the SADS studio and other conventional design studio. Over all, students were appreciative to what they have learned along the semester. Following are the conclusion of students' questionnaire survey, open colloquium, and IYTE's on-line course evaluation.

The questionnaire

The questionnaire form presented that 75% of the students had knowledge about sustainable design either from attending previous SADS or elective courses related to sustainable design.

Considering the three aspects of sustainable design (environmental, economical, and social) led the students to include them in their projects concept. The assessment showed that 37% included three aspect, and 42% with two aspects while 21% had one aspect in their project, which was a positive level of integration (Figure 6.14).

Furthermore, 90% of the students confirmed practice sustainable design in their professional life and 80% will chose it for their graduate education study subject.

The technical trip and case studies were on the top students' choice list of SADS pedagogy elements as it was in first and second experimental. On the other hand, the physical model and assignments were at the bottom list. The standard deviation score was 1.48, which was less than the previous two experimental research. In addition, the relative standard deviation score was 22.76%, which illustrated that the gap between top and bottom score element were less due to the modification of pedagogy structure and teaching method (Table 6.6) and (Figure 6.15).

The SADS's students had no experience of housing project from previous studios, which might explained some of their comments regarding the workload. However, there were positive comments regarding learning all three aspects of sustainability due to the instructors effort.

There were demands to offer an elective course of Revit in second year.

One more time, natural daylight and natural ventilation had the top score among students choice for SADS design principles elements where eco-friendly transportation scored the least points. On the other hand, the standard deviation between the elements was 1.56, which was less than previous two experimental research. The relative standard deviation score was 34.66%, which was less than previous experimental research that reflected closing gap between the top and lower elements (Table 6.7) and (Figure 6.16).

Colloquiums' comments

The modification of SADS pedagogy and teaching method reflected positively on the studio production.

Revit program would be handle easier if it has been learned out of the studio in earlier semester.

Visiting experts' workshops had positive impact on the students' design.

IYTE's online evaluation

The SADS scored higher points average than the Architecture Department and Architecture Faculty courses' point average in IYTE online evaluation. In addition, similar result achieved on each question of the online evaluation questionnaire form (Table 6.8).

6.5.2 Recommendations

Eventually, the conclusions introduced recommendations that would be available for future semesters and academic research work. Those were:

Again, the project size (meter square) shall be reduced to give better chance to focus on the sustainable design issues.

Revit and DesignBuilder software programs courses should be offered at earlier semester.

All aspects of sustainable design (environmental, social, and economical) should be included in the SADS from now on. While technical trip shall be more than one trip per semester.

Study models shall be made easier in term of materials and techniques) to encourage the students to use it.

Continually, simulation should be used for the evaluation of natural daylight quality evaluation of the space.

Figure 6.17: SADS's students - class of AR 302 spring 2016

CHAPTER 7

DISCUSSION

This research was based on both quantitative qualitative methods. The quantitative data were used for evaluating the sustainability integration level into the students' design projects. While the qualitative data were used for assessing the impact of the experimental design studios. Quantitative data were obtained from instructors' evaluations of the students' performance and final project, while the qualitative data were obtained from students' satisfaction questionnaire survey, end of term colloquium, IYTE online course evaluations, and personal interviews with the past SADS students now pursuing a professional career. Additionally, there was a qualitative data used by the instructor in evaluating the quality of the design itself.

This chapter also criticizes the status quo of architecture education at IYTE, and offers comparisons among the outcomes of the three SADS experimental studios' followed. Finally, insight gained through the personal interviews of former-students along with the discussion of the obtained results is given here.

7.1 Status Quo

The Architecture Department at IYTE aims to produce/develop practitioners competent in the design and execution of building; and perform related research projects that contribute to the development of architectural knowledge. While the mission of the department is to contribute to knowledge within the field of architecture through academic research, apply group-work methodologies, interdisciplinary approaches at both graduate and undergraduate levels, continuously develop the program of education, and produce architects who comprehend the social responsibilities of multi-dimensional/multi-variate building processes (Architecture Department IYTE 2018).

The Architecture Department curriculum is divided into two parts; core classes (mandatory to be studied), and elective classes (selected by the student). Student must take eight elective courses, six of them are technical (Appendix X). The curriculum is (Core and elective courses) divided into five main divisions:

a) Architecture design studio

b) Building technologies

c) Building physics

d) History of architecture

e) Digital technology & graphic communications

Existing design studio is a conventional format (teaching/learning action) as it referred to it in the literature review. Teacher is telling students what to do as well as the direction to how to do and students are following what they are told (master−apprentice interaction). The focus is on design concept and building form as main issues, the final design result has priority over the design process. While the integration of technical, environmental, structural issues depends on the studio instructor's experience and inclination. Digital technology is mainly used for final project presentation. Desk critique is the main communication and teaching tool throughout the semester. Even interim juries are in criticism not in educative format.

The architecture department curriculum at IYTE considered sustainability in many core and elective classes which is advance compare to most department in Turkey but it is not totally embedded into the curriculum so that the integration is "stand-alone studies focused on sustainable design principles" (Wright 2003). Therefore, SADS model is considered an innovative approach that focused on sustainable design principles with the use of the supporting environment and technology courses offered by the department.

Students who attended SADS would get benefits of some core courses before and during the semester work (Appendix X), these core classes are:

- Introduction to building materials and physics.
- Building physics I and II.
- Computer aided architectural modeling.
- Building science and Technology I, II, and III

Students are permitted to attend one elective course at first semester and two elective courses at second semester of the third year. Therefore, students who attended SADS may have been attending one to three sustainable design related courses before or during the semester work. These elective classes are related to:

- Computer aided architectural drawing.
- Ecological studies in architecture.
- Lighting analysis in building physics
- Building form and thermal performance.
- Building performance simulation for sustainable design.
- Design principles of energy efficient building.
- Design principles of passive heating and cooling systems of buildings.

7.2 Experimental Studios

The three experimental studios had changed over time for improvement reason. These changes and modifications included the pedagogy structure and the teaching method, which are illustrated in (Table 7.1). That required modifications to the timetable, sustainability checklist, questionnaire form, and evaluation system, is explained in related sections.

Tasks

The defined tasks that were given to the students within the frame of the innovated design studio's pedagogy structure elements using the creative teaching method with designed timetable to integrate sustainable design principles into the architecture project. The main task was designing sustainable architecture project. However, there were miner tasks throughout the design process, which were employed to achieve the main task, i.e. they were site analysis, case studies presentations, analyzing technical trip's buildings, juries requirements, charrette studio assignments, energy and daylight simulation, study models, and construction details drawings. Those tasks were modified from time to time according to the project types, and students' learning level as well instructors' observation and previous experimental studio recommendations.

On the other hand, pedagogy structure elements had no changes through the three experimental studios; however, the application order and the strength were modified to respond to each experimental studio's recommendations. There were serious changes on the teaching method as well as the time table which are shown in (Table 7.1)

Table 7.1: The changes on the teaching method of the three experimental studios. Modified elements are shown in red and green.

No.	Learning Technique	Pilot Experimental Studio's Teaching - Method AR 302 Spring 2015	Second Experimental Studio's Teaching - Method AR 301 Fall 2015	Third Experimental Studio's Teaching - Method AR 302 Spring 2016
1	*learning by teaching others.*	One case study was presented by each students (22 case studies). Case studies presentation had 2,5% of total class grade.	One case study was presented by each students (25 case studies). Finished in the first 6 weeks. Case studies presentation had 5% of total class grade.	One case study was presented by each students (25 case studies). **Finished in the first 5 weeks.** Case studies presentation had 5% of total class grade.
2	*practice by doing and group discussion*	Students were required to write the project program individually then in a small group of three then in a group of eight	Students were required to write the project program individually then in a small group of three then in a group of eight. The project size was reduced by 30%.	Students were required to write the project program individually then in a small group of three then in a group of eight. **The project size was reduced by 15%.**
3	*practice by doing*	Students were required to construct study models during the project design development process (4 models)	Students were required to construct study models during the project design development process (6 models) with various scales.	Students were required to construct study models during the project design development process (6 models) with various scales **and material types**
4	*deep learning*	Biweekly panel reviews were conducted (6 panel reviews) in two formats:	Weekly panel reviews were conducted (9 panel reviews) in two formats:	Weekly panel reviews were conducted **(12 panel reviews)** in two formats:
	group discussion	A) Group discussion of the design process and project development were conducted	A) Group discussion of the design process and project development were conducted	A) Group discussion of the design process and project development were conducted
	learning by demonstration	B) Students criticized each other's project by asking each student to present his/her project to the group	B) Students criticized each other's project by asking each student to present his/her project to the group	B) Students criticized each other's project by asking each student to present his/her project to the group
5		Technical trips to	Technical trips to	Technical trips to
	practice by doing	A) The project site and surrounding area	A) The project site and surrounding area. Existing exemplary project owned by the client.	A) The project site and surrounding area.
	learning by demonstration	B) Existing exemplary projects out of town (Istanbul, Turkey)	B) Existing exemplary projects out of town (Istanbul, Turkey)	B) Existing exemplary projects out of town (Bodrum, Turkey)
	learning by demonstration			**C) Existing exemplary projects in town (Izmir, Turkey)**
6	*practice by doing*	Instructors conducted biweekly charrette design assignments during the design process (4 assignments)	Instructors conducted weekly charrette design assignments during the design process (6 assignments)	Instructors conducted weekly charrette design assignments during the design process **(11 assignments)**
7	*practice by doing*	Various digital technologies were used throughout the design process	Various digital technologies were used throughout the design process	Various digital technologies were used throughout the design process
		A) Conceptual design period; climate consultant and Sketchup	A) Conceptual design period; climate consultant and Sketchup	A) Conceptual design period; climate consultant and Sketchup
		B) Design development period; Revit, Auto CAD, and Sketchup	B) Design development period; Revit, Auto CAD, and Sketchup	B) Design development period; Revit, Auto CAD, and Sketchup
		C) Design evaluation period; Rivet, DesignBuilder, and Sketchup	C) Design evaluation period; Rivet only	C) Design evaluation period; Rivet (Energy) **and DIALux evo (Light)**
		D) Final drawing and presentation; Rivet, Auto CAD, 3D Max, DesignBuilder, and Sketchup	D) Final drawing and presentation; Rivet, Auto CAD, 3D Max, and Sketchup	D) Final drawing and presentation; Rivet, Auto CAD, 3D Max, Sketchup, **and DIALux evo.**
8	*pubic interest and immediate use practice*	Project owner(s)/user(s) were invited to discuss the project (2 visits)	Project owner(s)/user(s) were invited to discuss the project and provide presentation and workshop (2 visits)	Project owner(s)/user(s) were invited to discuss the project and provide presentation and workshop (2 visits)
9	*learning by demonstration*	Monthly Outside expert(s) were invited for workshop (3 workshops)	Monthly Outside expert(s) were invited for workshop (3 workshops)	**Biweekly** Outside expert(s) were invited for workshop **(5 workshops)**
	practice by doing	A) Instructors assigned homework related assignment ahead of each workshop studio	A) Instructors assigned homework related assignment ahead of each workshop studio	A) Instructors assigned homework related assignment ahead of each workshop studio
10	*learning by demonstration*	Instructors conducted individual desk critics (10 desk critics)	Instructors conducted individual and small group desk critics (12 desk critics)	Instructors conducted individual and small group desk critics **(15 desk critics)**
11	*learning by visual, audio, and lecture*	Class instructors offered lectures about the project topics that included visuals and audios materials (6 Lectures)	Class instructors offered lectures about the project topics that included visuals and audios materials focusing on the low score elements from first pilot recommendation (13 Lectures)	Class instructors offered lectures about the project topics that included visuals and audios materials focusing on the low score elements from second pilot recommendation **and economical and social aspects of sustainability (15 Lectures)**
12		Juries	Juries	Juries
	learning by demonstration	A) Instructors conducted midterm juries (3 midterm juries)	A) Instructors conducted midterm juries (3 midterm juries)	A) Instructors conducted midterm juries (3 midterm juries) **including outside guest**
	learning by teaching others	B) Instructors hosted a final jury that included University Rector (project owner), academic members.	B) Instructors hosted a final jury that included Bornova Municipality president, University rector, experts, and academic members. The grade distribution was modified.	B) Instructors hosted a final jury that included Izmir Municipality represintative, the University Rector, experts, and academic members. **The grade distribution was modified.**
	learning by demonstration			**C) Instructors conducted role-play jury and student-led jury after third midterm jury**

Design process

The design process was the key points of implementing the integrating of sustainability into the design studio. In the pilot experimental studio, Figure 4.9 shows a positive correlation between the grades for design process and final project. The R-squared value of 0.6937 represents a strong fit of the data points to the regression line. However the difference between the lowest and highest grades is 20 points for the total design process, which is a wind range considering that the maximum was 40 points. This could be due to a lack of efficiency by the instructors, or the students or both. Moreover, it may be due to the habits of the conventional design studio culture that the students were adopted to it in previous semesters.

For the second experimental studio grades, Figure 5.11 shows an improvement in the correlation between the design process grades and the final grades with a stronger R-squared value of 0.8355, while the difference between the lowest and highest grades was reduced to 14 points, when the maximum design process grade was 40. This represented a better performance from the students' side on the design process and better adoption of the system.

The final experimental studio grades presented in Figure 6.12 showed a slightly better correlation between the design process grades and the final grades with a stronger R-squared value of 0.8639, which represented a strong data fit to the regression line. While the difference between the lower and highest points were the same 14 points; the total design process grade was now allocated 50 points, which were greater than the other two experimental studios points, i.e. 40. This improvement can be assigned to the fact that the students in this studio (Arch 302 third experimental studio) were mostly those who had also attended the Arch 301 second experimental studio and so were experienced in following the SADS pedagogy and able to understand the design process well.

Deliverables

The first or the "Pilot" experimental studio was successful in integrating sustainable design elements in the students' projects as it was illustrated in chapter 4 through the students' final projects. The average of the sustainable elements integration in students' project was 11.77 out of total 19 elements with almost 62% integration level (Figure 7.1). On the other hand, there was problems in using different simulation programs to evaluate project energy consumption due to late start and lack of experience.

The second experimental studio had better results in level of elements integration, which was illustrated in students' projects in chapter 5. The average of the sustainable elements integration in students' project was 12.44 out of total 19 elements i.e. 65.5% integration level (Figure 7.1). Furthermore, the project's energy performance evaluations were achieved positively due to the use of a single simulation program as well as starting to work on it earlier.

The third experimental studio delivered best results of all and included the three aspects of sustainable design, which are environmental, economical, and social. The level of elements integration into the students' projects was the highest (Figure 7.1). The average of the sustainable elements integration in students' project was 18.64 out of total 28 elements i.e. 66.6%. While the percentage differences between the second and third experimental studio were not big, it is important to mention that the sustainable design elements had been increased from 19 to 28 elements due to the inclusion of economic and social sustainability aspects. The building performance including energy consumptions and CO_2 reduction was better, while more than half of the studio students achieved daylight evaluations, even though it was an optional work.

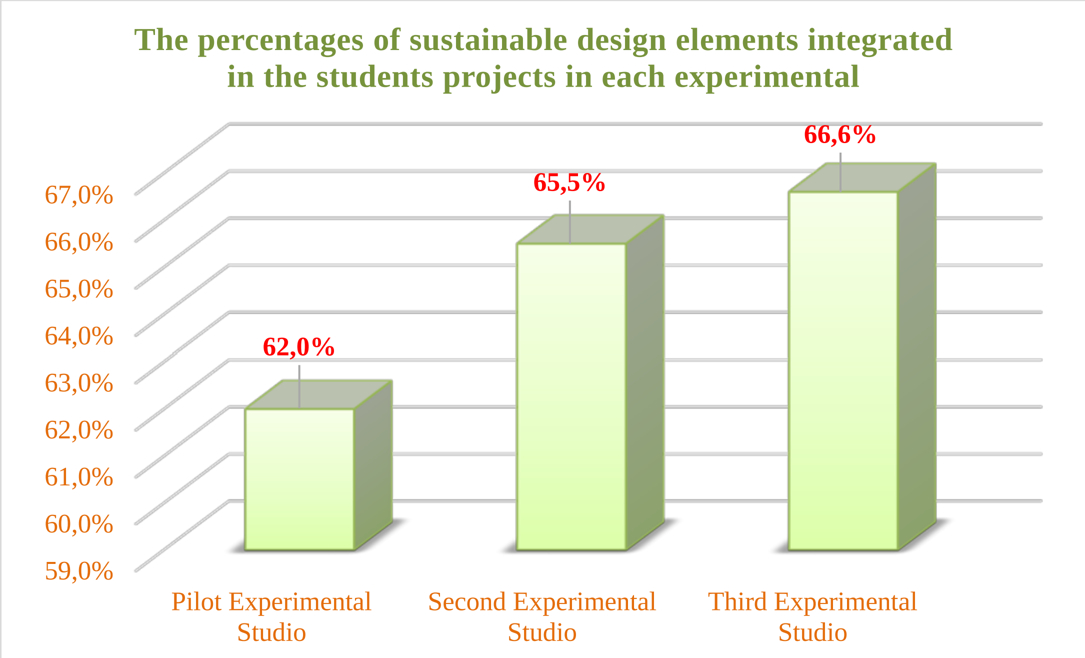


Figure 7.1: The percentages of sustainable design elements integration in the students' projects in each experimental studio.

7.3 Evaluation and Assessment

The evaluation had changed from one experimental studio to the other to emphasize on the importance of the integration level and the project performance.

- **By tutors:** Instructors' evaluations were concerned with the level of sustainable elements integration into students' projects. That was done through unique grading system measure not only the final result but also the design process. Moreover, the measurement of the final results included the design aspect, integration level and building performance.

  I. **The checklist form:** It was hand it to the students representing the sustainable design elements each students shall include in their project was the same at the first and second experimental studios while there was major change on the third experimental studio by adding economic and social aspect of sustainability. The outstanding projects that included 80% or more of sustainable elements were at first experimental 4 projects, second experimental 10 projects, and third experimental 11 projects. Further, the satisfactory projects, which included between 40% to 80% of sustainable elements were at first experimental 14 projects, second experimental 13 projects, and third experimental 9 project. Furthermore, the unsatisfactory projects that included less than 40% of sustainable elements were at first experimental 7 projects, second experimental 2 projects, and third experimental 5 projects. These results indicated a success in the integration from first to the last experimental studio.

II. **Juries:** There was no major changes in midterm juries' requirement while there were some minor changes on the set up. Second and third experimental, outside guests were invited, which reflected positively on the work as well as digital presentation were allowed in first midterm juries. In addition, various type of juries' format were applied, which was mentioned in chapter 3. In third experimental digital media were used more in final jury.

A follow-up peer reviewed jury was held in the second and third experimental studios, where the students presented their projects in the studio and they got critics from their studio mates. This technique helped instructors to ensure that the students knew his project's weaknesses, as well as learn to understand, evaluate, and criticize an architecture project.

III. **Grading:** Chapter 4 Figure 4.8 illustrated the positive trend between the sustainable design elements and the final grades with 60% of the students' grades on the trend line of the pilot experimental studio. Meanwhile, chapter 5 Figure 5.10 demonstrated better result of 70% for second experimental studio, while third experimental studio illustrated the best result of 80% of the students' grades on the graph trend line from chapter 6 Figure 6.11. I

- **By students:** Students' assessments were concerned with the studio pedagogy, and teaching method. There were changes and modifications on the questionnaire survey while no change was made in the colloquium. The questionnaire survey was the same in the first and second experimental studios but changes were made in the third experimental studio to respond to the economic and social aspect of sustainability.

Results comparison

Table 7.2 illustrated a comparison of all average results (grades and elements) among the three experimental studios. It is clear that there were positive improvements across line from the first to the third experimental studios with some exceptions. Design process grades average along the three experimental studios had the highest improvement due to the continuous modification of the teaching method. The final jury grades averages of the third experimental studio was a bit less than the first one. That may be due to the complexity of the housing project and the better grading system point distribution of the checklist and energy simulation.

Table 7.2: The comparison among the all results of the three experimental studios.

Results / Integration Average of SADS	First Pilot Experimental Studio AR 302 Spring 2015	Second Experimental Studio AR 301 Fall 2015	Third Experimental Studio AR 302 Spring 2016
Participation and performance (5 Points)	2,41	3,12	3,84
First midterm jury grades (5 Points)	2,59	3,20	3,35
Second midterm jury grades (5 Points)	3,08	3,62	3,27
Third midterm jury grades (5 Points)	3,67	3,88	3,08
Assignments in/out studio's grades (5 Points)	3,77	4,44	4,60
Design process grades (35 Points) / (40 Points) / (40 Points)	24,59	32,00	31,30
Numbers of intigrated design elements in the projects (19 Elements) / (19 Elements) / (28 Elements)	11,77	12,44	18,64
Percentage of intigrated design elements in the projects	61,95%	65,47%	66,57%
Sustainabiliy checklist and energy simulation test grades (40 Points) / (40 Points) / (50 Points)	34,09	31,48	37,68
Final jury grades (60 Points)	50,70	48,84	47,76
Final studio grades (100 Points)	75,29	80,19	79,06

7.4 Post Courses Interviews

The semi-structured post courses interviews started by contacting all 51 former students who attended one or more classes of SADS. The contacts were made through one or more of the following media; email, text message, phone call, or social professional media. The number of interviewed professional architects who had attended SADS were 31. While fifteen could not reached by any of the contact methods, while five responded after the survey's time was over. Twelve of the personal interviews were done in person while nineteen were done online. During the interviews, notes were taken. Generally, personal interviews' forms were filled by the interviewees at the same time. However, online interviews were completed by the interviewees then sent later. Online interviews took between 45 to 60 minutes each, while personal interviews took 60 to 120 minutes each. The survey form had two parts;

first concerned about the interviewee professional in a relation to sustainable design, second part focused on the SADS pedagogy and teaching method from the interviewee professional perspective, the questionnaire form is shown in (Appendix Y). The questions order was flexible depending on the interviewees' responses.

Post course interviews' results

Out of the 31 interviewees, sixteen attended one SADS studio while fifteen had attended two SADS. After all form were completed, data were extracted, organized, and analyzed. The following are the results:

1) Are you pursuing your graduate degree?

There were sixteen interviewees answered "Yes" of them ten are studying in IYTE while six are studying in other schools, three of them overseas. Furthermore, eleven of them working on sustainability related subjects.

2) Are you a practicing architect?

Twenty six persons had worked or had been working for period between six months to three years and half, while four had some internship time. Moreover, five of them were working while continuing their graduate studies.

3) How do you categorize your work place sector?

Most of the interviewees were working in private sector while one was working in the government and two in academic.

4) Have you practiced sustainable design in your professional work?

Sixteen persons answered "Yes". Two of them has been working with old building restoration in NY City and Izmir concerning about natural materials and thermal insulation. Some work in housing sectors that concern about natural light and sustainable materials. Furthermore, there was one concern about eco-friendly materials and natural materials in California while one person was involved in façade shading elements.

5) From scale 1 to 10 (10 is the strongest), how much has sustainable architecture design studio contributed to your professional career?

Scale 1 to 3 no one voted for it while four former students believed that the SADS has not contributed much to their career. One the other hand, vast majority believed that the SADS contributed positively to their professional career as it is shown in (Figure 7.2). The contributions were to their graduate study and getting jobs as well as it gave them leadership in their work position.

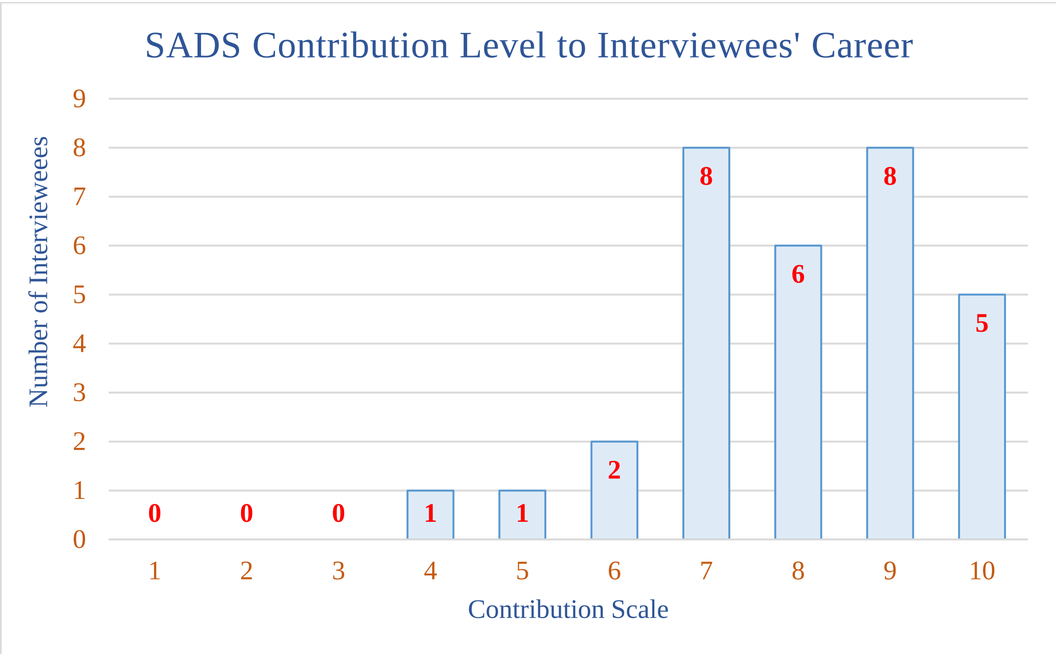


Figure 7.2: The interviewee perspective of the SADS contribution to their career

6) Have you attended any courses, seminars, conferences, etc. related to sustainable design?

There were twenty one architects who had attended courses, seminars, and conference, and seminars organized by the architecture union. In addition, some attended graduate courses local and overseas.

7) Have you participated in any sustainable architecture design project, competition, or academic paper/project, etc.?

There were nineteen participants in various type of architecture competitions and design projects. While some of them participated and won Students competitions in Turkey and overseas.

8) If you have any personal comments related to the first part, you may add it here.

Most commented that this studio should implemented in each year in the department while some expressed that they learned the value of the studio more in their professional life. Moreover, there was a comment from a professional perspective that Turkey has not taken sustainable design serious enough as in USA and Europe.

9) After two years of attending sustainable design studio, would you please describe how you started and finished your project? What was the starting points and what tools did you use. Please relate your answer to the studio instructors teaching method and tools.

Vast majority of the architects considered that good site analysis and multiple site visits were the starting points, followed by reading and searching the project topics, then viewing existing conventional and similar sustainable projects. Most of them believe that visiting similar project helped much in looking after the design details issues. Few believed that design in small group let the design process move faster.

10) Please describe, what kind of thoughts had you gone through during the design process time? That may include positive and negative thoughts, fears and confidence time, joy and sadness moments, etc. during the design process. Explain, why did it happen?

Many interviewees described that their fears mostly were at the starting of the design process due to their lack of knowledge of the sustainability topic meanwhile over short time this fear were gone because of the instructors teaching methods. Furthermore, they expressed that the design freedom that they were given brought confidence and peaceful mind to them.

Technical trips, group discussion and final jury brought joy to them. One person mentioned of its own past design studio psychologic problem that did not exist during attendance of SADS due to the positive teaching method.

The final jury presentation in front of official government members and the University Rector was the highest point of happiness to the students.

11) Relating sustainable design studio to conventional studio, from scale 1 to 10 (10 is the strongest). Were the studio’s timetable along the semester managed effectively?

There was not one voted from scale 1 to 5, while one gave scale 6 because he believed that the timetable was intense and over the capacity of middle level student to follow. While, most interviewees agreed that time table management of SADS was very successful as well as it brought positive energy to the design process time. Moreover, it defined clearly the studio objectives and requirements, as it is shown in (Figure 7.3)

12) From scale 1 to 10 (10 is the strongest), following the studio teaching method, had you been able to design a sustainable project that included some of the sustainability design elements?

Instructor teaching method had no one voted from scale 1 o 4, meanwhile six former students voted from 5 to 7 scale, they concern that the teaching method was loaded with many elements and materials that were hard sometimes to achieve. However, majority of the former students who attended SADS believed that the instructors teaching method was the reason for their success in designing sustainable projects (Figure 7.4). Many considered the tools that were used, such as case studies, technical trips, and lectures about the topic were done professionally. Moreover, they said, “studio's work process allows you to think/design sustainable projects later on”.

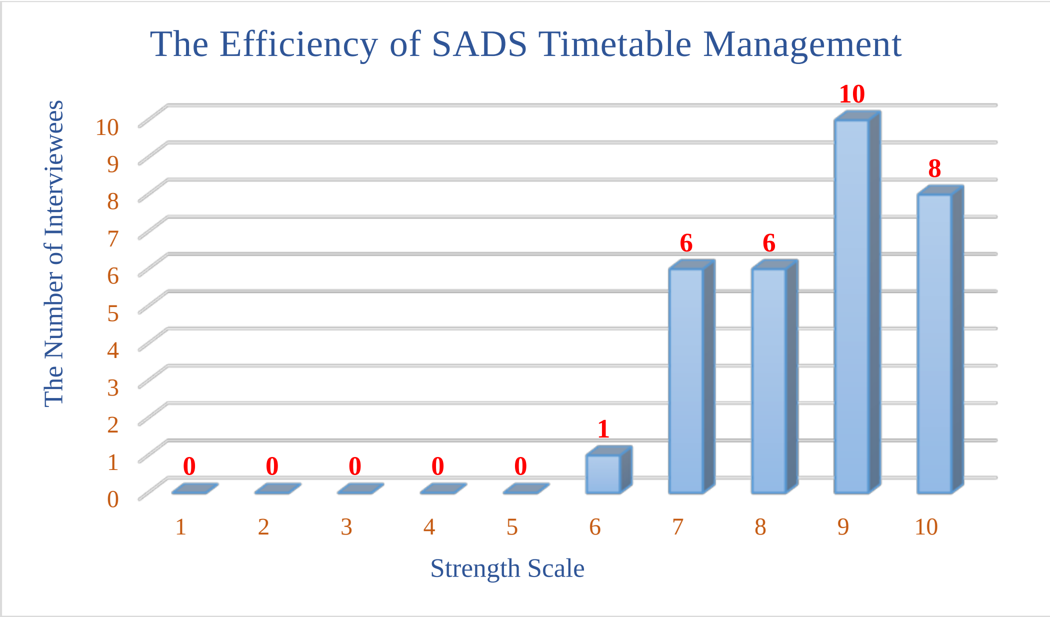


Figure 7.3: SADS timetable management efficiency in the perspective of interviewees

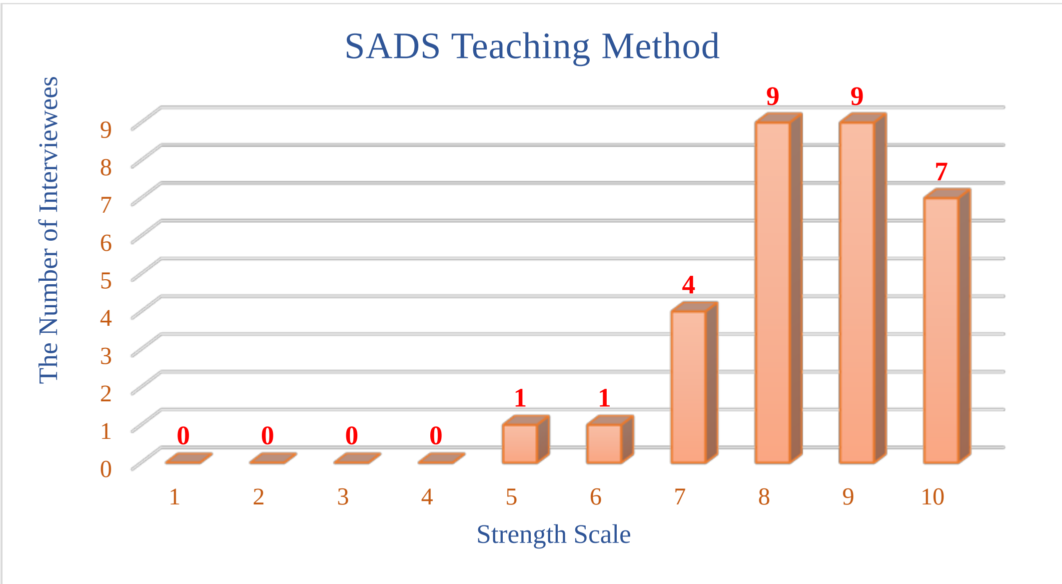


Figure 7.4: The SADS teaching method success

13) You had attended sustainable design studio and other conventional studios. Which one of the following you may consider it the unique characteristic of sustainable design studio? You may chose more than one option.

The highest score was for the Teaching method of the SADS. However, the timetable management, the design subject, and Juries' setup and requirements scored fair points too while studio work set up environment came at the end as it is shown in (Figure 7.5).

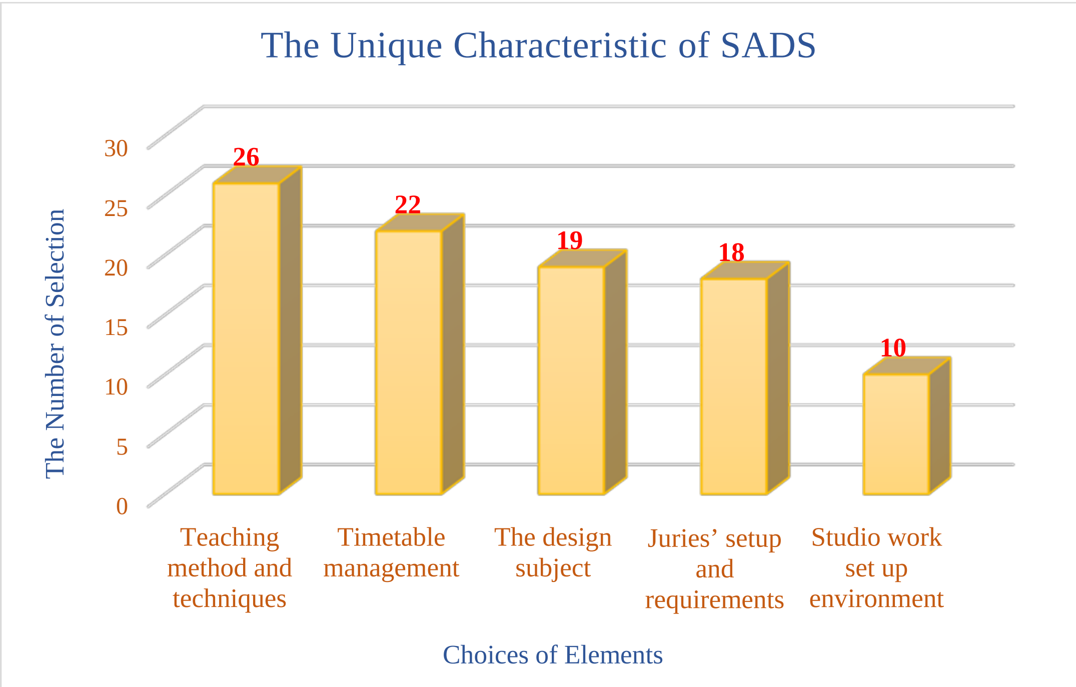


Figure 7.5: The SADS unique characteristic selection scoring chart

14) From scale 1 to 10 (10 is the strongest) how do you evaluate the use of the digital technology (various software) during the design process in the studio?

Majority of the interviewee considered the use of various software throughout the design process were unique experience as well as it contributed positively to their professional career.

15) Evaluation of Revit for energy and daylight analysis. From scale 1 to 10 (10 is the strongest), were you satisfied with Revit?

There were mixed answers, few were satisfied while others were not. On the other hand, the vast majority were in the middle.

The satisfied group were advanced Revit users as well as their projects' forms were easy to model, while the unsatisfied ones had complex project forms. The group who considered Revit is a satisfactory program said that because they believe it is easy to learn in short time and get some evaluation results.

16) The following were the design studio's pedagogy structure elements. Would you put these elements in order where the most beneficial to **your professional career** comes first and the least at last?

There were a group of five elements that scored close points where the lectures by instructors came first, then case studies, site analysis and technical trip came after while the use of digital technology was at the end of the top group.

The middle group had five elements, reading documents about the project subject was on the top, while group work, site trip, and lectures by visiting experts came after, followed by desk critiques at the end of the group.

Last group had four elements. Their order was assignments, physical models, and panel reviews, meanwhile midterm juries was at the tail of the list. The chart of the scoring average points of the SADS pedagogy structure elements is presented in (Figure 7.6).

17) Can you make an order of what do you consider the most important to least important in **your professional work** of the following sustainable design elements?

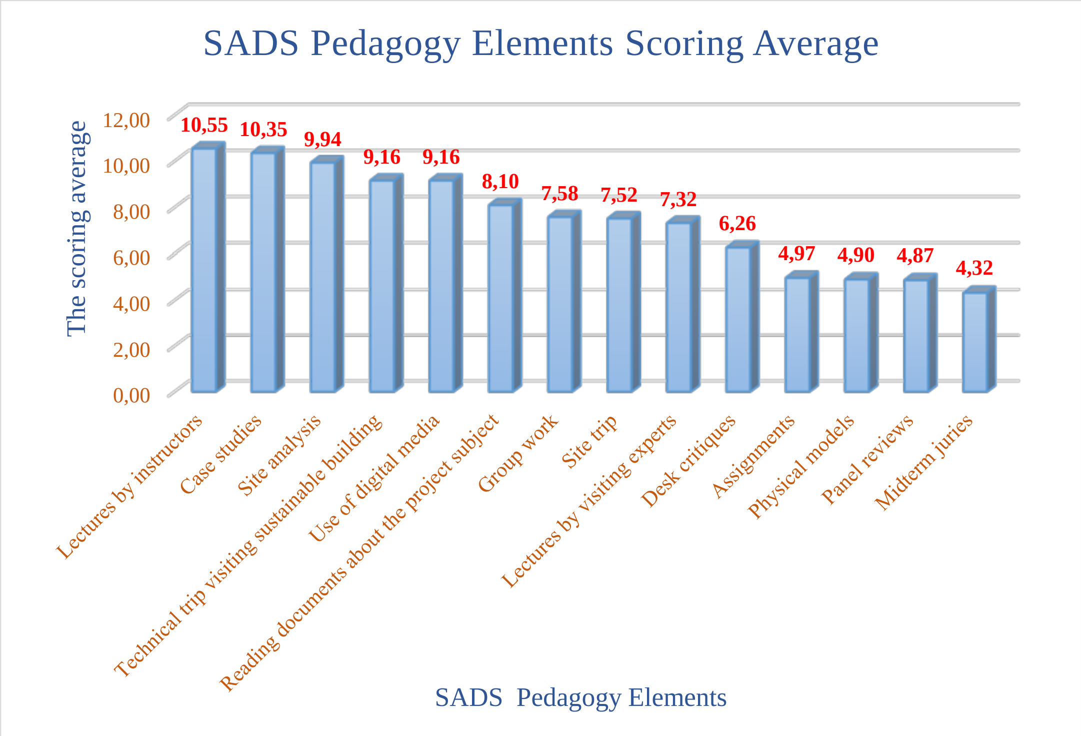


Figure 7.6: Chart of the scoring average points of the SADS pedagogy structure elements by the interviewees.

According to the scoring results, the elements were divided into four groups. First group had two elements where natural light came first followed by natural ventilation. The second group had also two elements where eco-friendly materials was first then shading elements.

However, third group had three elements, open space was on the top followed by renewable energy sources while use of thermal mass came at the end.

Finally, the last group of elements had two elements, where rainwater uses was first and eco-friendly transportation was at the end. The chart of the sustainable design elements scoring point’s average is presented in (Figure 7.7).

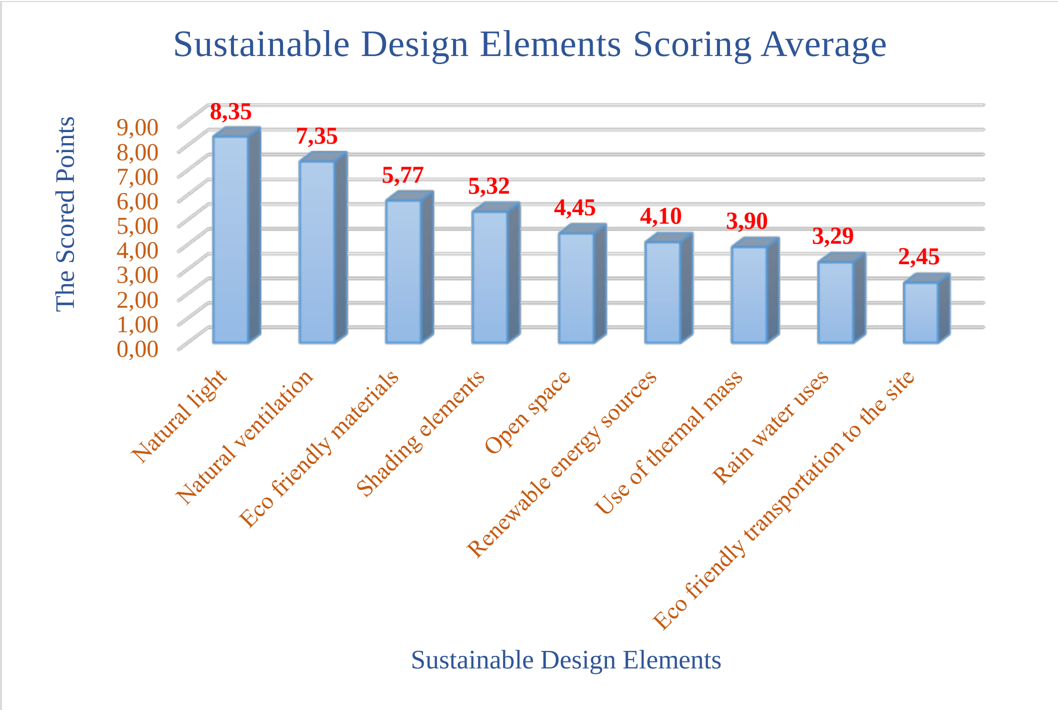


Figure 7.7: Chart of the sustainable design elements scoring points average by the interviewees.

18) Two years after attending sustainable design studio, please write your personal comments about the studio, and how can it be better for the future students?

The interviewees had various professional comments and positive innovative ideas and recommendations for SADS. All of them have been grouped in separated related paragraphs below.

Many comments stated that the teaching method was successful, which reflected on the studio final result while organized objective lectures and direct communication with the instructors were the key points. However, they expressed the view that there is a need for more elective courses related to the topic because the studio can not do it all alone. After all, unfortunately we had not seen anything related to sustainability in other studios in the department.

Most ex-students expressed the view that the studio was absolutely necessary, while the case studies were the key point of success, there should be presentations by the students of published articles followed by deep discussion of the sustainable design emphasizing on the innovative sustainable ideas and concepts. Moreover, gathering sustainability and concept will bring joy to the work.

Two contradicting comments where the first was recommending that the project should be very small so that the students would be able to focus on the technical issues of sustainable design. One the other hand, the second recommended was to keep the project big and complex because it is a great challenge and learning experience.

Few interviewees recommended that the physical models should be in bigger scale such as 1/10 or 1/20 in order to experience and visualize the natural daylight and natural ventilation effect on the designed space performance.

Couple of comments came from two interviewees who have been watching the SADS closely. They believed that the SADS has been improved semester after semester while most of their problems during their study time have been solved already.

Very interesting comments said, “Sustainable design first concerns the environmental issues while the most widely accepted measures for environmental performance exclude basic considerations of image, shape, and form”.

Another interesting comment said, “I have learned much about technical detail during the studio. I had the chance to combine architectural solutions with other engineering professions. The 1/20 system details section made us think about details. Learning materials and its usages were very helpful in my professional work. The design process was very systematic and students outside this systematization were unsuccessful. Finally, the grading system was very defined and fair”.

Discussion of post course interviews

Early on, there was doubt on the researcher side of the importance of these interviews to the research work. After the interviews had been processed, there was an essential obtained data and knowledge. Moreover, there were many benefits came out of it to the researcher and the research itself.

Generally, there was unexpected warm feeling towered the instructor from students who had problem with the studio or had low grades, which illustrated their professionalism and maturity. Further, there was general positive willingness to participate in the survey meanwhile there was respect to the timing and appreciation to the instructor teaching effort.

These interviews had three major achievements, which are:

- It helped us to learn the professional views and feelings of ex-students for SADS.
- It strengthened communication between the ex-students, including students who had problem with SADS studio, and the instructor.
- It helped to understand the relation between sustainable design in general and SADS in particular with professional architects.

CHAPTER 8

CONCLUSION

This chapter presents the conclusions based on the research findings as well as its importance to the research community. In addition, the research limitations are discussed here, as well as the future work.

8.1 Conclusions

It is essential to state that the research was a stand-alone study of integrating sustainability principles into undergraduate architecture design studio so that the study was independent in all aspect, which required creating new studio pedagogy followed by innovative teaching method supported by firm timetable. In addition, the method and level of integration success were evaluated and assessed, while feedback of participants were essential assessment of the on-going work. Furthermore, the work was concerned not only with the integration of sustainability but also the architectural studios' original objective set up by the department; however, having enthusiastic and hardworking students who were willing to learn and apply, was an important factor.

The new pedagogy structure teaching elements of the studio were the major reason behind the integration success, as well as the ingredient and flexibility to employ them in the studio. Focused lectures on the topics fulfilled the knowledge shortage while existing case study presentations provided wider design view aspects; meanwhile technical trips demonstrated the reality of sustainable design to the students. They all were the major top elements that I have experienced myself along with the students' feedbacks. Essentially, the timetable that had a restricted module was too hard to implement, while the students who were used to a lax time-module design culture, where the "design concept" can take three quarters of the semester time and importance is not given to any of the other design aspects. The serious but friendly instructors' attitude helped to apply the timetable firmly to achieve all required work for the integration. All of the previously mentioned results are an answer to the first research question i.e. “how can sustainability principles be integrated into design studio?”

Comparing the data in chapters 4, 5, and 6 (Figures 4.10, 5.13, and 6.15), case studies and technical trip had been rated on the top of the SADS pedagogy structure elements in all experimental studios while third position varied among three studios. First experimental studio, lectures by the instructors came in third position due to the newness of the topic to the students while desk critiques was third in the second experimental studio due to the lack of design experience of the students coming from second year level as well as the complexity of the design project itself. In the third experimental studio, panel review came third because of the design maturity of the students; they benefited more from group discussion and critiques than individual desk critiques.

The quantitative and qualitative evaluations by instructors and qualitative assessments by the students’ results were in parallel positive trend with each other. (Figures 4.11) had the natural daylight and natural ventilation scoring the highest point average from students’ assessments while (Figure 4.7) had all elements from sustainability checklist, which were related to daylight and natural ventilation scoring the highest points to by instructor’s evaluations. Similar situation were exist in second experimental studio in (Figures 5.14 and 5.9), however shading elements and eco-friendly materials had higher score than first experimental studio as well as in the instructors’ evaluation to the students projects. Furthermore, (Figures 6.16 and 6.8) demonstrated the same parallel results as well.

(Figure 8.1) presents the data is (Figures 4.7, 5,9, and 6.8). It illustrates a comparison among the three experimental studios regarding the times use of each of the 19 checklist elements in the students’ projects. The chart indications gradually increase in the times use of each elements in the total students’ projects with an exceptions in seven elements. These exceptions were due to the project type, difficulties of the use of such elements, or lack of knowledge about it.

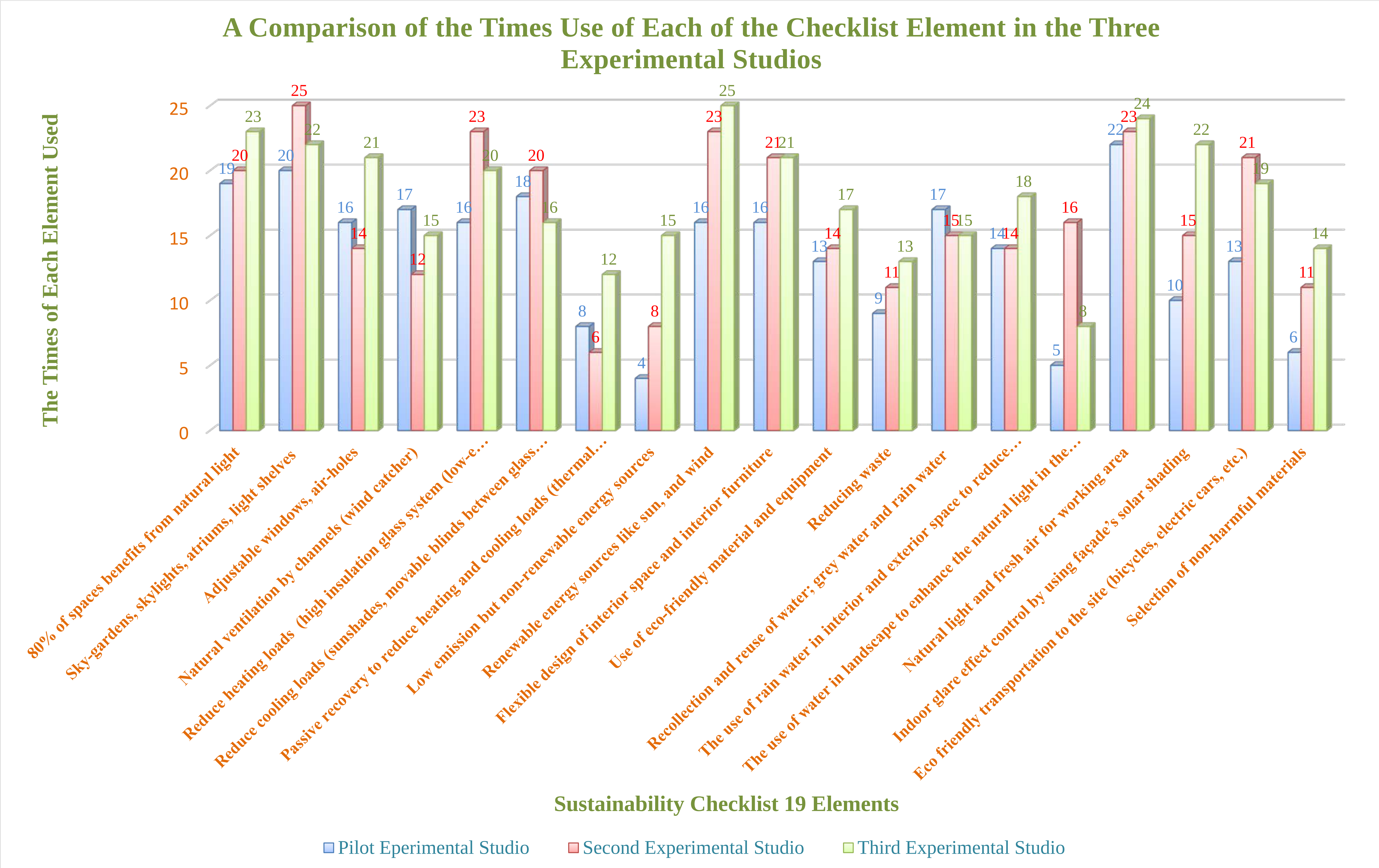


Figure 8.1: A Comparison of the Times Use of Each of the 19 Checklist Element of environmental aspect of sustainability in the Three Experimental Studios.

Other teaching elements were positive support to the holistic structure ingredient. The implementation of digital technology through the process brought excitement and dynamism to the design work, while the design modification responded to output data not to just subjective views. However, learning a new software during the studio time added extra workload even though it was essential to use an easy program. The method of the implementation with the level of sustainable elements integration were the answer to the third research question regarding to how can digital technology be useful to implement this integration?

Inviting external experts helped to close any knowledge shortage of the studio's instructors; however, that required an open-minded vision without ego, which was part of instructors' attitude. Furthermore, having students learning the others' opinion on the subject made them believe that it is not only the instructor's perspective but also wide spectrum perspective. It is critical to mention that it was hard to find an academic or practicing architect who is an expert in the subject, i.e. specially in architectural design field.

The negative jury culture in architecture schools was not the case in SADS studio. The research illustrated that selecting jury members based on knowledge in the subject, practical experience with positive teaching attitude resulted in a positive teaching method. Further, inviting government officials and University Rector brought trust and feeling of respect to the students as well as the importance of their work. Furthermore, publishing the final projects' works as well as participating in a public exhibition created a competitive atmosphere as well as feeling of pride. All of the above were essential answers to the fourth research question i.e. "how can design jury be employed as a tool to educate students and measure the final design product?"

One of the critical issue was the studio format. In a conventional studio, I have tried all types of formats that did not meet with much success. Two instructors were sufficient to bring a dynamic atmosphere to the studio and control the work needed to be done, meanwhile creating less distraction to the students' thoughts. Informing the students about their results based on performance in all fairness had brought mutual trust in the studio environment. Friendly group discussion in each class regarding any studio work aspect have contributed to the studio format success, which is the answer to the second research question i.e. “what should be the format of design studio?”

Certainly, the evaluation and assessment methods were the backbone of the studio success. No matter what subject has been taught, students were always looking at their grade. Fairness and clarity of the grade system and evaluation method were an essential issue. It is important to state that the workload at SADS was double or more than the workload of a conventional studio, i.e. from the instructor, students, jury members, and department official perspectives. This required special consideration by the instructors to keep the fairness of grading balance regarding other studios as well as bringing incentive mood for the future SADS. This issue was a heavy burden on the instructors mind. Therefore, the fifth and sixth research questions were answered i.e. “what could be the role of assessment in the integration method?”, and “what are the measurement criteria of integrating sustainability principles into students’ projects?”

Surely, the research fulfilled its two premises. There has been awareness among architecture students regarding sustainable design because of the SADS work achievements. This awareness is not only about the topic but also about its details. Furthermore, future SADS students come to the studio prepared with basic topic’s knowledge. Moreover, some of graduated students have been practicing sustainable design, which is creating wider public awareness. Certainly second premise was achieved. The integration of sustainability principles into design studio assignments had resulted in production of sustainable architecture project, which were demonstrated in chapters 4, 5, and 6 results.

Lastly, the research achieved its goal by providing the innovative *Studio Structure* and novel *Sustainable Architecture Design Studio Model* to the academics, i.e. architectural educators, planners, studio tutors, etc., that can be adopted for sustainability integration. Figure 8.2 illustrates the SADS Model structure that can be followed systematically in order to integrate sustainability principles into architectural design studio.

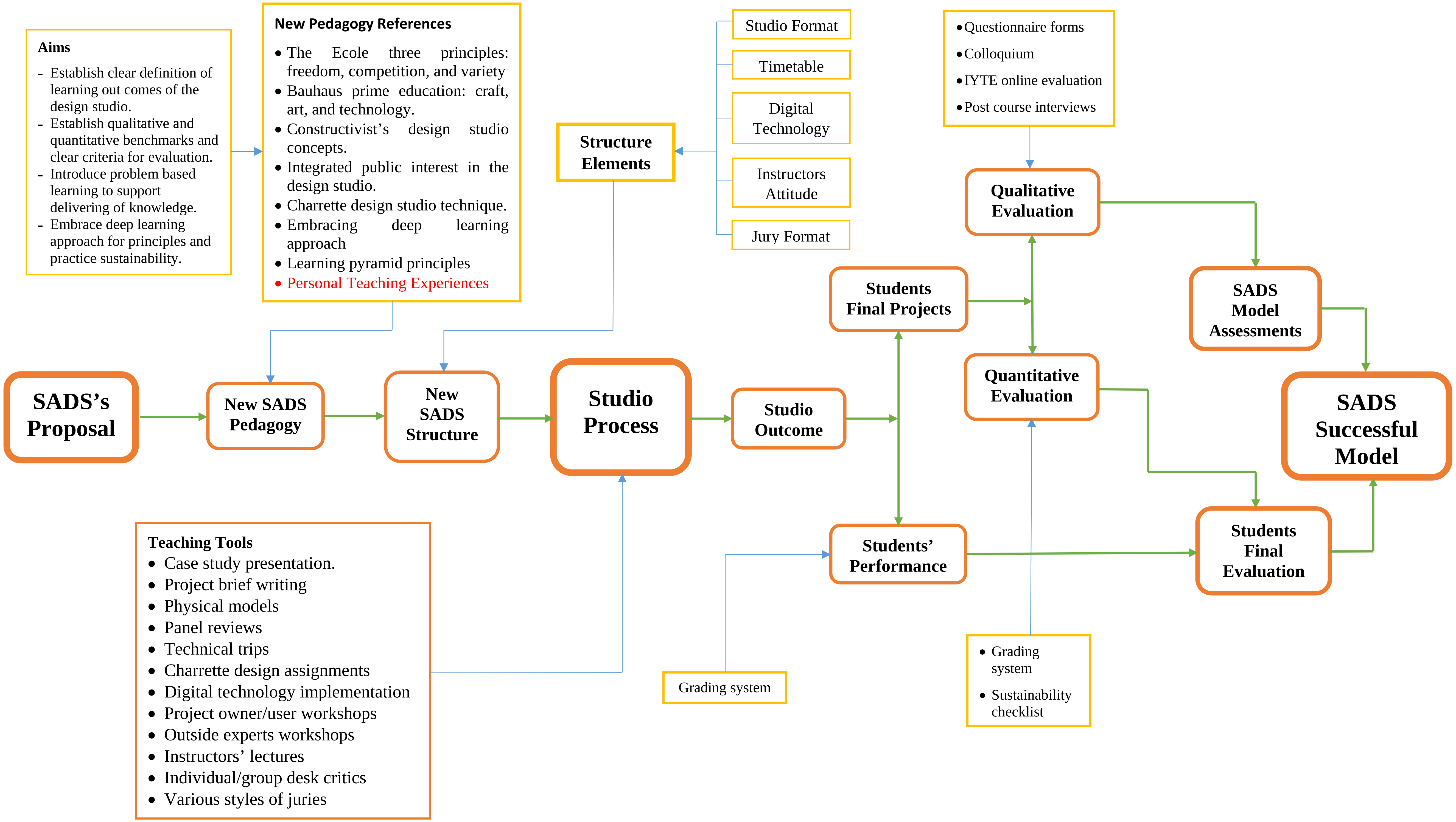


Figure 8.2: The final SADS model structure.

Interviews

The first part of the questionnaire form showed positive reflection of SADS on the interviewees' careers, where some of them continue their graduate studies in a sustainability related subject while others managed to practice sustainable design in their professional work. In addition, it contributed to the majority of them professionally as (Figure 7.2) illustrated.

Architects who attended SADS are convinced of the importance of the sustainable design so that most of them attended seminars, courses, and conference to improve their skills and update their knowledge, while most of their participations were voluntarily basis.

Many of the interviewees participated in sustainable design architecture competition (local and overseas), meanwhile some of them won them, which reflects on the education quality of SADS and their belief in the sustainability issue.

In the second part, there were mature and professional responses to the questions in comparison to the answers of questionnaires in chapters 4, 5, and 6. Most of them described that site analysis, reading documents, and searching case studies are the starting of the design, which is the same teaching method of SADS. Furthermore, the positive dynamic of the studio, the open communication with the instructors take away any negative feelings or fears. While communication with real life issues by inviting government officials and visiting existing projects brought joy and confidence, which were their answers regarding describing their feelings through the design process period.

The answers regarding the efficiency of the SADS timetable and the teaching method reflection on their ability to design sustainable project illustrated were positively strong, which are the answers to the first and second research questions. (Figure 7.3, 7.4, and 7.5).

The SADS pedagogy structure elements came in a surprising order priority in comparison to the questionnaires in chapters 4, 5, and 6. One reason could be that the answers from professional architect perspective are different from student perspective. While, lectures' knowledge and case studies documentation comes first for professional as well as digital technology and visiting existing projects. Furthermore, reading document (code, building requirements, etc.) and work in-group was in higher position in the chart (Figure 7.6), that was supported by the architects who are working overseas. The research pedagogy structure had worked well, the elements used were successful of integrated sustainability principles into design project, which is and answer for the research first question.

It is true that natural daylight and natural ventilation are the major sustainable design elements; they always come on the top of the list of the students and professional architects. However, eco-friendly materials and open space have high priority in professional architects, especially with architect practice overseas. In addition, rainwater uses and renewable energy were not concern of architects who work overseas because they are must in any project.

Limitations of the Study

There were some limitation regarding the research work that required special consideration during the research process.

I played a dual role during this experimental journey: as a researcher who was running the experiment required watching the students reactions and responses, and testing the new method. On the other hand, as an tutor I had to conduct the design studio, guide the students, and evaluate their performance and test the final design product.

There was one more instructor who helped me conduct the studio according to the method that I had formulated and, from time to time, she also gave me feedback related to the research work. She also contributed to the studio work by her partnership instructing the students on energy simulation methods in general, as well as the social aspect of sustainability. Additionally, we had a teaching assistant who was helping to monitor the students' response to the teaching method as well as assisting their use of digital technology.

It has been mentioned that the SADS were stand-alone innovative experimental studio. Although the work was supported by the department and faculty as creative work, it was necessary to carry out the studio objective of the department curriculum. That required to work on parallel lines i.e. department requirements and SADS methodology. SADS was the principles issue while the studio objective and requirements in the curriculum were integrated into it. That was reflected in the project type, locations, program complexity as well as the project size. Furthermore, the created grading system of SADS had to consider that students should not be failed based on integration of sustainability principles so that any failed students was based on conventional design aspect only. The integration success level was reflecting on the students' grades only on the range from "DD" to "AA". Moreover, students were informed of this limitation details.

While technical trip is an essential visual element aiding the student for their design. It was hard to find qualified sustainable design buildings locally, while it was impossible to travel overseas.

8.2 Recommendations

This research provided a pedagogy structure for the integration of sustainability principles into design studio. In addition, the research delivered a flexible teaching method for the integration that can be modified according to the required tasks. Both pedagogy structure and teaching method will contribute to the academic field positive support to instructors who aim to demonstrate the integration of sustainability principles into design studio.

The essential recommendation out of this research work lay on the important need of embedding sustainable design principles into architectural design studio as part of the architecture curriculum. Moreover, the department should offer various elective courses related to the topic. On the other hand, there should be one SADS in each education year.

Digital technology education should start from the first year with a focus on various software that support design process evaluation, and building performance.

Certainly, the SADS should keep focus on all three aspects of sustainability (environmental, social, and economical) not only the environmental aspect.

The studio should find the supporting funds for an overseas technical trip each term. Exposing the students to the international architecture projects will improve the integration level.

The studio should include big scale study models as part of the teaching method as a way of visualization of the effects of natural light and natural ventilation on the design.

The energy and daylight simulation should not be the only concern in the final evaluation of the building performance but also it should be implemented from the start of the design to reflect on the design modification decisions.

Future research

Further research could be related to the integration of sustainability principles into first year design studio, where the students study basic design elements. While students are learning about forms and mass relations, sensations, shapes, etc., they shall learn how these basic design elements could be sustainable.

REFERENCES

Al-Mogren, AA. 2006. "Architectural Learning: Evaluating the Work Environment and the Style of Teaching and Management in Design Studios." *Alexandria Engineering Journal* 45 (5):1-14.

Altomonte, Sergio, Paula Cadima, Simos Yannas, Andre'de Herde, Hana Riemer, Eliana Cangelli, Maria Lopez De AsiainS, and Sara Horvath. 2012. "Sustainable Environmental Design in Architectural Education and Practice."

Altomonte, Sergio, Hana Reimer, Peter Rutherford, and Robin Wilson. 2014. "Towards Education for Sustainability in University Curricula and in the Practice of Design'." Sustainable Architecture for a Renewable Future, Munich, Germany.

Altomonte, Sergio, Peter Rutherford, and Robin Wilson. 2014. "Mapping the Way Forward: Education for Sustainability in Architecture and Urban Design." *Corporate Social Responsibility and Environmental Management* 21 (3):143-154. doi: 10.1002/csr.1311.

Anderson, Bruce. 1990. *Solar building architecture*: Massachusetts Inst. of Tech., Cambridge, MA (USA).

Anderson, Nadia M. 2012. "Public Interest Design: A Vehicle for Change in Architectural Education and Practice." 2012 ACSA International Conference, Barcelona, Spain.

Anthony, Kathryn H. 1987. "Private Reactions to Public Criticism; Students, Faculty, and Practicing Architects State Their Views on Design Juries in Architectural Education." *Journal of Architectural Education* 40 (3):2-11.

Anthony, Kathryn H. 1991. "Design juries on trial: The renaissance of the design studio."

Architecture Department IYTE. 2018. "Architecture Education." accessed 02.02. http://architecture.iyte.edu.tr/.

Attoe, Wayne, and Robert Mugerauer. 1991. "Excellent studio teaching in architecture." *Studies in Higher Education* 16 (1):41.

Bakarman, Ahmed Abdullah. 2003a. "Architectural learning tool." University of Sheffield.

Bakarman, Ahmed Abdullah. 2003b. "Quality evaluation tool for the design studio practice."

Bala, H. A. 2010. "Sustainability in the Architectural Design Studio: A Case Study of Designing On-Campus Academic Staff Housing in Konya and Izmir, Turkey." *International Journal of Art and Design Education* 29 (3):330-348. doi: 10.1111/j.1476-8070.2010.01665.x.

Bashir, Faizah Mohammed, Mohammad Hamdan Ahmad, and Jibril Danazumi Jibril. 2014. "Green Building Components used in Universiti Teknologi Malaysia Design Studio." Advanced Materials Research.

Benkari, Naima. 2013. "The “Sustainability” Paradigm in Architectural Education in UAE." *Procedia - Social and Behavioral Sciences* 102 (0):601-610. doi: http://dx.doi.org/10.1016/j.sbspro.2013.10.777.

Bloom, Benjamin Samuel, and David R Krathwohl. 1956. "Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain."

Bodansky, Daniel. 1993. "United Nations Framework Convention on Climate Change: A Commentary, The." *Yale J. Int'l l.* 18:451.

Brown, J.B. and Pirrie, A. 2011. "Field/Work, Site, and Other Matters: Exploring Design Practice Across Disciplines." [Online], Last Modified 17.04.2015, accessed 17.04. https://www.academia.edu/1329059/Field_work_site_and_other_matters_exploring_design_practice_across_disciplines.

Bryman, Alan. 2012. *Social research methods*: Oxford ; New York : Oxford University Press, 2012. 4th ed. Non-fiction.

Buchanan, Peter. 2012a. "What’s wrong with architectural education? Almost everything." *Architectural Review* 28.

Buchanan, Peter. 2012b. "The Big Rethink: Rethinking Architectural Education." *V: Architectural Review* 28.

Canaan, D. 2003. "Research to Fuel the Creative Process, Design Research: Methods and Perspectives." *The MIT Press*: 234-240.

Carlhian, Jean Paul. 1979. "The Ecole des Beaux-Arts: Modes and Manners." 7.

Ceylan, Salih. 2014. "Redesigning architectural education: an exploration about the impact of worldwide energy problems on architectural education based on the changes in the education program contents of architecture schools." *International Journal of Sustainable Human Development*, 2 ((3)): 87-93.

Chafee, Richard Spofford. 1983. "The teaching of architecture at the Ecole des Beaux-Arts and its influence in Britain and America." Theses No attempt to code, University of London, EBSCOhost.

Cherry, Edith, and John Petronis. 2009. "Architectural Programming." The National Institute of Building Sciences, accessed 09.05. http://www.wbdg.org/design/dd_archprogramming.php.

Chickering, Arthur W, and Zelda F Gamson. 1987. "Seven principles for good practice in undergraduate education." *AAHE bulletin* 3:7.

Cho, Ji Young. 2013. "Customization and Autonomy: Characteristics of the Ideal Design Studio Instructor in Design Education." *ARCHITECTURAL RESEARCH* 15 (3):123-132.

Cornell University. 2015. "Bachelor of Architecture (B.Arch.), Cornell University." accessed 29.04. http://courses.cornell.edu/preview_program.php?catoid=22&poid=10782#barchcurriculumforstudentsmatriculatinginfall2014.

Des Architectes, Union Internationale. 1993. "Declaration of Interdependence for a Sustainable Future. UIA." AIA World Congress of Architects, Chicago, June.

Dib, Hazar, and Nicoletta Adamo-Villani. 2014. "Serious sustainability challenge game to promote teaching and learning of building sustainability." *Journal of Computing in Civil Engineering* (5).

Dizdar, Safiye Irem. 2014. "Some options about design studios of architectural education." *European Scientific Journal* 10 (36).

Drexler, Arthur. 1977. *The Architecture of the Ecole des Beaux-Arts*. New York: Museum of Modern Art / distributed by MIT Press; First edition.

Dutton, Thomas A. 1987. "Design and Studio Pedagogy." 16.

EDUCATE. 2012. "Sustainable Archtiectural Education." accessed 29.04. http://www.educate-sustainability.eu/downloads/white-papers/EDUCATE%20White%20Paper%20-%20Sustainable%20Architectural%20Education.pdf.

Edwards, Rosalind, and Janet Holland. 2013. *What is Qualitative Interviewing?* 1 ed, *The 'What is?' Research Methods Series*. London: Bloomsbury Academic.

Esherick, Joseph. 1977. Architectural education in the Thirties and Seventies : a personal view. Book.

Fan, Liya, and Xueqiang Wang. 2014. "Architecture Design Curriculum Reform Practice Triggered by the British Architectural Education and Certification System." *Applied Mechanics & Materials* (638-640):2393-2396. doi: 10.4028/www.scientific.net/AMM.638-640.2393.

Glyphis, J. 2001. "How can the architect contribute to a sustainable world." Proceedings of the Wingspread Conference.

Halawi, Leila A., Richard V. McCarthy, and Sandra Pires. 2009. "An Evaluation of E-Learning on the Basis of Bloom's Taxonomy: An Exploratory Study." *Journal of Education for Business* 84 (6):374-380.

Hall, Ashley, and T Barker. 2010. "Design collectives in education: evaluating the atelier format and the use of teaching narrative for collective cultural and creative learning, and the subsequent impact on professional practice Alternative Practices in design: past present and future." 1 (1):1-11.

Ham, Jeremy J. 2013. "The evolution of media use in the design studio: why are students not engaging in the cutting edge?" ANZAScA 2013: Cutting edge: Proceedings of the Architectural Science Association 2013 international conference.

Heylighen, Ann, Jan E. Bouwen, and Herman Neuckermans. 1999. "Walking on a thin line—Between passive knowledge and active knowing of components and concepts in architectural design. Between passive knowledge and active knowing of components and concepts in architectural design." *Design Studies* 20:211-235. doi: 10.1016/S0142-694X(98)00035-0.

Ibrahim, Norhati. 2008. "Sustainability and the Architectural Education: Are we there yet." *SENVAR+ ISESEE*.

Ilozor, Benedict D. 2006. "Balancing Jury Critique in Design Reviews." *Transactions* 3 (2):52-79.

Jankovic, Ljubomir. 2012. Designing zero carbon buildings using dynamic simulation methods. London and New York: Routledge.

John, Shiel. 2009. *Practical Greenhouse Gas Reduction Strategies for the Existing Building Stock*. Vol. Volume 52.4, pp 270-278: Architectural Science Review.

Jonassen, David, Mark Davidson, Mauri Collins, John Campbell, and Brenda Bannan Haag. 1995. "Constructivism and computer-mediated communication in distance education." *American journal of distance education* 9 (2):7-26.

Jonassen, David H. 1994. "Technology as cognitive tools: Learners as designers." *ITForum Paper* 1:67-80.

Kahvecioglu, N. P. 2007. "Architectural design studio organization and creativity." *Architectural design* 4 (2):6-26.

Karslı, Umut Tuğlu. 2013. "Integrating Sustainability in Interior Design Studio." *Procedia - Social and Behavioral Sciences* 106:1532-1539. doi: 10.1016/j.sbspro.2013.12.173.

Kearsley, G. . 1994. "Conditions of learning (R. Gagne).". Sookmyung Women's University, accessed

19.04. http://www.adesignmedia.com/onlineresearch/learning_theories_full_version.htm.

Kevin, Warburton. 2003. "Deep learning and education for sustainability." *International Journal of Sustainability in Higher Education* 4 (1):44.

Kibert, Charles J. 2012. Sustainable Construction: Green Building Design and Delivery: Green Building Design and Delivery: John Wiley & Sons.

Kostof, Spiro. 1986. *The Architect : Chapters in the History of the Profession*. New York: Oxford University Press. Book.

Kurt, Sevinc. 2011. "Use of constructivist approach in architectural education." *Procedia-Social and Behavioral Sciences* 15:3980-3988.

Kurt, Sevinc. 2012. "Applying Constructivist Instruction Method to the Basic Design Course." *International Journal of Arts and Sciences* 05 (05):253-262.

Kurt, Sevinç. 2009. "An analytic study on the traditional studio environments and the use of the constructivist studio in the architectural design education." *Procedia-Social and Behavioral Sciences* 1 (1):401-408.

Lofthouse, Natasha. 2013. "The Changing Nature of Architectural Education." MA, Development and Emergency Practice, Oxford Brookes University.

Manu, Sanyogita, Anurag Bajpai, Satish Kumar, Shruti Narayan, Ankur Tulsyan, and Rajan Rawal. 2012. "Architectural Curriculum Enhancement for Promoting Sustainable Built Environment in India." Proceedings of the ACEEE.

Mazria, Edward. 2003a. "It's the architecture, stupid!" *WORLD AND I* 18 (10):138-145.

Mazria, Edward. 2003b. It's the Architecture, Stupid! World & I.

Merriam-Webster. 2015a. "charette." accessed 03.05. http://www.merriam-webster.com/dictionary/charette.

Merriam-Webster. 2015b. "sustainable." accessed 01.05. http://www.merriam-webster.com/dictionary/sustainable.

Ministry of culture and communication. 2018. "Ecole des Beaux Arts Handbook." École nationale supérieure des beaux-arts, accessed 18.07. http://www.beauxartsparis.com/images/telechargements/pdf/student-handbook2012-13.pdf.

Mohamed, Kamal Eldin, and Zeynep Durmuş Arsan. 2016. BIF Ideas for Bornova: Municipality of Bornova Culture Centre Design Project / BIF Bornova için Fikirler: Bornova Belediyesi Kültür Merkezi Tasarım Projesi. Vol. 2. Izmir, Turkey: Bornova Municipality.

Mohamed, Kamal Eldin, and Soofia Tahira Elias Ozkan. 2017. "Sustainable architectural design education: A pilot study in a 3rd year studio." Al Azhar 14th International Conferance (AEIC) on: Engineering, Architecture & Technology, Cairo, Egypt, 12-14 December, 2017.

Moore, Keith Diaz. 2001. "The Scientist, the Social Activist, the Practitioner and the Cleric: Pedagogical exploration towards a pedagogy of practice." *Journal of Architectural and Planning Research* 18 (1):59-79.

Nicol, David, and Simon Pilling. 2000. *Changing Architectural Education : Towards a New Professionalism*. London: E & FN Spon. Book.

Nikolic, Dragana, John I Messner, Sanghoon Lee, and Chimay Anumba. 2010. "The virtual construction simulator-development of an educational simulation game." Proceedings of the International Conference on Computing in Civil and Building Engineering.

O'Brien, Will, and Joseph Sarkis. 2014. "The potential of community-based sustainability projects for deep learning initiatives." *Journal of Cleaner Production* 62:48-61. doi: 10.1016/j.jclepro.2013.07.001.

Odhabi, Hamad. 2007. "Investigating the impact of laptops on students' learning using Bloom's learning taxonomy." *British Journal of Educational Technology* 38 (6):1126-1131.

Oxford-Dictionaries. 2015a. "Charrette." accessed 03.05. http://www.oxforddictionaries.com/definition/english/charrette.

Oxford-Dictionaries. 2015b. "Sustainable." accessed 01.05. http://www.oxforddictionaries.com/definition/english/sustainable.

Oxman, Rivka. 1999. "Educating the designerly thinker." *Design Studies* 20 (2):105-122. doi: http://dx.doi.org/10.1016/S0142-694X(98)00029-5.

Parnell, Rosie, Rachel Sara, Charles Doidge, and Mark Parsons. 2007. *The crit: an architecture student's handbook*: Routledge.

Peäna, William, and Steven Parshall. 2001. *Problem seeking : an architectural programming primer*: New York : Wiley, c2001. 4th ed.

Pernice, Kara. 2013. "Charrettes (Design Sketching): Half Inspiration, Half Buy-In." Nielsen Norman Group, accessed 03.05. http://www.nngroup.com/articles/design-charrettes/.

Peterson, Matthew, and Brad Tober. 2014. "Institutionalizing the Vertical Studio: Curriculum, Pedagogy, and the Logistics of Core Classes with Mixed-Level Students." Proceedings of AIGA Connecting Dots Conference.

Pratt University. 2018. "Academics-Architecture-Undergraduate Architecture-Architecture B.ARCH." Pratt Institute, accessed 18.07. https://www.pratt.edu/academics/architecture/ug-dept-architecture/arch-b-arch/.

Romm, Joseph J, and Christine A Ervin. 1996. "How energy policies affect public health." *Public Health Reports* 111 (5):390.

Salama, Ashraf. 1995. New trends in architectural education: Designing the design studio: ARTI-ARCH.

Salama, Ashraf M, and MS El-Attar. 2010. "Student perceptions of the architectural design jury."

Sanoff, Henry. 1992. Integrating programming, evaluation and participation in design: A theory Z approach: Ashgate Publishing Company.

Sara, Rachel, and Rosie Parnell. 2004. "The review process." *Transactions* 1 (2):56-69.

Sarhan, Ahmed, and Peter Rutherford. 2014. "Integrating sustainability in the architectural design education process-taxonomy of challenges and guidelines." Fusion-Proceedings of the 32nd eCAADe Conference.

Schön, Donald A. 1990. Educating the reflective practitioner, The Josey-Bass higher education series: San Francisco : Jossey-Bass, 1987.

Taleghani, Mohammad, Hamid Reza Ansari, and Philip Jennings. 2011. "Sustainability in architectural education: A comparison of Iran and Australia." *Renewable Energy* 36 (7):2021-2025. doi: http://dx.doi.org/10.1016/j.renene.2010.11.024.

Technical University of Delft. 2015. "BSc Architecture." Architecture and built environment, accessed 09.05. http://www.tudelft.nl/en/study/undergraduates-bachelors/undergraduate-programmes/architecture/.

Terenzini, Patrick T, Ernest T Pascarella, and Gregory S Blimling. 1996. "Students' out-of-class experiences and their influence on learning and cognitive development: A literature review." *Journal of college student development*.

The Bauhaus-Universität Weimar. 2018. "What does the programme offer?". The Bauhaus-Universität Weimar, accessed 18.07. http://www.uni-weimar.de/en/architecture-and-urbanism/studies/bachelor/architecture/what-does-the-programme-offer/.

The Chamber of Architects of Turkey. 2015. "Legal Framework." TMMOB. http://www.mimarlarodasi.org.tr/index.cfm?sayfa=belge&sub=list&bid=220&mid=220.

The Great Soviet Encyclopedia. 1979. "Architectural Education ", accessed July 17 2018. http://encyclopedia2.thefreedictionary.com/Architectural+Education.

Tommerup, H., J. Rose, and S. Svendsen. 2007. "Energy-efficient houses built according to the energy performance requirements introduced in Denmark in 2006." *Energy and Buildings* 39 (10):1123-1130. doi: 10.1016/j.enbuild.2006.12.011.

UIA, General Secretaria. 2012. UIA AND ARCHITECTURAL EDUCATION REFLECTIONS AND RECOMMENDATIONS.

UNESCO. 2011. "UIA/UNESCO Charter for Architectural Education." UIA/UNESCO, accessed 29.04. http://www.uia.archi/sites/default/files/charte-en.pdf.

United-Nation. 1992. "United Nations Conference on Environment & Development." The Earth Summit, Rio de Janeiro, Brazil, 3-14 June.

United-Nations. 1987. "Report of the World Commission on Environment and Development: Our Common Future." *Oxford: Oxford University Press.* .

Utaberta, NANGKULA, BADIOSSADAT Hassanpour, and I Usman. 2010. "Redefining critique methods as an assessment tools in architecture design studio." *WSEAS transaction on advanced education* 359.

Vitruvius, Pollio. 1914. "The Ten Books on Architecture (ed. Morris Hicky Morgan)." Harvard University Press., accessed 18.04. http://www.perseus.tufts.edu/cgi-bin/ptext?lookup=Vitr.+1.1.1.

Wainwright, O. 2012. "Graduates face up to the future." *Building Design* (2023):12-15.

Walker, Jason B, and Michael W Seymour. 2008. "Utilizing the design charrette for teaching sustainability." *International Journal of Sustainability in Higher Education* 9 (2):157-169.

Wallschlaeger, Charles, Cynthia Busic-Snyder, and Meredith Morgan. 1992. *Basic visual concepts and principles for artists, architects, and designers*: McGraw Hill.

Whitford, Frank. 1992. *The Bauhaus: Masters & Students by Themselves*. London: Conran Octopus.

Wilkin, Margaret. 2005. "Reviewing the review." Changing architectural education: Towards a new professionalism:85.

Williamson, Terry J, Antony Radford, and Helen Bennetts. 2003. *Understanding sustainable architecture*: Taylor & Francis.

Wood, E. J. 2004. "Problem-Based Learning: Exploiting Knowledge of How People Learn to Promote Effective Learning." *Bioscience Education e-Journal* 3.

Wright, James. 2003. "Introducing sustainability into the architecture curriculum in the United States." *International Journal of Sustainability in Higher Education* 4 (2):100-105. doi: doi:10.1108/14676370310467131.

Yahya, Anwar Ali, Addin Osman, Ahmad Taleb, and Ahmed Abdu Alattab. 2013. "Analyzing the cognitive level of classroom questions using machine learning techniques." *Procedia-Social and Behavioral Sciences* 97:587-595.

Yu, Fang Da. 2014. "Impact of digital technology on Architectural Design Teaching." Advanced Materials Research.

Zhao, Zhi Qing, and Li Tao. 2014. "Cultivation of Students' Creativity in University Architectural Education in the 21st Century." Advanced Materials Research.

APPENDIX A

SADS spring 2015 - syllabus

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 302: Architectural Design IV - Section-2 Spring 2015
Monday 8:45-12:30 & 1:30-5:15 – Thursday 8:45-12:30
Building B – Room Z01

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED
T.A. Mümine GERÇE

Design studio

AR 302 is the fourth architectural design studio of the architectural curriculum at IYTE. It is the last architectural studio before your graduation project. You are expected to bring together a variety of knowledge areas that you have acquired during your previous undergraduate education.

Studio objective and theme

The studio general out frame theme is concerning global climate change and sustainable design. The design project would include proposing an urban analytic approach, configuring the building program and concept parallel to the urban analytic studies, integrating building construction systems with spatial configurations, using multi-media tools to test and express design ideas through diagrams and collages.

Design topics

1- Site analysis (local climate, urban fabric, movement and activities, site context, etc.) relation to develop innovative project concept, form the building mass, and create program scenario.
2- Sustainable design approach considering (mass form and orientation, natural light, natural ventilation, material choice, landscaping, heating-cooling strategies, etc.)
3- Translate the project programmatic elements to spatial configurations
4- Public/semi-private/private spaces and its contribution to sustainable design approach.
5- Structural solutions in relation to building mass (system and material).
6- Circulation patterns (vertical and horizontal) and its integration with building structure systems.
7- The use of multi-media as design test tools (Ecotect, Climate consultant, DesignBuilder) and graphic communication (Sketchup, Revit, etc.)
8- Minimum code requirements (handicap accessibility, height limits, etc.)
9- Materials choice and applications.
10- Workshop by outside visitors.

Bear in mind that design is an iterative process. You may have to revisit earlier steps frequently

Course Requirements

The primary teaching method of this studio will be **desk critiques** by the instructors, together with **panel reviews** and short **presentations** of supporting material. To obtain maximum benefit from the desk critiques, students must be prepared for each class with sufficient work and be ready to discuss their design work.

There will be regular **in-class assignments** during the semester. During the project development phase, there will three **(3)** midterms reviews. You must present your work at least in two **(2)** of the midterm reviews to pass the class. You have to get a passing grade (at least 60 out 100) from your final project submission to pass the class.

Each student is required to keep a logbook through the semester keep a record of the design process.

You are also required to turn in a portfolio at the end of the semester summarizing and highlighting your progress during the semester.

Attendance

Attendance to class is mandatory. Students should better not be absent at any class hours without an acceptable excuse.

More than six **(6)** absences (that include sick absences) will result in forced withdrawal with final grade (NA). For attendance purposes, Mondays will count as two classes and Thursdays will count as one class.

Grading

The grades will be determined based on the quality of students' work throughout the semester. The following list summarizes the percentages assigned to each studio phase during the semester and to additional required items:

1.	*Studio attendance and performance*	*5%*
2.	*Assignments and charrette design*	*5%*
3.	*Group work (site analysis, and model) & case study*	*5%*
4.	*Three midterm reviews*	*15%*
5.	*Final project*	*65%*
6.	*Portfolio*	*5%*

Communication

All announcements for this class and class materials and documents will be made available through CMS. Students are responsible for all communication made by the instructors through CMS.

Trips

1- Site visit to Izmir
2- Three days trip to Istanbul

Important

YOU ARE REQUIRED TO HAVE A CONSTANT AND REGULAR CONTACT WITH STUDIO INSTRUCTORS THROUGHOUT THE SEMESTER. YOUR PROJECT DEVELOPMENT WILL BE AN INTERACTIVE PROCESS IN CLOSE COLLABORATION WITH THE INSTRUCTORS.

APPENDIX B

SADS spring 2015 - project program description

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 302: Architectural Design IV - Section-2 Spring 2015

Project description

There is a debate among the architectural profession regarding the location of the architectural education institute. Shall it be in suburban or urban location? The view of having the architectural education in urban area claims that will help architectural students to have better sense of urban fabric and context. In addition, it makes the students able to observe, understand and analysis the city movement, character and problems in order to come with responsible design solution.
Responding to the above statement, Student will be asked to design IYTE architectural department project in the heart of down town Izmir at Alsancak. There are two sites locations. Each site has its own properties that you need to study, understand and analysis carefully before you choose one of them for you project location. Please refer to the class syllabus for design requirements and considerations. All other design limitations will be explained during the studio work.

Architectural Program

1	**Educational Spaces**	Sq. m.	Sq. m.
1.1	(4) undergraduate design studios (50 students each)	1000	
1.2	One graduate design studio (25 students)	150	
1.3	(4) class rooms (50 students each)	300	
1.4	(2) class rooms (30 students each)	90	
1.5	(2) computer labs (50 students each)	150	
1.6	Lockers, storage, and shelves spaces	50	
1.7	Printer and copy space	20	
	Subtotal	**1760**	
2	**Library Spaces**		
2.1	Book stacks space	100	
2.2	Reading spaces (seats 50 person)	100	
2.3	Visual media room	50	
2.4	(2) group study rooms	50	
2.5	Info. Desk area	10	
2.6	Press production office	40	
2.7	Storage	20	
	Subtotal	**370**	
3	**Conference and seminar spaces**		
3.1	Conference hall (400 persons)	600	
3.2	Foyer	100	
3.3	Backstage (dressing, undressing, storage)	100	
3.2	Seminar room (100 persons)	150	
	Subtotal	**950**	
4	**Workshop spaces**		
4.1	Model making lab	80	
4.2	Building physics lab	60	
4.3	Building science lab	60	
4.4	Wood work lab	100	
	Subtotal	**300**	
5	**Administrative spaces**		

5.1	Dept. head office	40	
5.2	(2) Dept. head assist. Offices	40	
5.3	Dept. secretary office (2 persons)	20	
5.4	Students registration office (2 persons)	20	
5.5	Academic members offices (20 members)	300	
5.6	Academic assistants offices (20 members)	200	
5.7	(3) meeting rooms (one big and 2 small)	70	
	Subtotal	**690**	
6	**Entrance** (includes entrance hall, waiting area, and info area)	50	
	Subtotal	**50**	
7	**Food and social spaces**		
7.1	Kitchen and serving area	120	
7.2	Refreshments, snacks, and cold sandwiches area	30	
7.3	Indoor dining with seating spaces for 200 persons (it may include lavabo rooms)	300	
7.4	Indoor dining with seating space for 50 persons of academics, admin., and visitors (it may include lavabo rooms)	100	
7.5	Game and media spaces	50	
7.6	Outdoor dining spaces (open and semi-open) at least equal to indoor spaces	As needed	
	Subtotal	**600**	
8	**Exhibit and display spaces**		
8.1	Indoor exhibit spaces	200	
8.2	Outdoor exhibit spaces	As needed	
	Subtotal	**200**	
9	**Services**		
9.1	Restrooms as need it (men, women, and handicapped)	400	
9.2	Changing rooms (men, women, and handicapped)	50	
9.3	Mechanical rooms (power room, phone, internet, heating and cooling)	100	
9.4	Sanctuary	300	
9.5	Minimum one housekeeping room per level. (10 m2 each)	50 (Approx.)	
9.6	Indoor car parking for 20 cars	500	
9.7	Bike racks for 200 Bicycles	150	
9.8	Bookstore	150	
9.9	Recycle and composting room	50	
9.10	Rain water storage (to be calculated by the students)	As needed	
	Subtotal	**1750**	
10	**Outdoor spaces (open and semi-open)**	**As needed**	
10.1	Sport activities (basketball, tennis, et.)	As needed	
10.2	Urban forum	As needed	
10.3	Outdoor car parking for 5 cars and one bus		
	Total		**6670**
11	**Circulations**		
	Staircases, elevators, corridors, etc. 10% of total project area.	667	
	Grand Total		**7337**
12	**Space to be provided individually**		
	Each individual student **should** add up to 5% to 10% of the total project enclosed area to the project. Students shall explain the need for extra space according to each individual concept and scenario.	366 – 733	
	Grand total with optional	**7703 to 8070 Sq. m.**	
13	**Project must be handicap accessible indoor and outdoor**		

APPENDIX C

SADS spring 2015 – calendar

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 302: Architectural Design IV - Section-2 **Spring 2015**
Monday 8:45-12:30 & 1:30-5:15 – Thursday 8:45-12:30
Building B – Room Z01

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED
T.A. Mümine GERÇE

Week No	Day/Date	Time Periods	Activity	Homework
1	M. 16.02.15	Conceptual idea (four weeks)	• Introduction to the class and syllabus handout • **Case study assignment handout 12 known and 12 sustainable projects (2.5%)** • Introduction to the project • Sites' models assignment 1/200 (two models) and site analysis group work • *Technical trip to the project's site in down town Izmir*	Group Site analysis Group model work Individual case study
	Th. 19.02.15		• Introduction to the sustainable design ***(lecture-1)*** • Draft presentation of group work of site analysis • Project program discussion • Environmental, social, and economic sustainability ***(lecture-2)*** • Site model group work progress	Draft of project program (by group of two students)
2	M. 23.02.15		• Intro to sustainable design principles "what it is, why, history and background" ***(lecture-3)*** • **Groups final presentation of site analysis and class discussion (2.5%)** • Draft project program assignment (by group of eight students), followed by class discussion. Site model progress. • Case study presentations ***(4 cases)***	
	Th. 26.02.15		• Site model submission and discussion • Sustainability principles; site issues "prevailing wind, sun path, daylight, geometry, plan depth and roof types" ***(lecture-4)*** • Project program handout and discussion • Case study presentation ***(2 cases)***	Individual site analysis Mass model exploration
3	M. 02.03.15		• Individual site analysis & mass model (panel review discussion) • Class assignment "mass model exploration" ***(Assignment 1)*** • Sustainability principles; "solar gain, shading elements, façade design considerations" ***(lecture 5)*** • Case study presentation ***(4 cases)***	Mass model exploration
	Th. 05.03.15		• Individual program analysis and concept's idea panel review • Mass model exploration (panel review) • Program analysis progress & plans and sections diagrams (desk critic)	Handout first midterm jury requirements
4	M. 09.03.15		• **First midterm jury review (%5)**	
	Th. 12.03.15		• First midterm jury discussion and grade announcement • Role-play review by students • Sustainability principles presentation related to building context "natural and mechanical ventilation" ***(lecture 6)***	Group presentation of each site of the technical trip
5	F. to M. 13- 16.03.15	Project development (four weeks)	• **Three days technical trip (Bursa and Istanbul)** ○ TED Istanbul Collage ○ Piri Reis university ○ Küçükçekmece municipality building and culture center ○ Rönesanc Office ○ Erka Yeşil Academy ○ Özyeğin university	
	Th. 19.03.15		• Case study presentation ***(2 cases)*** • Introduction to BIM and various simulation software ***(lecture 7)***	
6	M 23.03.15		• Case study presentation ***(4 cases)*** • Floor plans and sections development (desk critic) • Sustainability and mechanical issues in building ***(guest Lecturer 1)***	Natural light in building poster (1)

	Th. 26.03.15		• Floor plans and sections development (desk critic) • Sustainability and natural light ***(guest Lecturer 2)*** • Natural light in building workshop ***(guest workshop 1)***	
7	M. 30.03.15		• Case study presentation ***(4 cases)*** • Floor plans and sections development (desk critic) and panel review discussion • Revit & DesignBuilder in energy conception in building ***(lecture 8)***	
	Th. 02.04.15		• Floor plans and sections development (desk critic) • Panel review discussion • Revit & DesignBuilder in energy conception in building ***(lecture 9)***	
8	M. 06.04.15		• Case study presentation ***(4 cases)*** • Floor plans and sections development (desk critic)	Handout second midterm jury requirements
	Th. 09.04.15		• Floor plans and sections development (desk critic) • Panel review discussion	
9	M. 13.04.15	**Materials and testing (four weeks)**	• **Second midterm jury review (5%)**	Sustainable materials poster (2)
	Th. 16.04.15		• Second midterm jury discussion and grade announcement • Façade design and materials (desk critic) • Energy simulation with building materials assigned ***(lecture 10)***	
10	M. 20.04.15		• Sustainable materials presentation ***(guest Lecturer 3)*** • Sustainable materials workshop ***(guest workshop 2)*** • Façade and shading elements panel review discussion	
	Th. 23.04.15		• Plans, sections, and mass refinement with façade design and materials (desk critic)	
11	M. 27.04.15		• Façade and shading elements ***(guest Lecturer 4)*** • Plans, sections, and mass refinement with façade design and materials (desk critic)	
	Th. 30.04.15		• Construction materials in system detail drawing ***(lecture 11)*** • Plans, sections, and mass refinement with façade design and materials (desk critic)	
12	M. 04.05.15		• Plans, sections, and mass refinement with façade design and materials (desk critic) • Site and landscape consideration - review energy simulation results	Handout third midterm jury requirements
	Th. 07.05.15		• Plans, sections, and mass refinement with façade design and materials (desk critic) • Review energy simulation results	
13	M. 11.05.15	**Finishing and presentation (two weeks)**	• **Third midterm jury review (5%)**	
	Th. 14.05.15		• Third midterm jury discussion and grade announcement • Students-led review	
14	M. 18.05.15		• Architecture project presentation techniques with examples of architecture competition projects ***(lecture 12)*** • Final jury presentation technique ***(lecture 13)*** • Final desk critic & Models techniques • Review energy simulation results • Final portfolio requirements	Handout Final jury requirements
	Th. 21.05.15		• Final presentation drawing's week	
15	Tu. 26.05.15		• Final Jury submission (drawings and models)	
	Wed. 27.05.15		• **Final jury presentations 65%**	
16	Wed. 03.06.15		• **Final jury grade announcement 65%**	
	Th. 04.06.15		• **Portfolio submission 5%** • **Open colloquium meeting for class discussion**	

APPENDIX D

SADS spring 2015 - case studies

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 302: Architectural Design IV - Section-2 Spring 2015

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED
T.A. Mümine GERÇE

Case Studies

Architectural department case study buildings

1. Faculty of Engineering + Information Technology / Denton Corker Marshall
2. Strasbourg School of Architecture / Marc Mimram
3. Myra – School Of Business / Architecture Paradigm
4. College of Architecture and Landscape Architecture, UMINN / Steven Holl Architects
5. Abedian School of Architecture / CRAB Studio
6. Arts Building for University of Iowa / Steven Holl Architects
7. Advanced Engineering Building / Richard Kirk Architect + HASSELL
8. Yale Art + Architecture Building / Gwathmey Siegel & Associates Architects
9. Austin E. Knowlton School of Architecture / Mack Scogin Merrill Elam Architects
10. Yale School of Management / Foster + Partners
11. METU Architecture Department building, Ankara.
12. School of Design OCAD Building, Toronto, Canada
13. Waterloo School of Architecture / Levitt Goodman Architects

Your Presentation shall answer the following questions:

a. Main design idea
b. Mass strategy in relation to
    i. Site context
    ii. Project program
    iii. Plan and sections
    iv. Climate consideration
c. Special spaces such as (design studio, conference hall, food area, etc.)
d. Structure system
e. Materials
f. Open and semi open – public and private
g. Circulation and service area

Page 1

Sustainable case study buildings

1. UBC (The University of British Columbia) Centre for Interactive Research on Sustainability, Canada
2. Harvard Art Museums renovation and expansion, Cambridge, MA, U.S.A
3. California Academy of Sciences, San Francisco, U.S.A
4. Clemson University College of Architecture / Thomas Phifer and Partners
5. Oslo School of Architecture / JVA
6. Library Delft University of Technology, Mecanoo, Delft, Netherlands
7. Bullitt center, Miller Hull, Seattle
8. Sports and Leisure Centre / ACXT, by Javier Pérez Uribarri, Langreo, Asturias, Spain
9. Frontier Project, Rancho Cucamonga, California, USA, HMC Architects
10. University of Queensland Global Change Institute / HASSELL
11. Umeå School Of Architecture / Henning Larsen Architects
12. Surry Hills Library and Community Centre / FJMT

Your Presentation shall answer the following questions:

a. Sustainable design approach
b. Mass strategy in relation to
    i. Site context
    ii. Building orientation (sun, wind, etc.)
    iii. Natural ventilation
    iv. Natural light and shading
c. Structure system
d. Materials
e. Open semi-open space
f. Any sustainable design elements

APPENDIX E

SADS spring 2015 – midterm juries' requirements

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department

AR 302: Architectural Design IV - Section-2 Spring 2015

First midterm jury requirements

First midterm jury will take place on Monday 23/03/2015. Jury will start at 9:00. It will be one-day jury for all students (12 students in the morning and 12 students in the afternoon). Students will be drawn randomly by themselves at 9:10. You need to come early to pick up your card.

All students are required to attend the jury. Two attendance will be taken morning and afternoon. Half letter grades will be deducted for late submission (after 9:30) and full grade (after 13:30). No submission will be accepted after 16:00.

Each students will have 20 minutes, 10 minutes to present the project and 10 minutes for instructors and students comments.

Submission requirements:

1- Conceptual drawings representing your project concept, main idea, and scenario in format of sketches, diagrams, photos, individual site analysis, and existing architectural project.
2- Site plan 1/500, representing mass location and site land scape strategy.
3- Floor plans diagrams 1/200 showing spaces of the project program location and main service area and main approach entry/entries of the building.
4- Minimum of two sections diagrams 1/200 representing your space relations, natural light strategy, solar gain, and air movement strategy
5- Foot print of the building mass in the site with surrounding buildings at June 21 (at 7:00, 12:00, and 18:00) and at December 21 (at 8:00, 12:00, and 16:00)
6- Diagrams representing special idea and view of some space(s) of the project such as (design studio, library, exhibit, etc.)
7- Study model(s) 1/200 showing your building mass and landscape work.
8- If you have a façade idea that is part of your main concept, present 1/200 elevation sketch.

Please use colors, heavy lines and clear presentation materials to express your project. You are free to use any materials or techniques to present your project's idea. Posting all your presented materials on a standard sheets of your choice is very important.

First Midterm Jury requirements

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department

AR 302: Architectural Design IV - Section-2 Spring 2015

Second midterm jury requirements

Second midterm jury will take place on Monday 06/04/2015. Jury will start at 9:00. It will be one-day jury for all students (12 students in the morning and 12 students in the afternoon). Students will be drawn randomly by themselves at 9:10. You need to come early to pick up your card.

All students are required to attend the jury. Two attendance will be taken morning and afternoon. Half letter grades will be deducted for late submission (after 9:30) and full grade (after 13:30). No submission will be accepted after 16:00.

Each students will have 20 minutes, 10 minutes to present the project and 10 minutes for instructors and students comments.

Submission requirements:

1- Study model(s) 1/200 showing your building mass and landscape work (no model - no jury).
2- Conceptual drawings representing your project concept.
3- Site plan 1/500, representing mass location and site land scape strategy.
4- All Floor plans (not diagram) 1/200 showing spaces of the project program location and main service area and main approach entry/entries of the building.
5- Minimum of two sections (not diagrams) 1/200 representing your space relations, natural light strategy, solar gain, and air movement strategy
6- Foot print of the building mass in the site with surrounding buildings at June 21 (at 7:00, 12:00, and 18:00) and at December 21 (at 8:00, 12:00, and 16:00)
7- At least one main elevation. 1/200

Please use colors, heavy lines and clear presentation materials to express your project. You are free to use any materials or techniques to present your project's idea. Posting all your presented materials on a standard sheets of your choice is very important.

Good Luck

Second Midterm Jury Requirements

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department

AR 302: Architectural Design IV - Section-2 Spring 2015

Third midterm jury requirements

Third midterm jury will take place on Monday 04/05/2015. Jury will start at 9:00. It will be one-day jury for all students (12 students in the morning and 12 students in the afternoon). Students will be drawn randomly by themselves at 9:10. You need to come early to pick up your card.

All students are required to attend the jury. Two attendance will be taken morning and afternoon. Half letter grades will be deducted for late submission (after 9:30) and full grade (after 13:30). No submission will be accepted after 16:00. Students, who had missed one midterm jury before, should not miss this jury.

Each students will have 20 minutes, 10 minutes to present the project and 10 minutes for instructors and students comments.

Submission requirements:

1- Detail Model 1/200 showing your building façade (opening and materials) and landscape work (no model - no jury). It would be better if the model is openable to see each floor and the internal spaces relations (optional).
2- Conceptual drawings representing your project concept and idea.
3- Site plan 1/500, representing mass location, site landscape, open car parking, close car park ramp, and adjacent building.
4- All Floor plans (not diagram) 1/200 showing spaces of the project program location and main service area and main approach entry/entries of the building. You must show structure system (structure elements and axes), door, and windows. Ground floor plan should include all project site area.
5- Minimum of two sections (not diagrams) 1/200 representing your space relations, natural light strategy, solar gain, and air movement strategy (summer / winter strategy). Be careful about the location of your section line. Please show the adjacent buildings on your section.
6- Four elevation (or three for some of the seaside site project) 1/200.
7- Foot print of the building mass in the site with surrounding buildings at June 21 (at 7:00, 12:00, and 18:00) and at December 21 (at 8:00, 12:00, and 16:00)
8- Two 3D drawings, one showing the best internal space in your project (court, gallery, studio, etc.), the second showing the exterior part of your building.
9- Use group 3D model that was prepared by Nazar and Irmak to show your building in it.
10- Draft drawing of system detail section at the most important part of your façade scale 1/20.

Please use colors, heavy lines and clear presentation materials to express your project. You are free to use any materials or techniques to present your project's idea. Posting all your presented materials on a standard sheets of your choice is very important.

Good Luck

Third Midterm Jury requirements

APPENDIX F

SADS spring 2015 – hand out jury brochure

ARSAN - MOHAMED - Gercek

Sustainable Design of Architectural Department Building IYTE, Alsancak

AR 302 Section (2) - Architectural Design IV Spring 2015

"First we shape our buildings and afterwards the buildings shape us." Winston Churchill

Architectural education intends to teach students a collection of design skills and professional knowledge, where the design studio has the unique special privilege of the architectural curriculum.
Design studio, as a learning environment, is a '**Melting Pot**' in which different skills and knowledge, that have been accumulated and acquired during the school's years, are integrated and interrelated. (Bakarman 2003). Design studio is the heart of architectural curricula where students learn visualizing and representing phenomena graphically. They learn how to think architecturally, practice-making decisions, design process, and synthesis, which required identifying what information needed to accomplish the design
Design is a strategic tactic or a roadmap of someone to accomplish a unique expectation, while design jury is the assessment tool to evaluate the design product. Students are not only anticipated to comprehend new concepts, but also they are obligated to accomplish at least two tasks simultaneously "to design and to learn to design". On the other hand, students should learn how to present and defend their design concept graphically and verbally on the top of that, they shall know how to form trust and commitment relationship with their studio instructors.

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 and Seymour 2008). Integrating sustainability into architectural design studio is an urgent need to produce an architect who will be able to design sustainable building and stopping the deterioration of our planet.
Sustainability is the fulfilling the needs of the present generation without compromising the ability of future generations to fulfill their own needs.
The social change reflected on the architect role where architects are no longer seen with the same reverence that they have had in last half-century. Now days, the built environment is a huge forces that inform the final product. Architects can no longer keep believing that building form is that answer. Architects has to change naturally to be better facilitators, collaborators, negotiators, and more participatory in order to have a future. People looking for a team to work with, and if we are not changing ourselves, that may not include architect. (Chris Livingston, 2013)

Project description

There is an ongoing debate among the architectural profession regarding the location of the architectural education institute. Shall it be in suburban or urban location? The view of having the architectural education in urban area claims that will help architectural students to have better sense of urban fabric and context. In addition, it makes the students able to observe, understand and analysis the city movement, charac
ter and problems in order to come with responsible design solution. Responding to the above statement, Student were asked to design Sustainable Building of Architectural Department of IYTE in the heart of down town Izmir at Alsancak. There are two sites locations. Each site has its own properties that the students studied, understood, and analysis carefully to choose one of them for their project location.

Studio work structure

Sustainable design studio had different structure format this semester in order to achieve its goals. The focus was on design process during the 14 weeks semester not on the finished project. The major change was to minimize one-on-one desk critiques hours and focus on group work, discussion, and learn it by teaching someone else.
1-Lectures by the class instructors on weekly bases about design and sustainability (12 lectures)
2-Lectures by outside visitors in and out of studio (9 lectures)
3-Case studies prepared and presented by the students (24 case studies one for each student)
4-Work heavily on physical models
5-Three days Istanbul trip visiting sustainable buildings.
6-Charrette design assignments
7-Workshops in and out of studio(4 workshops)
8-In and out studio assignments (4 graded assignments)
9-Group panel review (4 reviews)
10-System details and construction materials
11-Use of simulation software to test building energy consumption.
12-Three midterm juries (graded juries)

SUSTAINABLE DESIGN OF ARCHITECTURAL DEPARTMENT BUILDING - IYTE, ALSANCAK

Architectural Program

1	**Educational Spaces**	Sq. m.	
1.1	(4) undergraduate design studios (50 students each)	1000	
1.2	One graduate design studio (25 students)	150	
1.3	(4) class rooms (50 students each)	300	
1.4	(2) class rooms (30 students each)	90	
1.5	(2) computer labs (50 students each)	150	
1.6	Lockers, storage, and shelves spaces	50	
1.7	Printer and copy space	20	
	Subtotal	**1760**	
2	**Library Spaces**		
2.1	Book stacks space	100	
2.2	Reading spaces (seats 50 person)	100	
2.3	Visual media room	50	
2.4	(2) group study rooms	50	
2.5	Info. Desk area	10	
2.6	Press production office	40	
2.7	Storage	20	
	Subtotal	**370**	
3	**Conference and seminar spaces**		
3.1	Conference hall (400 persons)	600	
3.2	Foyer	100	
3.3	Backstage (dressing, undressing, storage)	100	
3.2	Seminar room (100 persons)	150	
	Subtotal	**950**	
4	**Workshop spaces**		
4.1	Model making lab	80	
4.2	Building physics lab	60	
4.3	Building science lab	60	
4.4	Wood work lab	100	
	Subtotal	**300**	
5	**Administrative spaces**		
5.1	Dept. head office	40	
5.2	(2) Dept. head assist. Offices	40	
5.3	Dept. secretary office (2 persons)	20	
5.4	Students registration office (2 persons)	20	
5.5	Academic members offices (20 members)	300	
5.6	Academic assistants offices (20 members)	200	
5.7	(3) meeting rooms (one big and 2 small)	70	
	Subtotal	**690**	
6	**Entrance** (includes entrance hall, waiting area, and info area)	50	
	Subtotal	**50**	
7	**Food and social spaces**		
7.1	Kitchen and serving area	120	
7.2	Refreshments, snacks, and cold sandwiches area	30	
7.3	Indoor dining with seating spaces for 200 persons (it may include lavabo rooms)	300	
7.4	Indoor dining with seating space for 50 persons of academics, admin., and visitors (it may include lavabo rooms)	100	
7.5	Game and media spaces	50	
7.6	Outdoor dining spaces (open and semi-open) at least equal to indoor spaces	As needed	
	Subtotal	**600**	
8	**Exhibit and display spaces**		
8.1	Indoor exhibit spaces	200	
8.2	Outdoor exhibit spaces	As needed	
	Subtotal	**200**	
9	**Services**		
9.1	Restrooms as need it (men, women, and handicapped)	400	
9.2	Changing rooms (men, women, and handicapped)	50	
9.3	Mechanical rooms (power room, phone, internet, heating and cooling)	100	
9.4	Sanctuary	300	
9.5	Minimum one housekeeping room per level. (10 m2 each)	50 (Approx.)	
9.6	Indoor car parking for 20 cars	500	
9.7	Bike racks for 200 Bicycles	150	
9.8	Bookstore	150	
9.9	Recycle and composting room	50	
9.10	Rain water storage (to be calculated by the students)	As needed	
	Subtotal	**1750**	
10	**Outdoor spaces (open and semi-open)**	**As needed**	
10.1	Sport activities (basketball, tennis, et.)	As needed	
10.2	Urban forum	As needed	
10.3	Outdoor car parking for 5 cars and one bus		
	Total		**6670**
11	**Circulations**		
	Staircases, elevators, corridors, etc. 10% of total project area.	667	
	Grand Total		**7337**
12	**Space to be provided individually**		
	Each individual student **should** add up to 5% to 10% of the total project enclosed area to the project. Students shall explain the need for extra space according to each individual concept and scenario.	366 – 733	
	Grand total with optional	**7703 to 8070 Sq. m.**	
13	**Project must be handicap accessible indoor and outdoor**		

APPENDIX G

SADS spring 2015 – final jury's requirements

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department

AR 302: Architectural Design IV - Section-2 **Spring 2015**

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED

T.A. Mümine GERÇE

Final jury submission requirements

- All poster must be A0 size and it has to be posted on the gray carton with clips at the day of submission.
- Each students 30 minutes of presentation time, 15 minutes to speak and 15 minutes to answer juries' questions and listen to their comments.
- Submission will be on Tuesday of 2nd of June from 14:00 – 17:00 at our studio.
- First late submission will be until Wednesday 3rd of June at 10:00 am with half letter grade deduction, last late submission will be on Wednesday 3rd of June from 10:00 to 14:00 on Wednesday with full letter grade deduction and no jury presentation.

Requirements

1- One A4 size text page in English describing you project (site analysis, concept, sustainability strategy, etc.). Once someone read this page would understand your project without you. Do not use this page to read from during your jury.

2- Detail Model 1/200 showing your building façade (opening and materials) and landscape work. The model should be openable to see each floor and the internal spaces relations. Underground floors areas should be in a separated model. Make sure your model base fit into the site model.

3- Conceptual drawings representing your project concept and idea. That may include sketches, diagrams, photos from the site or somewhere else, etc.

4- Site plan 1/500, representing mass location, site landscape, open car parking, close car's parking ramp, and adjacent building. Give sun shadow to your building. You may show the sun path and wind direction on it. North arrow should be up.

5- Foot print of the building mass in the site with surrounding buildings at June 21 (at 7:00, 12:00, and 18:00) and at December 21 (at 8:00, 12:00, and 16:00).

6- All Floor plans (not diagram) 1/200 showing spaces of the project program location and main service area and main approach entry/entries of the building. You must show structure system (structure elements and axes), door, and windows. Ground floor should show all project site and adjacent streets and buildings. All floor plans should have the north arrow up. You may use color. All plans should have furniture. If you have any technical issue of how to draw any part of your floor plans, you need to ask us. (car ramp, handicap restroom 1 for 50, elevators, stairs, fire stairs, exit doors, two doors for room of 50 or more)

7- Minimum of three sections (not diagrams) 1/200 representing your space relations, natural light strategy, solar gain, and air movement strategy (summer / winter strategy). Be careful about the location of your section line. Please show the adjacent buildings on your section. If you have any technical issue of how to draw any part of your section, you need to ask us.

8- Minimum of two elevation (one of them has to be the main building entry elevation) 1/200.

9- One silhouette 1/500 including your building and surrounding from site analysis file that was prepared by Eric.

10- Minimum of two 3D drawings, one showing the best internal space in your project (court, gallery, studio, etc.), the second showing the exterior part of your building.

11- Use group 3D model to show your building in it.

12- System detail section scale 1/20 at the most important part of your façade. The section should start from your underground floor level to the roof level of your building.

13- From simulation by Revit, Diagrams: Sun shading detail, ventilation, solar gain (sun angles), natural lighting, material selection, waste, water and transportation strategy, heating and cooling strategy, annual energy consumption.

- Please use colors, heavy lines under sections and elevations (but without exaggeration) and clear presentation materials to express your project.
- You are free to use any materials or techniques to present your project's idea.
- You need to check your project against the sustainability checklist requirements to make sure your project include every things
- Make sure that your project include all program space elements and you are within the required meter square space.
- Those who will use video media to present their project, the video should not be very long (2 to 3 minutes) and all video should be installed on one laptop and ready from early morning. One person shall be next to the laptop to run the video for all class.

Final energy test submission:

1. Annual energy consumption (heating, cooling, lighting, electrical appliances included) per m^2 for all building & Annual CO_2 release per m^2 for all building
2. Excel graphic for total monthly energy consumption
3. Excel graphic for energy consumption for heating, cooling and lighting, and electrical appliance for all building.
4. Excel graphic for energy consumption per fuel (electricity, gas, oil)
5. Comparative study: possible comparisons based on annual or seasonal **energy consumption**:
    a. Material comparison: **energy consumption** with conventional and your material selection (solid surface and/or openings)
    b. Shading comparison: **energy consumption** without shading and with shading
    c. Orientation comparison: **energy consumption** of spaces facing North and South per m^2
    d. Double skin comparison: **energy consumption** without double-skin and with double-skin

APPENDIX H

SADS spring 2015 – sustainability checklist elements

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 302: Architectural Design IV - Section-2 Spring 2015

Sustainability Check List

Sustainable architecture is architecture that seeks to minimize the negative environmental impact of buildings by efficiency and moderation in the use of **materials, energy, and development space**.

1- Energy

Due to Izmir whether, it is preferable to work on two energy strategies one for summer and one for winter. However, it is up to each individual student explaining how the designed project will reduce energy consumption.

a. Reducing the energy used for lighting
   i. At least 80% of spaces benefits from natural light
   ii. Elements such as sky-gardens, skylights, atriums, light shelves are used to increase natural light
b. Reducing the energy used for ventilation
   i. All spaces benefit from adjustable windows, air-holes
   ii. Any natural ventilation opportunities facilitated by channels (wind catcher, etc.)
c. Reducing energy used for heating and cooling
   i. In order to reduce heating loads (high insulation glass system (low-e glass), double-wall application, double skin facades)
   ii. In order to reduce cooling loads (sunshades, movable blinds between glass layers, etc.)
   iii. Passive recovery to reduce heating and cooling loads (thermal mass, etc.)
d. Use of renewable energy sources
   i. Low emission but non-renewable energy sources
   ii. Renewable energy sources like sun, and wind.

2- Materials

a. Flexible design of interior space and interior furniture
b. Use of eco-friendly material and equipment.
c. Reducing waste

3- Water

a. Recollection and reuse of water
   i. Grey water and rain water is stored in the building, filtered and reused reservoirs and garden irrigation.
b. The use of rain water in interior and exterior space to reduce the cooling load during summer.
c. The use of water in landscape to enhance the natural light in the building.

4- Health

a. Natural light and fresh air for working area.
b. Indoor glare effect control by using façade's solar shading.
c. Eco friendly transportation to the site (bicycles, electric cars, etc.)
d. Selection of non-harmful materials.

APPENDIX I

SADS spring 2015 – questionnaire form

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 302: Architectural Design IV - Section-2 Spring 2015

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED
T.A. Mümine GERÇE

Questionnaire form for integrating sustainability into design studio

1- Did you have information about sustainable architectural design before this design studio?
   a. No
   b. Yes .... How? ....

2- Did you attend any related course(s) about the technical aspects of sustainable architectural design before this design studio?
   a. No
   b. Yes How many course(s)? ....
   What about? ....

3- Design studio pedagogy structure included many elements during the semester. Would you put these elements in order, the most beneficial to your design project process first and the least at last.
   a. Physical models
   b. Site analysis
   c. Lectures by ınstructors
   d. Case studies
   e. Site trip
   f. Technical trip visiting sustainable building
   g. Lectures by expert visitors
   h. Panel reviews
   i. Midterm juries
   j. Desk critiques
   k. Assignments
   l. Use of digital media

4- Will you practice sustainable design in your profession in the future?
   a. No
   b. Yes

5- If you will continue your graduate study in the future, would you chose an architecture environmental subject such as sustainable design, ecological design, energy saving design, etc. as your study topic?
   a. No
   b. Yes

Page 1

6- What are the difficulties for designing a sustainable building in the design studio course?

7- Can you make an order of what you considered the most important to least important in your design in this semester?

   a. Natural light
   b. Eco friendly materials
   c. Natural ventilation
   d. Shading elements
   e. Renewable energy sources
   f. Use of thermal mass
   g. Rain water uses
   h. Eco friendly transportation to the site (bicycles, electric cars, etc.)

8- Please write your personal comments about the sustainable design studio spring of 2015

Page 2

APPENDIX J

IYTE on-line evaluation form

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE
Architectural Department

AR 302: Architectural Design IV **Spring 2015**
Course Type: Core
Instructor: Kamal Eldin Mohamed

On-Line Evaluation Form

1) Do you believe that you are working enough in this lesson?
2) Were the content of the class, expectations of the students' work, and the class objectives were announced at the beginning of the semester?
3) Were subjects processed according to the content of the course?
4) Was the lecturer on time and ready?
5) Did the lecturer present the course topics in an understandable way, with effective examples?
6) Did the lecturer give opportunity to the discussion environment?
7) Did the lecturer devote time to student activities outside of class hours?
8) Did the lecturer give the class in English?
9) Were homework, projects, and practices influential and understandable?
10) Were the examinations accurately measured the content and skills taught?
11) Would I recommend this course to other students?

APPENDIX K

SADS fall 2015 – syllabus

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 301: Architectural Design III - Section-2 Fall 2015
Monday 8:45-12:30 & 1:30-5:15 – Thursday 8:45-12:30
Building B – Room 202

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED
T.A. Mümine GERÇE

Design studio

AR 301 is the third architectural design studio of the architectural curriculum at IYTE. It is the first step toward architecture profession career. You are expected to bring together a variety of knowledge areas that you have acquired during your previous two years of education.

Studio objective and theme

The studio general out frame theme is concerning global climate change and sustainable design. The design project would include proposing an urban analytic approach, configuring the building program and concept parallel to the urban analytic studies, integrating building construction systems with spatial configurations, using multi-media tools to test and express design ideas through diagrams and collages.

Design topics

1- Site analysis (local climate, urban fabric, movement and activities, site context, etc.) relation to develop innovative project concept, form the building mass, and create program scenario.
2- Sustainable design approach considering (mass form and orientation, natural light, natural ventilation, material choice, landscaping, heating-cooling strategies, etc.)
3- Translate the project programmatic elements to spatial configurations
4- Public/semi-private/private spaces and its contribution to sustainable design approach.
5- Structural solutions in relation to building mass (system and material).
6- Circulation patterns (vertical and horizontal) and its integration with building structure systems.
7- The use of multi-media as design test tools (Ecotect, and Climate consultant) and graphic communication (Sketchup, Revit, etc.)
8- Minimum code requirements (handicap accessibility, height limits, etc.)
9- Materials choice and applications.
10- Workshop by outside visitors.

Bear in mind that design is an iterative process. You may have to revisit earlier steps frequently

Course Requirements

The primary teaching method of this studio will be **desk critiques** by the instructors, together with **panel reviews** and short **presentations** of supporting material. To obtain maximum benefit from the desk critiques, students must be prepared for each class with sufficient work and be ready to discuss their design work.

There will be regular **in-class assignments** during the semester. During the project development phase, there will three **(3)** midterms reviews. You must present your work at least in two **(2)** of the midterm reviews to pass the class. You have to get a passing grade (at least 60 out 100) from your final project submission to pass the class.

Each student is required to keep a logbook through the semester keep a record of the design process.

You are also required to turn in a portfolio at the end of the semester summarizing and highlighting your progress during the semester.

Attendance

Attendance to class is mandatory. Students should better not be absent at any class hours without an acceptable excuse.

More than six **(6)** absences (that include sick absences) will result in forced withdrawal with final grade (NA). For attendance purposes, Mondays will count as two classes and Thursdays will count as one class.

Grading

The grades will be determined based on the quality of students' work throughout the semester. The following list summarizes the percentages assigned to each studio phase during the semester and to additional required items:

1. *Attendance*	5%
2. Assignments and quizzes	5%
3. *Group work (site analysis, and model)*	*5%*
4. Case study	*5%*
5. *Three midterm reviews*	*15%*
6. *Final project*	60%
7. *Portfolio*	5%

Communication

All announcements for this class and class materials and documents will be made available through CMS. Students are responsible for all communication made by the instructors through CMS.

Trips

1- Site visit to Izmir
2- Three days trip inside Turkey (Istanbul)

Important

YOU ARE REQUIRED TO HAVE A CONSTANT AND REGULAR CONTACT WITH STUDIO INSTRUCTORS THROUGHOUT THE SEMESTER. YOUR PROJECT DEVELOPMENT WILL BE AN INTERACTIVE PROCESS IN CLOSE COLLABORATION WITH THE INSTRUCTORS.

APPENDIX L

SADS fall 2015 – project program description

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 301: Architectural Design III - Section-2 Fall 2015

Project description

Bornova district is located in the heart of Izmir city. European/Levantine merchants and foreign consuls favored Bornova very early on to flee the hot summer weather in central Izmir to seek the cooler breeze of the slopes of the Mount "Yamanlar" at a distance of about five kilometers inland starting from the tip of the Gulf of İzmir. Bornova today has various ethnic typology (migrants from Bulgaria, Yugoslav, Bosnian, Albanian, etc.). The population majority of Bornova are youth under the age of 25. Furthermore, Bornova has three major universities; Ege, Yasar, and Şifa.

Bornova Municipality has two culture centers serving the Bornova population but it does neither respond to the residents needs nor to the population typology, which bring the urgent need to design a new Bornova Municipality culture center.

In the near future, Bornova municipality will open an architecture design competition for its new Culture center. This center shall represent Bornova population typology, invite young generation, and welcome all Izmir city activities. The building shall respond to the context of its location with a sustainable concept design.

The location of the project in Bornova Evka 3 neighborhood as is shows in the provided maps. Total land area is 9473 m2, with total construction are (KAKS 0.8) of 7570 m2 and TAKS is 1.0, and 5m set back all around the site.

As a third years architecture student you are requested to respond to the above statements providing a creative and innovative solution idea. There are two sites locations. Each site has its own properties that you need to study, understand and analysis carefully before you choose one of them for you project location.

Please refer to the class syllabus for design requirements and considerations. All other design limitations will be explained during the studio work.

Architectural Program

1	**Concerts, Conference, and seminar spaces**	Sq. m.	Sq. m.
1.1	Concerts, Conference hall (400 persons) (one hall or portable halls with 360 degree theater)	600	
1.2	Cocktail lounges that can be given after various events	150	
1.3	Foyer	100	
1.4	Backstage (dressing, undressing, storage)	100	
	Subtotal	**950**	
2	**Art activities courses**		
2.1	(4) Paint – sculpture – handmade materials – etc. (25 students each)	260	
2.2	(2) Music – dance – etc. (15 students)	100	
2.3	(4) Courses spaces (ethnic arts – labs - etc.) (25 students each)	200	
2.4	Library space (books – digital – etc.)	150	
2.5	Lockers, storage, and shelves spaces	20	
***	Class rooms shall be flexible design to be converted to bigger seminars rooms and small theater		
	Subtotal	**730**	
3	**Youth and University students activities**		
3.1	Sport activities spaces (light type of sports – sole sport – etc.)	150	
3.2	A creative idea of workshop space for youth gathering (politics – exhibit – etc.)	150	
	Subtotal	**300**	
4	**Technology spaces**		
4.1	Modern arts – digital arts– five senses – etc.	300	
	Subtotal	**300**	

5	**Production spaces**		
5.1	People production exhibit and selling area	150	
5.2	Bornova municipality production	100	
2.3	Service and storage space	30	
	Subtotal	**280**	
6	**Administrative spaces**		
6.1	Center head manager space	40	
6.2	(2) Manager assistants spaces	30	
6.3	Office spaces (8 persons)	60	
6.4	Instructors spaces (8 persons)	60	
6.5	Meeting space – break space – storage area	50	
	Subtotal	**240**	
6	**Entrance**		
6.1	Building entrance space (includes entrance hall, waiting area, and info area)	200	
	Subtotal	**200**	
7	**Food and social spaces**		
7.1	Kitchenette, serving, and storage area	50	
7.2	Refreshments, snacks, and cold sandwiches area with seating space	200	
7.3	Lavabo space	30	
7.4	Hourly child care space	30	
7.5	Outdoor refreshments, snacks, and cold sandwiches area spaces (open and semi-open) at least equal to indoor spaces	As needed	
	Subtotal	**310**	
8	**Exhibit and display spaces**		
8.1	Indoor exhibit spaces	300	
8.2	Outdoor exhibit spaces	As needed	
	Subtotal	**300**	
	Project total area		**3660**
9	**Services**		
9.1	Restrooms as need it (men, women, and handicapped)	200	
9.3	Mechanical rooms (power room, phone, internet, heating and cooling)	100	
9.4	Sanctuary	300	
9.5	Minimum one housekeeping room per level. (10 m2 each)	40 (Approx.)	
9.6	Indoor car parking for 20 electrical cars	500	
9.7	Bike racks for 200 Bicycles	150	
9.8	Recycle and composting room	50	
9.9	Rain water storage (to be calculated by the students)	As needed	
	Subtotal	**1340**	
10	**Outdoor spaces (open and semi-open)**	**As needed**	
10.1	Sport activities (child playground, basketball, tennis, running, etc.)	As needed	
10.2	Urban forum	As needed	
10.3	Outdoor car parking for 5 cars and one bus		
	Total		**5000**
11	**Circulations**		
11.1	Staircases, elevators, ramps, corridors, etc. 10% of total project area.	500	
	Subtotal	**500**	
	Grand Total		**5500**
12	**Project must be handicap accessible indoor and outdoor, and fire scape protected**		

Page 2

APPENDIX M

SADS fall 2015 – semester calendar

IZMIR INSTITUTE OF TECHNOLOGY

FACULTY OF ARCHITECTURE - Architectural Department
AR 301: Architectural Design III - Section-2 **Fall 2015**
Monday 8:45-12:30 & 1:30-5:15 – Thursday 8:45-12:30
Building B – Room 202

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED
T.A. Mümine GERÇES

Week No	Day/Date	Time Periods	Activity	Homework
1	Th. 01.10.15	**Intro**	• Introduction to the class and syllabus handout • **Case study assignment handout 13 and 13 sustainable projects (5%)** • Introduction to the project • Sites' models assignment 1/200 & Site analysis group work • Introduction to the sustainable design ***(lecture-1)***	Group Site analysis Group model work Survey work Individual case study
2	M. 05.10.15	**Conceptual idea (four weeks)**	• Project program discussion & site model group work progress • Case study presentations ***(2 cases)*** • Environmental sustainability ***(lecture-2)*** • ***Technical trip to the project's site and existing youth social centers in Bornova. (presentation by Bornova municipality members, interviews by the students to existing users)***	Individual case study
	Th. 08.10.15		• Draft presentation of group work of site analysis • Draft project program assignment (by group of eight students), followed by class discussion. Site model progress • Case study presentations ***(2 cases)*** • Intro to sustainable design principles "history and background" ***(lecture-3)***	Draft of project program (by group of two students)
3	M. 12.10.15		• **Groups final presentation of site analysis and class discussion (5%)** • Case study presentations ***(6 cases)*** - Site model submission and discussion • Sustainability principles; site issues "prevailing wind, sun path, daylight, geometry, plan depth and roof types" ***(lecture-4)***	Individual site analysis Mass model exploration
	Th. 15.10.15		• Project program handout and discussion - Case study presentation ***(4 cases)*** • Sustainability principles; "solar gain, shading elements, façade design considerations" ***(lecture 5)*** • Homework assignment "mass model exploration" ***(Assignment 1)***	Mass model exploration
4	F. to M. 16-19.10.15		• **Three days technical trip (Istanbul)** ○ Erka Yeşil Academy ○ Kozyatağı kültür merkezi and Meclis binasi ○ Piri Reis University & Deniz müzesi ○ Kumbaracı 50 Yalınayak Müzikhol & Zorlu merkezi ○ Küçükçekmece Belediyesi Binası & The Seed Sababcı	Group presentation of each site of the technical trip ***(Assignment 2)***
	Th. 22.10.15		• Individual site analysis & mass model ***(panel review discussion)*** • Individual program analysis and concept's idea **(panel review)** • Mass model exploration **(panel review)** • Program analysis progress & plans and sections diagrams **(desk critic)**	Handout first midterm jury requirements
5	M. 26.10.15		• **First midterm jury review (%5)**	
	Th. 29.10.15		• First midterm jury discussion and grade announcement • Role-play review by students • Sustainability principles presentation related to building context "natural and mechanical ventilation" ***(lecture 6)***	***(Assignment 3)***
6	M. 02.11.15	**Project development**	• Case study presentation ***(6 cases)*** • Introduction to BIM and various simulation software ***(lecture 7)*** • Floor plans and sections development **(desk critic)**	***(Assignment 4)***
	Th. 05.11.15		• Case study presentation ***(4 cases)*** • Floor plans and sections development **(desk critic)**	
7	M 09.11.15		• Floor plans and sections development **(desk critic)** • Sustainability and mechanical issues in building ***(guest Lecturer 1)***	Natural light in building

	Th. 12.11.15		• Floor plans and sections development **(desk critic)** • Sustainability and natural light ***(guest Lecturer 2)*** • Natural light in building workshop ***(guest workshop 1)***	poster (1) ***(Assignment 5)***
8	M. 16.11.15		• Floor plans and sections development **(desk critic)** • Revit & DesignBuilder in energy conception in building ***(lecture 8)*** • Panel review discussion	
	Th. 19.11.15		• Floor plans and sections development **(desk critic)** • Charrette assignment. ***(Assignment 6) &*** panel review discussion • Revit & DesignBuilder in energy conception in building ***(lecture 9)***	
9	M. 23.11.15		• Floor plans and sections development **(desk critic)** • Charrette assignment. ***(Assignment 7) &*** panel review discussion • Energy simulation with building materials assigned ***(lecture 10)***	Handout second midterm jury requirements
	Th. 26.11.15		• Floor plans and sections development **(desk critic)** • Charrette assignment. ***(Assignment 8) &*** panel review discussion	
10	M. 30.11.15	**Materials and testing (four weeks)**	• **Second midterm jury review (5%)**	Sustainable materials poster (2)
	Th. 03.12.15		• Second midterm jury discussion and grade announcement • Façade design and materials **(desk critic)**	
11	M. 07.12.15		• Sustainable materials presentation ***(guest Lecturer 3)*** • Sustainable materials workshop ***(guest workshop 2)*** • Façade and shading elements panel review discussion	
	Th. 10.12.15		• Plans, sections, and mass refinement with façade design and materials **(desk and group critic)**	
12	M. 14.12.15		• Façade and shading elements ***(guest Lecturer 4)*** • Plans, sections, and mass refinement with façade design and materials **(desk and group critic)** • Construction materials in system detail drawing ***(lecture 11)***	
	Th. 17.12.15		• Plans, sections, and mass refinement with façade design and materials **(desk and group critic)**	
13	M. 04 21.12.15		• Plans, sections, and mass refinement with façade design and materials (desk critic) • Architecture project presentation techniques with examples of architecture competition projects ***(lecture 12)*** • Site and landscape consideration - Review energy simulation results	Handout third midterm jury requirements
	Th. 24.12.15		• Plans, sections, and mass refinement with façade design and materials (desk critic) • Review energy simulation results	
14	M. 28.12.15	**Finishing and presentation (two weeks)**	• **Third midterm jury review (5%)**	
	Th. 31.12.15		• Third midterm jury discussion and grade announcement • Students-led review	
15	M. 04.01.16		• Final jury presentation technique ***(lecture 13)*** • Final desk critic & Models techniques • Review energy simulation results - Final portfolio requirements	Handout Final jury requirements
	Th. 07.01.16		• Final presentation drawing's week	
16	Tu. 12.01.16		• Final Jury submission (drawings and models)	
	Wed. 13.01.16		• Final jury presentations 60%	
17	Wed. 20.01.16		• Final jury grade announcement 60%	
	Th. 21.01.16		• Portfolio submission 5% • Open colloquium meeting for class discussion	

Page 2

APPENDIX N

SADS fall 2015 – case studies

AR 301: Architectural Design III **Fall 2015**
<u>Section - 2</u>

Case Studies

Sustainable case study buildings

1. Erke Building, Istanbul, Turkey
2. Visitor Centre at the Swiss Ornithological Institute / mlzd, Switzerland
3. Kauffnan Center- Moshe Safdie, Kansas City, MO, USA
4. Phoenix Valley- Studio 505, Wujin, Changzhou, Jiangsu, China.
5. Culture Forest- Unsagdong Architects, SeongDong-gu, Republic of Korea.
6. Machynileth Building: Education Centre Development Wales, by David Lea and Pat Borer, Wales, UK.
7. Between Intuition and Pragmatism: Peter Clegg on Holistic Sustainability
8. Brooklyn Botanic Garden Visitor Center / Weiss / Manfredi
9. Knox Innovation Opportunity and Sustainability Centre / Woods Bagot
10. Vincent Callebaut Proposes "Wooden Orchids" Green Shopping Center for China
11. Perez Art Museum / Herzog & de Meuron, Miami, FL, USA.
12. Library and Concert Hall in Bodø, Norway by DRDH
13. Library Delft University of Technology, Mecanoo, Delft, Netherlands.

Your Presentation shall answer the following questions:

a. Sustainable design approach
b. Mass strategy in relation to
i. Site context
ii. Building orientation (sun, wind, etc.)
iii. Natural ventilation
iv. Natural light and shading
c. Structure system
d. Materials
e. Open semi-open space
f. Any sustainable design elements

Culture centers case study buildings

1. MuuM Designs Mountain-Inspired Cultural Center in Turkey
2. NL Architects Chosen to Design Arnhem's ArtA Center, Amsterdam, Netherland.
3. AD Classics: Centre Culturel Jean-Marie Tjibaou / Renzo Piano,
4. National Center for Civil and Human Rights / The Freelon Group (Now part of Perkins+Will) + HOK, Atlanta, USA
5. Montforthaus in Feldkirch / HASCHER JEHLE Architektur + mitiska wäger architekten, Feldkirch, Austria
6. Changzhou Culture Center / gmp Architekten,
7. Raif Dinçkök Yalova Cultural Center / Emre Arolat Architects, Yalova, Turkey.
8. China Pavilion - Milan Expo 2015 / Tsinghua University + Studio Link-Arc, Italy.
9. Italy Pavilion – Milan Expo 2015 / Nemesi, Milano, Italy.
10. Miguel Delibes Space / Rafael de La-Hoz, Madrid, Spain.
11. Salburua Civic Center / ACXT, Gonzalo Carro, Araba, Spain.
12. Stedelijk Museum Amsterdam / Benthem Crouwel Architects.
13. Cultural Centre in Madrid by Rafael de La-Hoz.
14. School Of Music In Lisbon / João Luís Carrilho da Graça.

Extra

15. Culture Yard- AART Architects, Denmark
16. Cultural Centre on the Azores, Menos é Mais Arquitectos Associados
17. Cathedral of Créteil Extension / Architecture-Studio, Paris, France.
18. Kulturzentrum Ischgl / Parc Architekten, Ischgl, Austria
19. Minsheng Contemporary Art Museum / Studio Pei-Zhu
20. Culture Yard- AART Architects, Denmark
21. Brussels Environment / architectenbureau cepezed, Brussel, Belgium.
22. John M. Harper Branch Library & Stork Family YMCA / Teeple Architects, Waterloo, Canada
23. La Enseñanza School Auditorium / OPUS + MEJÍA, Medellín, Antioquia, Colombia
24. Vershina Trade and Entertainment Center- Erick Van Egeraat,
25. Kodály Centre / Építész Stúdió, Pecs, Hungary.
26. La Quintaine / atelier d'architecture King Kong, Chasseneuil-du-Poitou, France.

Your Presentation shall answer the following questions:

a. Main design idea
b. Mass strategy in relation to
i. Site context
ii. Project program
iii. Plan and sections
iv. Climate consideration
c. Special spaces such as (courses spaces, conference hall, food area, etc.)
d. Structure system
e. Materials
f. Open and semi open – public and private
g. Circulation and service area

APPENDIX O

SADS fall 2015 – final jury requirements

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department

AR 301: Architectural Design III - Section-2 **Fall 2015**

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED

T.A. Mümine GERÇE

Final submission requirements

- All poster must be (A0) size and it has to be posted on the gray carton (5 mm thick) with clips at the day of submission.
- Each students has 15 minutes of presentation time, 5 minutes to speak and 10 minutes to answer juries' questions and listen to their comments.
- Submission will be on Wednesday 13th of January from 14:00 – 16:30 at our studio.
- Our studio need to be totally vacated by the students by 10:00 on Wednesday 13th of January.
- First late submission will be until Thursday 14th of January at 10:00 am with half letter grade deduction, last late submission will be on Thursday 14th of January from 10:00 to 14:00 on Thursday with full letter grade deduction and no jury presentation.

Submission requirements:

1- One A4 size text page in English describing you project (site analysis, concept, sustainability strategy, etc.). Once someone read this page would understand your project without you. Do not use this page to read from during your jury.

2- Detail Model 1/200 showing your building façade (opening and materials) and landscape work. The model should be openable showing each floor and the internal spaces relations. Underground floors areas maybe in a separated model. Make sure your model base fit into the site model. Please place existing trees in your site.

3- Conceptual drawings representing your project concept and idea. That may include sketches, diagrams, photos from the site or somewhere else, etc.

4- Site plan 1/500, representing mass location, site landscape, open car parking, close car's parking ramp, and adjacent building. Give sun shadow to your building. You may show the sun path and wind direction on it. North arrow should be up.

5- Solar footprint of the building mass in the site with surrounding buildings at June 21 (at 9:00, 12:00, and 16:00) and at December 21 (at 9:00, 12:00, and 16:00). Please make sure it is readable.

6- All Floor plans (not diagram) 1/200 showing spaces of the project program location and main service area and main approach entry/entries of the building. You must show structure system (structure elements and axes), door, windows, and leveling of each floor. Show section lines locations and numbers. Make sure all text are readable. Ground floor should show all project site and adjacent streets and buildings. All floor plans should have the north arrow up and placed at the same site plan orientation. You may use color and rendering. All plans should have furniture. If you have any technical issue of how to draw any part of your floor plans, you need to ask us. Make sure that car ramp, handicap restroom (1 for 50), elevators, stairs, fire stairs, exit doors, and two doors for room of 50 or more are shown in your floor plans.

7- Minimum of three sections (not diagrams) 1/200 representing your space relations, natural light strategy, solar gain, and air movement strategy (summer / winter strategy). You may use a perspective sections. Be careful about the location of your section line. Please show the adjacent and background buildings on your section. If you have any technical issue of how to draw any part of your section, you need to ask us.

8- Minimum of three elevations (one of them has to be the main building entry elevation) 1/200. Show adjacent and background building in very light tone.

9- One silhouette 1/500 including your building and surrounding from site analysis file that was prepared by Ecem and Funda.

10- Minimum of two 3D drawings, one showing the best internal space in your project (court, gallery, studio, etc.), the second showing the exterior part of your building, and the third location up to your choice.

11- Use group 3D model that was prepared by Omer's group to show your building in it.

12- System detail section scale 1/20 at the most important part of your façade. The section should start from your underground floor level to the roof level of your building.

13- From simulation by Revit, Diagrams: Sun shading detail, ventilation, solar gain (sun angles), natural lighting, material selection, waste, water and transportation strategy, heating and cooling strategy, annual energy consumption.

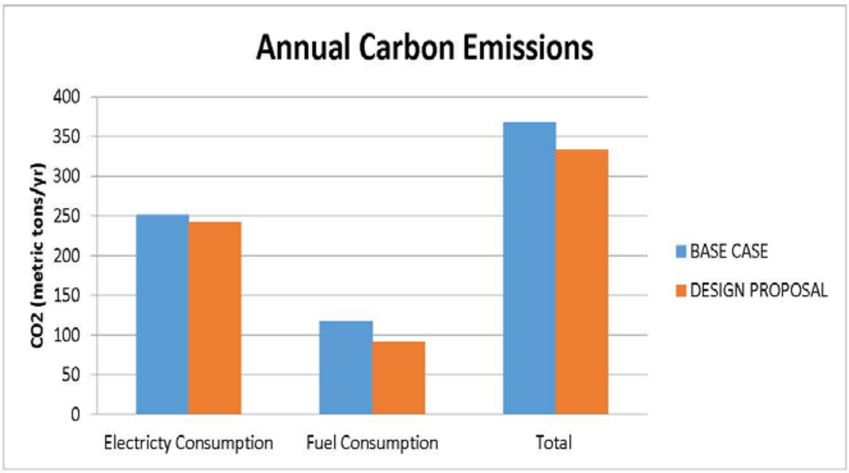
- Please use colors, heavy lines under sections and elevations (but without exaggeration) and clear presentation materials to express your project.
- You are free to use any materials or techniques to present your project's idea.
- You need to check your project against the sustainability checklist requirements to make sure your project include every things
- Make sure that your project include all program space elements and you are within the required meter square space.
- Those who will use video media to present their project, the video should not be very long (2 to 3 minutes) and all video should be installed on one laptop and ready from early morning. One person shall be next to the laptop to run the video for all class.

DATA FROM ENERGY SIMULATION THROUGH REVIT

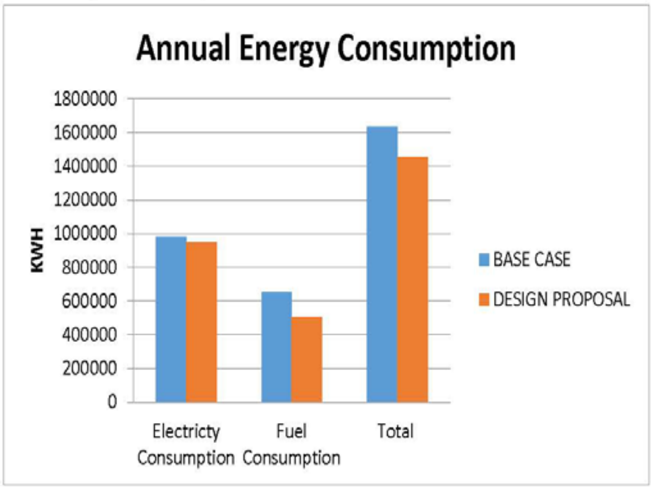
You will derive following information from your Revit model and simulation results:

1. LIST 1: U values representing base case Revit model
2. LIST 2: U values of each building component and their material selections based on your design from newer Revit model
3. Annual CO2 release per m2 for all building (look at the example excel file)

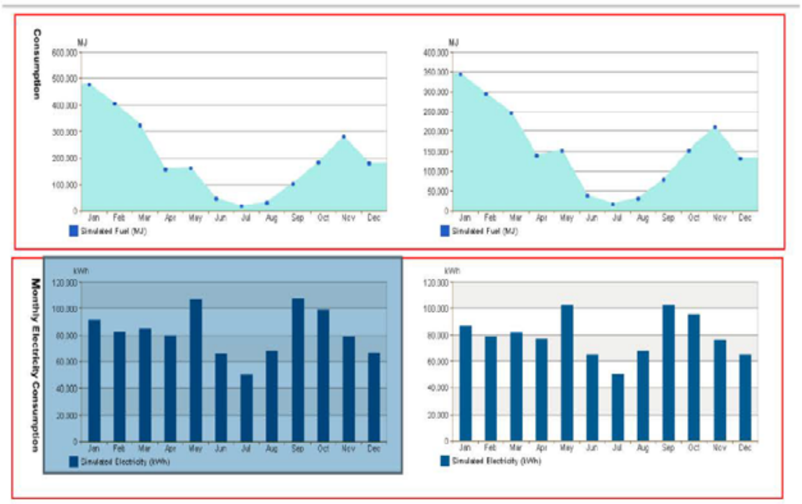
a.



4. Annual energy consumption (heating, cooling, lighting, electrical appliances included) per m2 for all building (look at the example excel file)

a. 

5. Excel graphic for total monthly energy consumption (look at REVIT simulation file for graphics)



6. Percentage of decrease for total fuel use (look at the example excel file)
   22% DECREASE IN TOTAL FUEL ENERGY CONSUMPTION
7. Percentage of decrease for total electricity use (look at the example excel file)
   22% DECREASE IN TOTAL ELECTRICAL ENERGY CONSUMPTION
8. **Comparative studies**: **which sustainable solutions are most effective or better than the others**
   Possible comparisons based on **energy consumption and CO2 emissions (explained as 1 and 2 graphs)**:
   a. Material comparison with conventional (base case) and your material selection (solid surface and/or openings)
   b. Shading comparison without shading and with shading (while you design materials assigned)
   c. Orientation comparison, if the total mass is shifted to East or West some degrees (5, 10, or, more according your design) (while you design materials assigned)
   d. Double skin comparison without double-skin façade and with double-skin (while you design materials assigned)

APPENDIX P

SADS spring 2016 – syllabus

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 301: Architectural Design IV - Section-2 Spring 2016
Monday 8:45-12:30 & 1:30-5:15 – Thursday 8:45-12:30
Building B – Room Z01

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED
T.A. Mümine GERÇE

Design studio

AR 302 is the fourth architectural design studio of the architectural curriculum at IYTE. It is the last architectural studio before your graduation project. It focuses mainly on housing design and its related subjects. Housing design may be the most common project type that you will deal with in your professional practice after your school life. You are expected to bring together a variety of knowledge areas that you have acquired during your previous undergraduate education. Throughout the semester, you will work individually without forgetting that you will also be part of a larger group of students and instructors thinking through the same problem. The studio environment will be more productive if it becomes a platform to **share ideas and questions**.

Studio theme

The studio general out frame theme is concerning sustainable design of large scale hosing environmentally, economically, and socially. Housing project required parallel design strategy: unite(s) design and building(s) mass design in order to achieve a successful project. Unit(s) design concern space comfort, natural light, natural ventilation, spatial relationships (privacy), furniture arrangements, spatial dimensions, etc. Building(s) mass design concern how individual units of different sizes are brought together, how privacy issues are addressed, and how spaces of different functions are inhabited, how housing projects relate to their immediate urban surroundings and how they could create public and semi-public urban spaces.

Studio objectives

At the end of the semester, each student is expected to develop an understanding of:
- Housing as one of the fundamental constituent of the urban fabric
- Levels of privacy and publicness
- Building orientation, site planning, and landscaping
- Section and plan development for a relatively complex architectural program
- Space occupancy
- Environmental, economical, and social factors under the sustainable umbrella concept

Design topics

1- Site analysis (local climate, urban fabric, movement and activities, site context, site topology, existing residents' ethnologies, etc.) relation to develop innovative project concept, form the building mass, and create program scenario.
2- Sustainable design approach considering
   a. Environment issues such as (mass form and orientation, natural light, natural ventilation, material choice, landscaping, heating-cooling strategies, etc.)
   b. Social issues
   c. Economic issues such as (material, module design, do it yourself approach, etc,)
3- Translate the project programmatic elements to spatial configurations.
4- Public/semi-private/private spaces and its contribution to sustainable design approach.
5- Structural solutions in relation to individual unites and total buildings mass (system and material).
6- Circulation patterns (vertical and horizontal) and its integration with building structure systems.
7- The use of multi-media as design test tools (Ecotect, and Climate consultant) and graphic communication (Sketchup, Revit, etc.)
8- Minimum code requirements (handicap accessibility, height limits, etc.)
9- Materials choice and applications.

10- Workshop by outside visitors.

Bear in mind that design is an iterative process. You may have to revisit earlier steps frequently. In addition, you will need to work with parallel design strategy.

Course Requirements

The primary teaching method of this studio will be **desk critiques** by the instructors, together with **panel reviews** and short **presentations** of supporting material. To obtain maximum benefit from the desk critiques, students must be prepared for each class with sufficient work and be ready to discuss their design work.
There will be regular **in-class assignments** during the semester. During the project development phase, there will three **(3)** midterms reviews. You must present your work at least in two **(2)** of the midterm reviews to pass the class. You have to get a passing grade (at least 60 out 100) from your final project submission to pass the class.
Each student is required to record his/her individual design process in a **logbook** size A4 or larger and submit this logbook for review with his/her portfolio. Sketches, observations, course notes, diagrams; images of study models, progress prints of drawings, and exploration of alternatives should all be included in the logbook.
You are also required to turn in a portfolio at the end of the semester summarizing and highlighting your progress during the semester.

Attendance

Attendance to class is mandatory. Students should better not be absent at any class hours without an acceptable excuse.
More than six **(6)** absences (that include sick absences) will result in forced withdrawal with final grade (NA). For attendance purposes, Mondays will count as two classes and Thursdays will count as one class.

Grading

The grades will be determined based on the quality of students' work throughout the semester. The following list summarizes the percentages assigned to each studio phase during the semester and to additional required items:

1.	*Attendance*	5%
2.	Assignments and quizzes	5%
3.	*Group work (site analysis, and model)*	*5%*
4.	*Case study*	*5%*
5.	*Three midterm reviews*	*15%*
6.	*Final project (50% design issues, 50% sustainability integration)*	60%
7.	*Portfolio*	5%

Communication

All announcements for this class and class materials and documents will be made available through CMS. Students are responsible for all communication made by the instructors through CMS.

Trips

1- Site visit to Izmir
2- In Izmir housing projects visit
3- Three days technical trip to Bodrum, Turkey

Important

YOU ARE REQUIRED TO HAVE A CONSTANT AND REGULAR CONTACT WITH STUDIO INSTRUCTORS THROUGHOUT THE SEMESTER. YOUR PROJECT DEVELOPMENT WILL BE AN INTERACTIVE PROCESS IN CLOSE COLLABORATION WITH THE INSTRUCTORS.

APPENDIX Q

SADS spring 2016 –project description

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 301: Architectural Design IV - Section-2 **Spring 2016**
Monday 8:45-12:30 & 1:30-5:15 – Thursday 8:45-12:30
Building B – Room Z01

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED
T.A. Mümine GERÇE

"We shape our buildings; thereafter they shape us."- Winston Churchill, 1944

"Our entire culture rest on the nature of our dwellings." - Alvar Aalto, 1957

Housing project

Introduction

One of the goal of any government is elevating the life standard of its people, achieving that require improving where people live. Izmir Municipality had determined to improve the housing quality at many existing old neighborhoods; one of these places is at Bayrakli.

Izmir Municipality developed an urban regeneration site plan of Bayrakli site. The developed design proposes more green area, better street locations, recreation places, and better service facilities. It proposes new locations of residential buildings where the base buildable allowed area is 50% of total giving land. The housing proposal is standard towers that have height range from 12 to 16 floors.

Problem description

The total area of Bayrakli housing site is about 400 Hectares. The semester's project site is about 4330 m^2, and located at the front west part of the main site. The site has various characters such as; very steep slope, wide front sea view on Izmir bay, mountain back view, etc. Since the total site has almost the same character, you shall consider your design is a prototype, which can be applied to the all site.

The housing market in Turkey roughly has three various models: The most famous one seem to be the gated communities, which is mostly developed around the cities. It is about building housing groups for upper middle class inhabitants that are built by the private sector in cities; gated communities provide a number of housing units with social activities such as sport, shopping, education, security systems etc. Surrounded by physical and visual barriers, gated communities define a high level of privacy and isolation from the urban life, with the self-contained social life they offer. The second model is based on the production of individual buildings scattered in different parts of the city. As a result of what is called the "build and sell concept" (yap-sat), based on a contract between land owners and small scale contractors, this model mostly offers small scale houses on a single parcel. The third model that has been witnessed widely in the last ten years is the "TOKİ konutları". It is housing developed by the Toplu Konut İdaresi (Mass Housing Administration) which is a governmental organization that plays the roles of investor, legislator and land provider founded in order to provide affordable housing for the low-to-medium income sectors of the Turkish population.

Izmir Municipality are planning to apply the second housing market model on Bayrakli site. There is a debate among many scholars arguing the failure of these three models. These three models failed to adopt the Turkish housing culture style, changed many of the family social activities, and did not consider traditional design space nor material wise.

Project theme

"Architectural design is the melting pot to all other disciplines combination with all of its knowledge and skills and design studio is the place of the special learning environment for it."- Bakarman 2003a

Considering the above introduction and problem statements, you are required to design housing project for specific number of units with its social activities, commercial services, and other facilities.

The design should consider the following:

1. Different housing design proposal from the above three existing models
2. Various traditional housing design in Turkey.
3. Maximum use of the site's existing characters.
4. Sustainability principals from all three aspects; environment, social, and economic.

Program

1. Housing

A. Units

Total of 60 units	
10 units 40 – 55 m^2	400 - 550 m^2
20 units 60 – 75 m^2	1200 - 1500 m^2
20 units 80 – 100 m^2	1600 - 2000 m^2
10 units 110 – 130 m^2	1100 - 1300 m^2
Total	**4300 - 5350 m^2**

The given meter square of each unit shall include the following:
Master bedroom (sleeping space) with bath, bedroom(s) (sleeping spaces), dining area, living area(s), bath(s), toilet, kitchen area, entry, storage and mechanical area. There is 10% plus or minus flexibility of the given area.
Terraces and balconies area (open and semi-open) **min. 10%**

B. Resident areas (buildings)

- Building circulation ...., 10% - 15% of ground floor resident area
  That includes stairs, fire stairs, elevators, ramps, corridors, etc.
- Building mechanical space .... Space depends on the chosen system
- Remote storage for each unit (min. 5 m^2 for each unit)
- Custodial space, Building manager office, and security office (if needed)

2. Commercial space

20% - 40% of the buildable footprint of the site **600 - 1200 m^2**

Small businesses such as: retail shops, Café, Restaurant, etc. serving the project residents and the surrounding community area

3. Social spaces

20% - 40% of the buildable footprint of the site **600 - 1200 m^2**

Multi-purpose space, sport space, social meeting space, children space, etc.

4. Off-street car parking

Car parking closed space for 50 cars and possibly some surface parking area serving the residents and fulfilling the minimum requirements by Izmir Municipality code. **1250 m^2**

5. Open space

As needed to serve your project main concept and idea.
It includes social activities, gardening area, playground for kids, various sport fields car rods, pedestrian ways, etc. Open space includes private and public spaces. In addition, it can be open or semi open with light structure.

6. Codes and limitations

- Setback for any structure is 5 meters all around the given site.
- TAKS is 0.5 of allowed buildable area.
- KAKS is free of any limitation.
- Allowed projection off any building behind the setback line is 1.5 meter.
- Project must be handicap accessible indoor and outdoor, and fire scape protected
- Please refer to the class syllabus for design requirements and considerations. All other design limitations will be explained during the studio work.

Ne yaparsan yap aşk ile yap
Whatever you do, do it with love

APPENDIX R

SADS spring 2016 – semester calendar

IZMIR INSTITUTE OF TECHNOLOGY

FACULTY OF ARCHITECTURE - Architectural Department
AR 302: Architectural Design IV - Section-2 **Spring 2016**
Monday 8:45-12:30 & 1:30-5:15 – Thursday 8:45-12:30
Building B – Room Z01

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED
T.A. Mümine GERÇE

Week No	Day/Date	Time Periods	Activity	Homework
1	M. 22.02.16	Conceptual idea (four weeks)	• Introduction to the class and syllabus handout • **Case study assignment handout 25 various projects (5%)** • Introduction to the project • Introduction to the sustainable design ***(lecture-1)*** • Sites' models 1/200 & 1/500 (two models) and site analysis group work • ***Technical trip to the project's site in Bayrakli, Izmir (1)***	Group Site analysis Group model work Individual case study
	Th. 25.02.16		• Draft presentation of group work of site analysis - site model work progress • Project program discussion • Case study presentations ***(3 cases)*** • Environmental, social, and economic sustainability ***(lecture-2)***	Draft of project program (by group of two students)
2	M. 29.02.16		• Intro to sustainable design principles "what it is, why, history and background" ***(lecture-3)*** • **Groups final presentation of site analysis and class discussion (5%)** • Draft project program assignment (by group of eight students), followed by class discussion. Site model progress. • Case study presentations ***(6 cases)***	Group model work
	Th. 03.03.16		• Site model submission and discussion • Sustainability principles; site issues "prevailing wind, sun path, daylight, geometry, plan depth and roof types" ***(lecture-4)*** • Project program handout and discussion • Case study presentation ***(3 cases)***	Individual site analysis Mass model exploration
3	M. 07.03.16		• Individual site analysis, concept's idea, and mass model ***(panel review)*** • Class assignment "mass model exploration" (charrette design) ***(Assignment 1)*** • Sustainability principles; "solar gain, shading elements, façade design considerations" ***(lecture 5)*** • Case study presentation ***(6 cases)***	Mass model exploration First design diagrams
	Th. 10.03.16		• Case study presentation ***(3 cases)*** • Program analysis progress & plans and sections diagrams ***(desk critic)*** • Sustainability principles presentation related to building context "natural and mechanical ventilation" ***(lecture 6)***	Handout first midterm jury requirements
	12.03.16		• ***Visiting Existing housing projects in Izmir (one day trip) (2)*** ○ 35 Street Houses project ○ Folkart Narlidere housing ○ Green housing project Narlidere ○ Olympic village houses 2005 ○ Point Bornova residential building	Technical trip ***(Assignment 2)***
4	M. 14.03.16		• **First midterm jury review.** Presentation may be digital or / and manual **(%5)**	
	Th. 17.03.16		• First midterm jury discussion and grade announcement • Role-play review by students • Introduction to BIM and various simulation software ***(lecture 7)*** • Case study presentation ***(4 cases)***	BIM ***(Assignment 3)***
5	M. 21.03.16	Project developmen t (four	• Floor plans and sections development ***(desk critic)*** • BIM – Revit simulation ***(lecture 8)*** • Sustainability mechanical issues in building ***(guest Lecturer 1)& (workshop 1)***	BIM ***(Assignment 4)***
	Th. 24.03.16		• Floor plans and sections development ***(desk critic)*** • Living space (charrette design) ***(Assignment 5) (panel review)***	Natural light in building poster ***(Assignment 6)***

6	M 28.03.16		• Floor plans and sections development ***(desk critic) & (panel review)*** • Sustainability and natural light ***(guest Lecturer 2)*** • Natural light in building workshop ***(guest workshop 2)***	
	Th. 31.03.16		• Floor plans and sections development (desk critic) • Open and semi-open space (charrette design) ***(Assignment 8) (panel review)***	Technical trip ***(Assignment 7)***
7	F - M. 1-4.04.16		• ***Three days technical trip to Bodrum (3)*** ○ Ada Hotel, Göltürkbükü - Demir Evleri ○ Bodrum Evleri, Richard Meier ○ Sandima köyü ve evleri - Gümüşsu Villaları ○ Kütüphanesi, Bodrum Merkez - Ahmet Gazi (Ulu) Camii ○ Bodrum Sualtı Arkeoloji Müzesi Binası ve yenilemesi ○ Milas Yerleşimi, Milas Evleri, Milas Hanı, Hacı İlyas Camii ○ Novron Azure Villaları ○ Magnesia, Germencik, Aydın (antik kent)	
	Th. 07.04.16		• Floor plans and sections development ***(desk critic) & (panel review)*** • Revit in energy conception in building ***(lecture 9)***	Landscape poster ***(Assignment 9)***
8	M. 11.04.16		• Floor plans and sections development ***(desk critic) & (panel review)*** • Open space and landscape ***(guest Lecturer 3) & (guest workshop 3)***	Handout second midterm jury requirements
	Th. 14.04.16		• Floor plans and sections development ***(desk critic)*** • Panel review discussion	
9	M. 18.04.16	**Materials and testing (four weeks)**	• **Second midterm jury review (5%)**	
	Th. 21.04.16		• Second midterm jury discussion and grade announcement • Façade design and materials ***(desk critic)*** • Energy simulation with building materials assigned ***(lecture 10)***	Sustainable materials poster ***(Assignment 10)***
10	M. 25.04.16		• Sustainable materials presentation ***(guest Lecturer 4)*** • Sustainable materials workshop ***(guest workshop 4)*** • Façade and shading elements panel review discussion	
	Th. 28.04.16		• Plans, sections, and mass refinement with façade design and materials ***(desk critic) & (panel review)*** • Light simulation with DIALux evo ***(lecture 11)***	Light simulation test ***(Assignment 11)***
11	M. 02.05.16		• Façade and shading elements ***(guest Lecturer 5)& (guest workshop 5)*** • Plans, sections, and mass refinement with façade design and materials ***(desk critic) & (panel review)***	
	Th. 05.05.16		• Construction materials in system detail drawing ***(lecture 12)*** • Plans, sections, and mass refinement with façade design and materials ***(desk critic) & (panel review)***	
12	M. 09.05.16		• Plans, sections, and mass refinement with façade design and materials ***(desk critic) & (panel review)*** • Site and landscape consideration - review energy simulation results	Handout third midterm jury requirements
	Th. 12.05.16		• Plans, sections, and mass refinement with façade design and ***(desk critic) & (panel review)*** • Review energy simulation results	
13	M. 16.05.16	**Finishing and presentation (two weeks)**	• **Third midterm jury review (5%)**	
	Th. 19.05.16		• Third midterm jury discussion and grade announcement • **Students-led review**	
14	M. 23.05.16		• Architecture project presentation techniques with examples of architecture competition projects ***(lecture 13)*** • Final jury presentation technique ***(lecture 14)*** • Portfolio technique presentation ***(lecture 15)*** • Final desk critic & Models techniques • Review energy simulation results • Final portfolio requirements	Handout Final jury requirements & Final portfolio requirements

Page 2

	Th. 26.05.16		• Final presentation drawing's week	
15	Tu. 01.06.16		• Final Jury submission (drawings and models)	
	Wed. 02.06.16		• **Final jury presentations (60%)**	
16	Wed. 09.06.16		• **Final jury grade announcement (60%)**	
	Th. 11,06.16		• **Portfolio submission (5)%** • **Open colloquium meeting for class discussion**	

APPENDIX S

SADS spring 2016 – case studies

AR 302: Architectural Design IV **Spring 2016**

Section – 2

Case Studies

Sustainable case study buildings

1. Ove Arup engineering group, (2) residential projects of energy saving buildings
2. William McDonough + Partners, (2) residential projects of energy saving buildings
3. Hellmuth, Obata & Kassabaum (HOK), (2) residential projects of sustainable buildings
4. Herzog and de Meuron , (2) residential projects of sustainable buildings
5. Houses - 1
   a. Pugh + Scarpa, Solar Umbrella house, Venice, California, USA
   b. Derya Ekim, Ian Hayton - ECO House
6. Houses – 2
   a. Prairie Sky Cohousing Cooperative, Canada
   b. Wolf Willow Cohousing, Canada
7. Affordable housing
   a. LILAC (Low Impact Living Affordable Community), UK
   b. Elemental, Alejandro Aravena Architecture
   c. Housing project for, Charles Mark Correa
8. Sustainable
   a. Jeanne Gang, Windermere West condominium, Chicago, USA
   b. Carabanchel 16 Housing, Foreign Office Architects
   c. Behnisch, Behnisch & Partner, Genzyme Center
9. Germany
   a. Siedlung Halen Toplu Konut Yerlesmesi, Bern, Germany
   b. BIGyard – Co-Housing, Zanderroth Architekten, Berlin, Germany
10. UK
    a. BedZED, Uk
    b. RMJM Architects, GlaxoWellcome House West Headquarters, Greenford, West London, UK
11. Austria
    a. Baumschlager and Eberle, Shuttered Rooms, Innsbruck Austria
    b. Wohnanlage Messequartier Graz, Austria
12. Energy housing
    a. Järvenpää Zero Energy House, Finland
    b. Multi-family apartment building Šparna hiža, Koprvnica, Croatia
13. Ken Yeang - 2 projects
    a. Menara UMNO tower, Penang, Malaysia
    b. EDITT Tower proposal

Your Presentation shall answer the following questions:

c. Sustainable design approach
d. Mass strategy in relation to
   i. Site context
   ii. Orientation (sun, wind, etc.)
   iii. Natural ventilation
   iv. Natural light and shading
e. Social and economic sustainable approach
f. Sustainable approach to the units design
g. Structure system
h. Materials
i. Open semi-open space
j. Any sustainable design elements

Residential case study buildings

1. Foster + Partners
    a. Albion Riverside, London, UK
    b. Duisburg Housing, Duisburg, Germany
2. Renzo Piano
    a. Cite Internationale, Lyon, France
    b. Rue de Meaux housing, Paris, France
3. Traditional houses (Vernacular) - Turkish
    a. Central Anatolian
    b. Aegean
    c. Black Sea
    d. Southeastern
4. Japan
    a. Traditional houses, Kyoto, (min. 2 examples)
    b. Modern, space-efficient apartments, Tokyo (min. 2 examples)
5. Emre Arolat
    a. Maksimum Evler, Ulus, Istanbul
    b. Göktürk Arketip Konutları, Göktürk, Istanbul
    c. Tekeli Sisa, Metro City, Maslak, Istanbul
6. Moshie Safdie
    a. Habitat '67, Montreal, Canada
    b. Another housing project by Moshie Safdie
7. Hasan Fathy
    a. Shahira Mehrez Apartment
    b. Other private residences (min. 2) by Fathy
8. MVRDV
    a. Celosia Housing, MVRDV + Blancas
    b. WoZoCo Housing, MVRDV
9. Dormitory Style
    a. Tietgenkollegiet (Dormitory), Lungaard & Traneberg Arkitekter
    b. Dutch housing design, the "Amsterdam School", Michel de Klerk, three housing blocks, spaarndammerplantsoen in Amsterdam
10. Le Corbusier
    a. Immeuble Villas + Immeuble Clarte
    b. Unite d' Habitation
11. Turkish Architects
    a. Loft I and Loft II, Tabanlioglu Mimarlik.
    b. Tibas Hatay Toplu Konut Sitesi, Matu Mimarlik (Salih Zeki Pekin)
12. Jose A Coderch
    a. Casa de la Marina, Barcelona
    b. Edifici Catasús, Barcelona
13. Alvar Aalto
    a. Hansaviertel Apartments
    b. Neue Vahr Apartments

Your Presentation shall answer the following questions:

c. Main design idea
d. Mass strategy in relation to:
   Site context - Climate consideration - Unites design - Project program (residential and commercial) - Plan and sections.
e. Units design (light, ventilation, space relation, furniture, privacy, etc.)
f. Special spaces such as (social activities, kids play ground, sport activities, etc.)
g. Structure system
h. Materials
i. Open and semi open – public and private
j. Circulation and service area

APPENDIX T

SADS spring 2016 – midterm juries requirements

First midterm jury requirements

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 302: Architectural Design IV - Section-2 Spring 2016

First midterm jury requirements

First midterm jury will take place on Monday 21/03/2016. Jury will start at 9:00. It will be one-day jury for all students (12 students in the morning and 13 students in the afternoon). We may stay after 5:00 to finish all students if the situation required doing so, please be prepared for that. Students will be drawn randomly by themselves at 9:10.

All students are required to attend the jury. Half letter grades will be deducted for late submission.

Each student will have 20 minutes, 10 minutes to present the project and 10 minutes for instructors and students comments. ***You are allowed to present your work digitally or / and manually.***

Submission requirements:

1- Conceptual drawings representing your project concept, main idea, and scenario in format of sketches, diagrams, photos, individual site analysis, and existing architectural project.
2- Write your own program according to your project scenario.
3- Study model(s) (1/ 500 or 1/200).
4- Site plan 1/500, representing mass location and landscape strategy.
5- Floor plans diagrams 1/200 showing units' distribution location and main service area and main approach entry/entries of mass(s).
6- Minimum of one section diagram 1/200 representing your space relations, natural light strategy, solar gain, and air movement strategy
7- Foot print of the building mass in the site with surrounding buildings at June 21 (at 7:00, 12:00, and 18:00) and at December 21 (at 8:00, 12:00, and 16:00)
8- Units plans 1/200 (minimum two unites)

Please use colors, heavy lines and clear presentation materials to express your project. You are free to use any materials or techniques to present your project's idea. Posting all your presented materials on a standard sheet of your choice is very important.

Second midterm jury requirements

IZMIR INSTITUTE OF TECHNOLOGY

FACULTY OF ARCHITECTURE - Architectural Department

AR 302: Architectural Design IV - Section-2 Spring 2016

Second midterm jury requirements

Second midterm jury will take place on Monday 18/04/2016. Jury will start at 9:00. It will be one-day jury for all students (12 students in the morning and 13 students in the afternoon). We may stay after 5:00 to finish all students if the situation required doing so, please be prepared for that. Students will be drawn randomly by themselves at 9:10.

All students are required to attend the jury. Two attendance will be taken morning and afternoon. Half letter grades will be deducted for late submission (after 9:30) and full grade (after 13:30). No submission will be accepted after 16:00. If you don't show once your jury's turn come, you will be considered absent.

Each student will have 20 minutes, 10 minutes to present the project and 10 minutes for instructors and students comments. All students are required to present and participate in juries all day. You need to learn how to present your project in short time with full professional explanation.

Please note that if you do not attend two midterm juries you will be accepted as NA.

Submission requirements:

1- Study models 1/500 and 1/200 showing your building mass and landscape work (**no models - no jury**).
2- Conceptual drawings representing your project concept, idea, and scenario. Please show us the evolution steps of your mass and/or idea in simple way.
3- Write your own program according to your project scenario **including meter square**.
4- Site plan 1/500, representing mass location and site landscape strategy. Draw site plan with surrounding existent masses, trees, walls (not only your mass)
5- All Floor plans (not diagram) 1/200 showing spaces of the project program location and main service area and main approach entry/entries of the building. Ground floor (main entrance of the project) should include total project land. Windows, doors, furniture should be indicated. Differentiate circulation areas with color. Show the structure system in floor plans.
6- Minimum of two sections (not diagrams) 1/200 representing your space relations, natural light strategy, solar gain, and air movement strategy. Indicate your floors with heavy lines.
7- Minimum of three unites types floor plans and sections 1/100 (3D option)
8- Foot print of the building mass in the site with surrounding buildings at June 21st (at 7:00, 12:00, and 18:00) and at December 21st (at 8:00, 12:00, and 16:00). Please indicate them in readable sizes and colors by the jury members
9- At least one main elevation. 1/200

Please use colors, heavy lines and clear presentation materials to express your project. You are free to use any materials or techniques to present your project's idea. Posting all your presented materials on a standard sheet of your choice is very important.

Good Luck

Third midterm jury requirements

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department

AR 302: Architectural Design IV - Section-2 Spring 2016

Third midterm Jury requirements

Third midterm jury will take place on Monday 16/05/2016. Jury will start at 9:00. It will be one-day jury for all students (12 students in the morning and 13 students in the afternoon). We may stay after 5:00 to finish all students if the situation required doing so, please be prepared for that. Students will be drawn randomly by themselves at 9:10. You need to come early to pick up your (Kura). If you are not there at 9:10, your friend will pick up number for you.

All students are required to attend the jury. Two attendance will be taken morning and afternoon. Half letter grades will be deducted for late submission (after 9:30) and full grade (after 13:30). No submission will be accepted after 16:00. If you don't show once your jury's turn come, you will be considered absent.

Each student will have 20 minutes, 10 minutes to present the project and 10 minutes for instructors and students comments. All students are required to present and participate in juries all day. You need to learn how to present your project in short time with full professional explanation.

Please note that if you do not attend two midterm juries you will be accepted as NA.

Submission requirements:

1- Study models 1/500 and 1/200 **showing your building façade details and landscape work** **<u>(no models - no jury).</u>**

2- Conceptual drawings representing your project concept, idea, and scenario. Please show us the evolution steps of your mass and/or idea in simple way.

3- Write your own program according to your project scenario **including meter square**.

4- Site plan 1/500, representing mass location and site landscape strategy. Draw site plan with surrounding existent masses, trees, walls (not only your mass)

5- All Floor plans (not diagram) 1/200 showing spaces of the project program location and main service area and main approach entry/entries of the building. Ground floor (main entrance of the project) should include total project land. Windows, doors, furniture should be indicated. Differentiate circulation areas with color. Show the structure system in floor plans. Write total square meter area of ground floor where the building touch the ground and total floors area.

6- Minimum of two sections (not diagrams) 1/200 representing your space relations, natural light strategy, solar gain, and air movement strategy. Indicate your floors with heavy lines. **Show adjacent existing building in both side.**

7- Minimum of four unites type's floor plans and sections 1/50 or 3D. **Provide total area and each space area for each unite.**

8- Foot print of the building mass in the site with surrounding buildings at June 21st (at 7:00, 12:00, and 18:00) and at December 21st (at 8:00, 12:00, and 16:00). Please indicate them in readable sizes and colors by the jury members

9- Three main elevation 1/200 with shadow and materials. **Show adjacent existing building in both side.**

10- Use group 3D model that was prepared by the class to show your building in it.

11- Draft drawing of system detail section at the most important part of your façade scale 1/20.

12- Two 3D drawings, first showing the best internal space in your project (court, gallery, studio, etc.), the second showing the exterior part of your building.

13- Energy and natural light data result for basic materials.

Please use colors, heavy lines and clear presentation materials to express your project. You are free to use any materials or techniques to present your project's idea. Posting all your presented materials on a standard sheet of your choice is very important.

Good Luck

APPENDIX U

SADS spring 2016 – final jury requirements

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 302: Architectural Design IV - Section-2 Spring 2016

Final submission requirements

- All poster must be A0 size and it has to be posted on the gray carton with clips at the day of submission.
- Each student has 30 minutes of presentation time, 15 minutes to speak and 15 minutes to answer juries' questions and listen to their comments.
- Submission will be on Tuesday of 31st of May from 14:00 – 17:00 at our studio.
- Our studio need to be totally vacated by the students by 11:00 on Tuesday 31st of May.
- First late submission will be until Wednesday 1st of June at 10:00 am with half letter grade deduction, last late submission will be on Wednesday 1st of June from 10:00 to 14:00 on Wednesday with full letter grade deduction and no jury presentation.

Submission requirements:

1- One A4 size text page in English describing you project (site analysis, concept, sustainability strategy, etc.). Once someone read this page would understand your project without you. Do not use this page to read from during your jury.

2- Detail Model 1/200 showing your building façade (opening and materials) and landscape work. The model should be openable to see each floor and the internal spaces relations. Underground floors areas should be in a separated model. 1/ 500 mass model reflecting the relationship between your mass and the context surrounding your project. Make sure both models base fit into the site models.

3- Conceptual drawings representing your project concept and idea. That may include sketches, diagrams, photos from the site or somewhere else, etc. Please show us the evolution steps of your mass and/or idea in simple way.

4- Site plan 1/500, representing mass location, site landscape, open car parking, close car's parking ramp, and adjacent building. Give sun shadow to your building. You may show the sun path and wind direction on it. **North arrow should be up**. Draw site plan with surrounding existent masses, trees, walls (not only your mass)

5- Foot print of the building mass in the site with surrounding buildings at June 21st (at 7:00, 12:00, and 18:00) and at December 21st (at 8:00, 12:00, and 16:00). Please indicate them in readable sizes and colors by the jury members

6- All Floor plans (not diagram) 1/200 showing spaces of the project program location and main service area and main approach entry/entries of the building. You must show structure system (structure elements and axes), door, and windows. Ground floor should show all project site and adjacent streets and buildings. All floor plans should have the north arrow up. You may use color. All plans should have furniture. If you have any technical issue of how to draw any part of your floor plans, you need to ask us. (car ramp, handicap ramps, elevators, stairs, fire stairs, exit doors, etc.)

7- Minimum of three sections (not diagrams) 1/200 representing your space relations, natural light strategy, solar gain, and air movement strategy (summer / winter strategy). Be careful about the location of your section line (use moving section line to present good places in the project). Please show the adjacent buildings on your section. If you have any technical issue of how to draw any part of your section, you need to ask us. You may draw extra partial section to show special places in the project. It would be better if you use 3D section than 2D section drawings.

8- Minimum of four unites type's floor plans and (sections option) 1/50 or 3D. **Provide total area and each space area for each unite**

9- Minimum of two elevations (north and south facades) 1/200. Show the adjacent and background buildings.

10- One silhouette 1/500 including your building and surrounding from site analysis file that was prepared by site analysis group.

11- Minimum of two 3D drawings, one showing the best internal space in your project (court, gallery, studio, etc.), the second showing the exterior part of your project.

12- Use group 3D model that was prepared by site analysis group to show your building in it.

13- System detail section scale 1/20 at the most important part of your façade. The section should start from your underground floor level to the roof level of your building.

14- From simulation by Revit, Diagrams: Sun shading detail, ventilation, solar gain (sun angles), natural lighting, material selection, waste, water and transportation strategy, heating and cooling strategy, annual energy consumption.

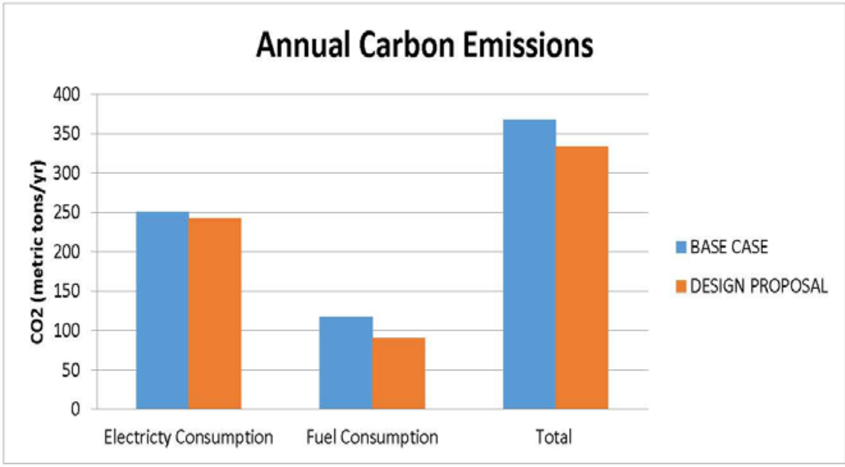
15- Light simulation test of the natural light quality of some selected spaces in the project.

- Please use colors, heavy lines under sections and elevations (but without exaggeration) and clear presentation materials to express your project.
- You are free to use any materials or techniques to present your project's idea.
- You need to check your project against the sustainability checklist requirements to make sure your project include every things
- Make sure that your project includes all program space elements and you are within the required meter square space.
- ***Those who will use video media to present their project, the video should not be very long (2 to 3 minutes) and all video should be installed on one laptop and ready from early morning. One person shall be next to the laptop to run the video for all class.***

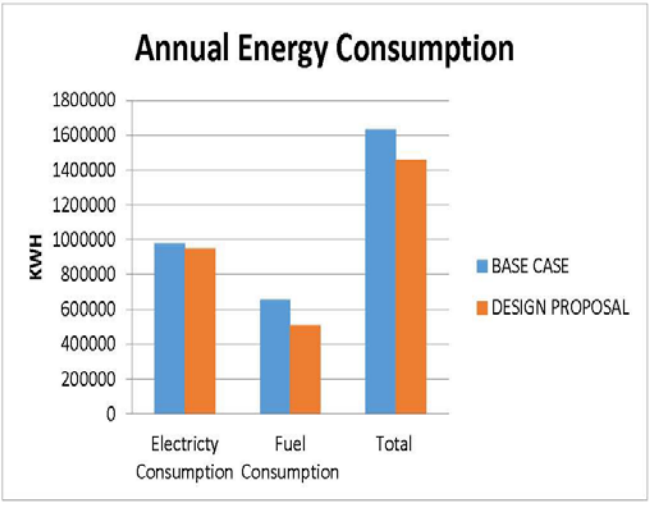
DATA FROM ENERGY SIMULATION THROUGH REVIT

You will derive following information from your Revit model and simulation results:

1. LIST 1: U values representing base case Revit model
2. LIST 2: U values of each building component and their material selections based on your design from newer Revit model
3. Annual CO_2 release per m2 for all building (look at the example excel file)

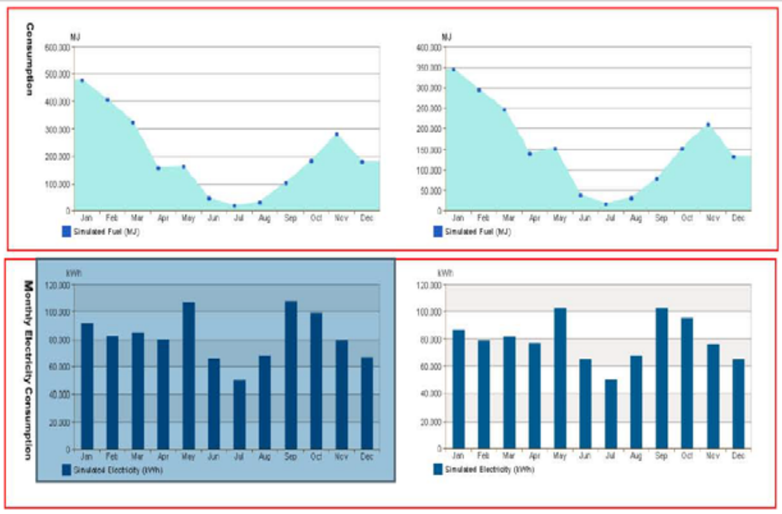
a. 

4. Annual energy consumption (heating, cooling, lighting, electrical appliances included) per m2 for all building (look at the example excel file)



a.

5. Excel graphic for total monthly energy consumption (look at REVIT simulation file for graphics)



6. Percentage of decrease for total fuel use (look at the example excel file)

22% DECREASE IN TOTAL FUEL ENERGY CONSUMPTION

7. Percentage of decrease for total electricity use (look at the example excel file)

22% DECREASE IN TOTAL ELECTRICAL ENERGY CONSUMPTION

8. **Comparative studies**: **which sustainable solutions are most effective or better than the others**

Possible comparisons based on **energy consumption and CO2 emissions (explained as 1 and 2 graphs)**:

a. Material comparison with conventional (base case) and your material selection (solid surface and/or openings)

b. Shading comparison without shading and with shading (while you design materials assigned)

c. Orientation comparison, if the total mass is shifted to East or West some degrees (5, 10, or, more according your design) (while you design materials assigned)

d. Double skin comparison without double-skin façade and with double-skin (while you design materials assigned)

APPENDIX V

SADS spring 2016 – sustainability checklist elements

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - **Architectural Department**
AR 302: Architectural Design IV - Section-2 Spring 2016

Sustainability Check List

Sustainable architecture is architecture that seeks to minimize the negative environmental impact of buildings by efficiency and moderation in the use of **materials, energy, and development space** as well as the consideration of the economic and social aspects too.

1- Energy

Due to Izmir whether, it is preferable to work on two energy strategies one for summer and one for winter. However, it is up to each individual student explaining how the designed project will reduce energy consumption.

a. Reducing the energy used for lighting
   i. At least 80% of spaces benefits from natural light
   ii. Elements such as sky-gardens, skylights, atriums, light shelves are used to increase natural light
b. Reducing the energy used for ventilation
   i. All spaces benefit from adjustable windows, air-holes
   ii. Any natural ventilation opportunities facilitated by channels (wind catcher, etc.)
c. Reducing energy used for heating and cooling
   i. In order to reduce heating loads (high insulation glass system (low-e glass), double-wall application, double skin facades)
   ii. In order to reduce cooling loads (sunshades, movable blinds between glass layers, etc.)
   iii. Passive recovery to reduce heating and cooling loads (thermal mass, etc.)
d. Use of renewable energy sources
   i. Low emission but non-renewable energy sources
   ii. Renewable energy sources like sun, and wind.

2- Materials

a. Flexible design of interior space and interior furniture
b. Use of eco-friendly material and equipment.
c. Reducing waste

3- Water

a. Recollection and reuse of water
   i. Grey water and rain water is stored in the building, filtered and reused reservoirs and garden irrigation.
b. The use of rain water in interior and exterior space to reduce the cooling load during summer.
c. The use of water in landscape to enhance the natural light in the building.

4- Health

a. Natural light and fresh air for working area.
b. Indoor glare effect control by using façade's solar shading.
c. Eco friendly transportation to the site (bicycles, electric cars, etc.)
d. Selection of non-harmful materials.

5- Architectural solutions for economic sustainability

a. Increase in the use of local available materials in construction instead of expensive imported materials.
b. Change negative perception of low-cost housing as UGLY, NON-DURABLE, LOW QUALITY, AND ONLY FOR LOW-INCOME FAMILIES by using cost-effective building technologies and materials.
c. Decrease energy consumption.
d. Allow self-build.

6- Architectural solutions for social sustainability (Solidarity, equity, justice)

a. Enhance awareness of available alternative options in local social structures influencing human behavior to change through collective, democratic, and sustainable ways of life.
b. Design for cooperation and sustainability.
c. Design for combating the alienation and solation that many experience today.
d. Design for a sense of individual and collective identity.
e. Design for an ecologically oriented society with a belief that the society alone can remove the root cause of the current ecologic crisis.

APPENDIX W

SADS spring 2016 – questionnaire survey form

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE - Architectural Department
AR 302: Architectural Design IV - Section-2 Spring 2016

Ins. Dr. Zeynep D. ARSAN Ins. Kamal MOHAMED

Questionnaire form for integrating sustainability into design studio

1- Did you have information about sustainable architectural design before this design studio?
   a. No
   b. Yes ....

   If yes, was it from AR 301 Design studio class
   Yes ....
   No, Can you say from where? ....

2- Did you attend any related course(s) about the technical aspects of sustainable architectural design before this design studio?
   a. No
   b. Yes How many course(s)? ....
   What about? ....

3- Which one of the Sustainability aspects did you consider in your design project?
   a. Environmental
   b. Social
   c. Economical
   Please, say why? ....
   ....
   ....

4- Design studio pedagogy structure included many elements during the semester. Would you put these elements in order, the most beneficial to your design project process first and the least at last.
   a. Physical models
   b. Site analysis
   c. Lectures by instructors
   d. Case studies
   e. Site trip
   f. Technical trip visiting sustainable building
   g. Lectures by expert visitors
   h. Panel reviews
   i. Midterm juries
   j. Desk critiques
   k. Assignments
   l. Use of digital media

Page -1.

5- Will you practice sustainable design in your profession in the future?
   a. No
   b. Yes

6- If you will continue your graduate study in the future, would you chose an architecture environmental subject such as sustainable design, ecological design, energy saving design, etc. as your study topic?
   a. No
   b. Yes

7- What are the difficulties for designing a sustainable building in the design studio course?

8- Can you make an order of what you considered the most important to least important in your design in this semester?
   a. Natural light
   b. Eco friendly materials
   c. Natural ventilation
   d. Shading elements
   e. Renewable energy sources
   f. Use of thermal mass
   g. Rain water uses
   h. Eco friendly transportation to the site (bicycles, electric cars, etc.)

9- Please write your personal comments about the sustainable design studio spring of 2016

APPENDIX X

IYTE-Architecture Department courses list

İZMİR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE

2017-2018 YEARS

DEPARTMENT OF ARCHITECTURE UNDERGRADUATE PROGRAM					
LIST OF COURSES					
1. SEMESTER					
Course Code	**Course Name**	**Core/ Elective**	**Prerequite**	**Credit**	**ECTS Credits**
AR 101	Introduction to Design	Core		(4+8) 8	12
AR 121	Introduction to Architecture	Core		(3+0) 3	5
AR 161	Graphic Communication	Core		(2+2) 3	6
MATH 121	Mathematics I	Core		(4+0) 4	4
ENG 101	Development of Reading and Writing Skills I	Core		(3+0) 3	3
				Total Credits	**21**
				Total ECTS	**30**
2. SEMESTER					
Course Code	**Course Name**	**Core/ Elective**	**Prerequite**	**Credit**	**ECTS Credits**
AR 102	Introduction to Architectural Design	Core	AR 101	(4+8) 8	8
AR 122	History and Theory of Architecture I	Core		(3+0) 3	3
AR 152	Building Technology and Science I	Core	AR 161	(2+4) 4	4
AR 182	Introduction to Building Materials and Physics	Core		(2+0) 2	3
AR 164	Computer Applications for Designers	Core		(1+2) 2	3
ENG 102	Development of Reading and Writing Skills II	Core		(3+0) 3	3
SP191	Summer Practice I: Measured Drawing (2 Weeks)			0	2
SP192	Summer Practice II : Surveying And Mapping Knowledge (4 Weeks)			0	4
				Total Credits	**22**
				Total ECTS	**30**
3. SEMESTER					
Course Code	**Course Name**	**Core/ Elective**	**Prerequite**	**Credit**	**ECTS Credits**
AR 201	Architectural Design I	Core	AR 102	(4+8) 8	11
AR 221	Architectural History and Theory II	Core		(3+0) 3	3
AR 231	Structures in Architecture I	Core		(3+0) 3	3
AR 251	Building Technology and Science II	Core	AR 161	(2+2) 3	3
AR 281	Building Physics I	Core		(2+2) 3	3
ENG 201	Advanced Reading & Communication Skills	Core		(3+0) 3	3
TURK 201	Turkish Language I	Core		(2+0) NC	2
TURK 203	Turkish for Foreigners I	Core		(2+0) NC	2
HIST 201	Principles of Ataturk I	Core		(2+0) NC	2
HIST 203	History of Turskish Revolution I	Core		(2+0) NC	2
				Total Credits	**23**
				Total ECTS	**30**
4. SEMESTER					
Course Code	**Course Name**	**Core/ Elective**	**Prerequite**	**Credit**	**ECTS Credits**
AR 202	Architectural Design II	Core		(4+8) 8	9
AR 222	Architectural History and Theory III	Core		(3+0) 3	3
AR 232	Structures in Architecture II	Core		(3+0) 3	3
AR 252	Building Technology and Science III	Core		(2+2) 3	4
AR 264	Computer Aided Architectural Modeling	Core		(2+2) 3	3
TURK 202	Turkish Language II	Core		(2+0) NC	2

Page – 1.

TURK 204	Turkish for Foreigners II	Core		(2+0) NC	2
HIST 202	Principles of Ataturk II	Core		(2+0) NC	2
HIST 204	History of Turskish Revolution II	Core		(2+0) NC	2
AR 290	Summer Practice III: Construction Site / Archaeological Site Practice (6 Weeks)			0	4
				Total Credits	**20**
				Total ECTS	**30**
	5. SEMESTER				
Course Code	**Course Name**	**Core/ Elective**	**Prerequite**	**Credit**	**ECTS Credits**
AR 301	Architectural Design III	Core	AR 202	(4+8) 8	13
AR 331	Structures in Architecture III	Core		(2+2) 3	4
AR 351	Building Technology and Science IV	Core		(2+2) 3	5
AR 381	Building Physics II	Core		(2+2) 3	4
	* Elective	Elective			4
				Total Credits	**17+Credit**
				Total ECTS	**30**
	6. SEMESTER				
Course Code	**Course Name**	**Core/ Elective**	**Prerequite**	**Credit**	**ECTS Credits**
AR 302	Architectural Design IV	Core		(4+8) 8	10
AR 332	Structures in Architecture IV	Core		(2+2) 3	4
AR 352	Building Technology and Science V	Core		(2+2) 3	4
	* Elective	Elective			4
	* Elective	Elective			4
AR 390	Summer Practice IV: Architectural Office Practice (6 Weeks)			0	4
				Total Credits	**14+Credit**
				Total ECTS	**30**
	7. SEMESTER				
Course Code	**Course Name**	**Core/ Elective**	**Prerequite**	**Credit**	**ECTS Credits**
CP 401	Urban Design Studio	Core	AR 302	(4+8) 8	12
AR 451	Project and Building Management	Core		(3+0) 3	6
CP 453	Urban Planning and Design Principles	Core		(3+0) 3	4
	* Elective	Elective			4
	* Elective	Elective			4
				Total Credits	**14+Credit**
				Total ECTS	**30**
	8. SEMESTER				
Course Code	**Course Name**	**Core/ Elective**	**Prerequite**	**Credit**	**ECTS Credits**
AR 402	Architectural Design V	Core	CP 401	(4+8) 8	18
	* Elective	Elective			4
	* Elective	Elective			4
	* Elective	Elective			4
				Total Credits	**8+Credit**
				Total ECTS	**30**
Elective Courses					
Course Code	**Course Name**		**Prerequite**	**Credit**	**ECTS Credits**
AR 310	Introduction to Photography			(2+2) 3	4
AR 311	Freehand Drawing from Observation			(3+0) 3	4

AR 312	Architectural Portfolio Design		(3+0) 3	4
AR 313	Computer Aided Architectural Drawing		(2+2) 3	4
AR 328	Ancient Egyptian Architecture		(3+0) 3	4
AR 330	Form Structure Relation		(2+2) 3	4
AR 333	Earthquakes and Building Behavior		(3+0) 3	4
AR 335	Historic Building Materials		(3+0) 3	4
AR 336	Contemporary Earth Architecture		(3+0) 3	4
AR 355	Professional Ethics in the Built Environment		(3+0) 3	4
AR 361	Digital Media and Architectural Design		(3+0) 3	4
AR 382	Ecological Studies in Architecture		(3+0) 3	4
AR 383	Lighting Analysis in Building Physics		(2+2) 3	4
AR 384	Introduction to Architectural Acoustics		(3+0) 3	4
AR 385	Building Form and Thermal Performance		(3+0) 3	4
AR 403	Studio in Product Design		(2+2) 3	4
AR 404	Studio in Architectural Conservation	CP 401	(2+2) 3	4
AR 405	Studio in Interior Design		(2+2) 3	4
AR 406	Studio in Landscape Design		(2+2) 3	4
AR 423	Introduction to Ottoman Readings in the History of Architecture		(3+0)3	4
AR 424	Regionalism in Architecture		(3+0) 3	4
AR 425	Contemporary Archaeological Approaches to Architectural Heritage		(3+0) 3	4
AR 426	Spatial Perception and Representation		(3+0) 3	4
AR 427	Environmental Psychology		(3+0) 3	4
AR 428	Orientalism and Architecture		(3+0) 3	4
AR 429	Introduction to Architectural Restoration		(3+0) 3	4
AR 433	Thinking on the History of Structure		(3+0) 3	4
AR 434	Designing the Geometry of Motion		(2+2) 3	4
AR 435	Design of Earthquake Resistant Buildings		(3+0) 3	4
AR 440	Architectural Design Approaches		(3+0) 3	4
AR 444	Programming and Evaluation in Architecture		(3+0) 3	4
AR 446	Design Evolution		(3+0) 3	4
AR 447	Rural Built Environment		(3+0) 3	4
AR 454	Construction Project Planning & Scheduling		(2+2) 3	4
AR 455	Construction Administration		(3+0) 3	4
AR 456	Building Economics		(3+0) 3	4
AR 462	Housing Studies		(3+0) 3	4
AR 472	Architectural Building Types of Medieval Anatolia		(3+0) 3	4
AR 473	Selected Issues on Architecture and the City		(3+0) 3	4
AR 475	Architecture of the Republican Era		(3+0) 3	4
AR 482	Building Performance Simulation for Sustainable Design		(3+0) 3	4
AR 483	Design principles of energy efficient building		(2+2) 3	4
AR 484	Ottoman and Republican Architecture		(3+0) 3	4
AR 485	Integrated Building Systems		(3+0) 3	4
AR 486	Design Principles of Passive Heating and Cooling Systems of Buildings		(3+0) 3	4

Instructions:

*Students must take 8 elective courses with total of 24 credits in the final 4 semesters, 18 credits of these courses should be technical electives.

APPENDIX Y

Post course interview questionnaire form

IZMIR INSTITUTE OF TECHNOLOGY
FACULTY OF ARCHITECTURE
Architectural Department

Integrating Sustainability Principles into Design Studio

Personal Interview Questionnaire Form of Ex-Students

Part One- Personal Career

Name: Studio(es) Attended:

1) Are you pursuing your graduate degree?

Yes No
If yes, in which subject…………………

2) Are you a practice architect?

Yes. No
If yes, for how long? ………………
If no, what else do you do?..
……..

3) How do you categorize your work place sector?

a. Government
b. Private
c. Academic
d. Ownership by you
e. Others………………………………….

4) Have you practiced sustainable design in your professional work?

Yes No
If yes, explain how?
………
……...

5) From scale 1 to 10 (10 is the strongest), how much has sustainable architecture design studio contributed to you professional career?

……

6) Have you attended any courses, seminars, conferences, etc. related to sustainable design?

Yes No
If yes, specify what it is and for what reasons?...
……
…….

7) Have you participated in any sustainable architecture design project, competition, or academic paper/project, etc.?

Yes No

If yes, specify what it is? ……………………………………………………………………………..
………

8) If you have any personal comments related to the first part, you may add it here.

………
………
………
………
………
………

Part Two-Sustainable Architecture Design Studio from Architectural Professional Views

9) After two years of attending sustainable design studio, would you please describe how you started and finished your project? What was the starting points and what tools did you use. Please relate your answer to the studio instructors teaching method and tools.

………
………
………
………
………
………
………
………
………
………
………

10) Please describe, what kind of thoughts had you gone through during the design process time? That may include positive and negative thoughts, fears and confidence time, joy and sadness moments, etc. during the design process. Also, explain why did it happen?

………
………
………
………
………
………
………
………
………
………
………
………

11) Relating sustainable design studio to conventional studio, from scale 1 to 10 (10 is the strongest). Were the studio's timetable along the semester managed effectively?

……
……

12) From scale 1 to 10 (10 is the strongest), following the studio teaching method, had you been able to design a sustainable project that included some of the sustainability design elements?

……
……

13) You had attended sustainable design studio and other conventional studios. Which one of the following you may consider it the unique characteristic of sustainable design studio? You may chose more than one option.

a. Teaching method and techniques
b. Timetable management
c. The design subject
d. Studio work set up environment
e. Juries' setup and requirements
f. Others ……………………

14) From scale 1 to 10 (10 is the strongest) how do you evaluate the use of the digital technology (various software) during the design process in the studio?

……
……

15) Evaluation of Revit for energy and daylight analysis. From scale 1 to 10 (10 is the strongest), were you satisfied with Revit?..

Please explain your answer ……………………………………………………………………………………..
……
……
……
……

16) The following were the design studio's pedagogy structure elements. Would you put these elements in order where the most beneficial to **your professional career** comes first and the least at last?

a. Physical models
b. Site analysis
c. Lectures by instructors
d. Case studies
e. Site trip
f. Technical trip visiting sustainable building
g. Lectures by visiting experts
h. Panel reviews
i. Midterm juries
j. Desk critiques
k. Assignments (in class drawing "charrette design" & homework posters)
l. Use of digital media
m. Group work
n. Reading documents about the project subject

17) Can you make an order of what do you consider the most important to least important in **your professional work** of the following sustainable design elements?

a. Natural light
b. Eco friendly materials
c. Natural ventilation
d. Shading elements
e. Renewable energy sources
f. Use of thermal mass
g. Rain water uses
h. Eco friendly transportation to the site (bicycles, electric cars, etc.)
i. Open space

18) Two years after attending sustainable design studio, please write your personal comments about the studio, and how can it be better for the future students?

....
....
....
....
....
....Thank you.

INFORMED CONSENT FORM

This research is carried out within the scope of the course code 8540 PhD Thesis in Building Science, Architecture Department, Middle East Technical University, Ankara and the courses codes AR301 Architecture Design III and AR302 Architecture Design IV, Architecture Department, Izmir Institute of Technology, Izmir as a thesis work by Kamal Eldin Mohamed, Instructor at IYTE Architecture Department. This form is designed to inform you about the research conditions.

What is the aim of working?

The aim of the research is to evaluate the level of integration of sustainable design principles and the teaching method created for the Sustainable design studio.

What kind of help you can provide?

If you agree to participate in the personal or over Skype interview survey, you will answer some questions that it will take about 45 minutes. The meeting may voice recorded for later evaluation.

How the collected information will be used?

Your participation in the research personal interview is voluntary. The information obtained from you will be evaluated collectively and used in scientific publications. Your identity information will be kept confidential.

What else we may use?

Your design project that you produce during your third year design studio may be used in scientific publication with/without your name posted on it.

I have read the above information and agree completely with this work voluntarily. I also agree that my answers and my design project can be used in scientific publications.

Name, last name: **Signature:** **Date:**

APPENDIX Z

Outstanding projects examples of the three experimental studios

Pilot experimental studio

The project presented the design of the Architecture department by Melda Ozlem Dirgin That 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 gray water, and solar panels. The proposed design had %32 reduction in annual energy consumption (Figure Z.1), while the project managed to integrate 15 sustainable elements

Figure Z.1: Outstanding example project by Melda Ozlem Dirgin.

Second experimental studio

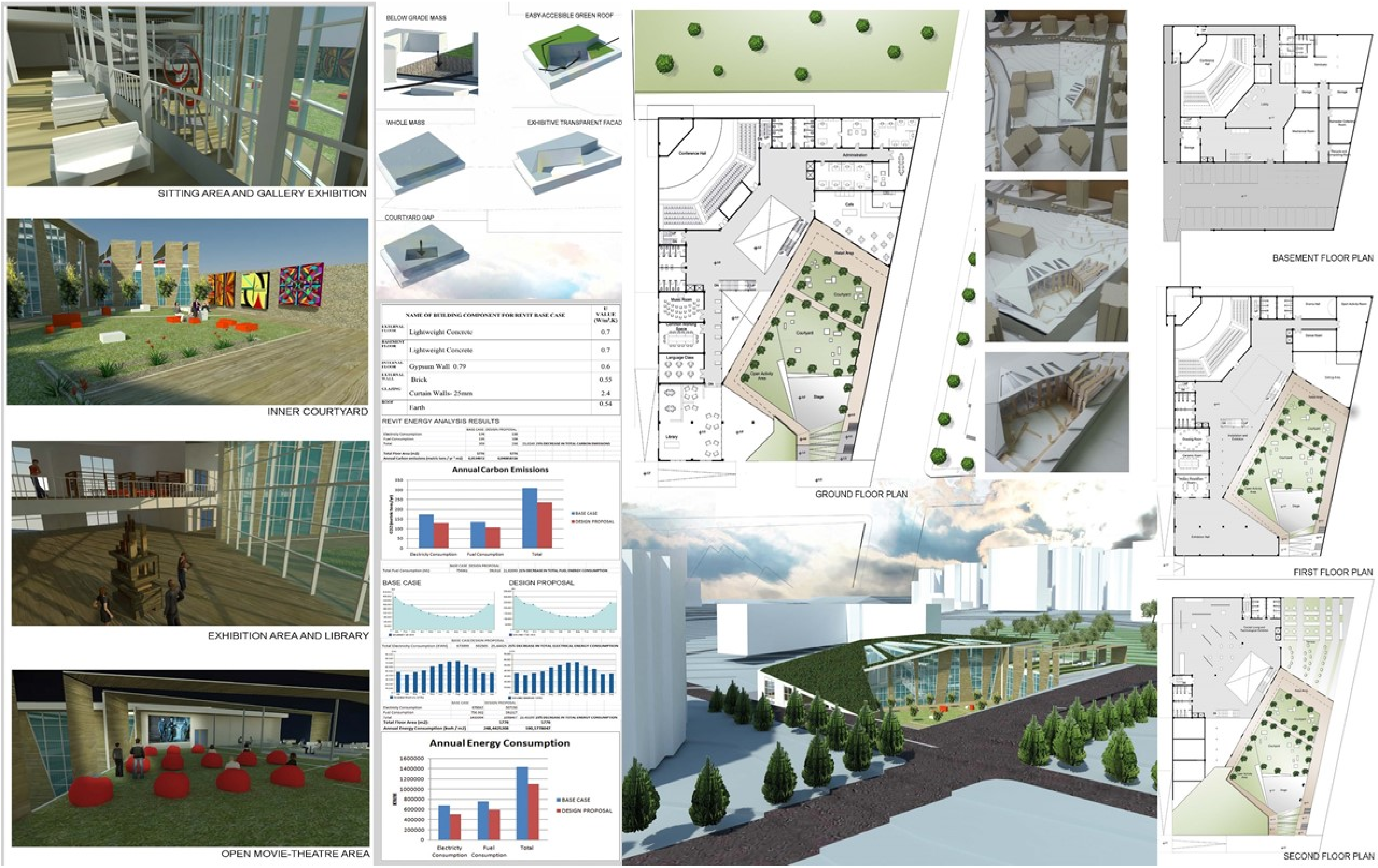
Four outstanding examples are presented from the second experimental studio.

Bornova culture center by “Ezgi Çam” was exploit the idea of a center mass that included the major program spaces while it was surrounded by lower mass that included other spaces (Figures Z.2 & Z.3). That strategy provided good quality of natural light and natural ventilation throughout the open space created between the two masses as well as various open and semi open spaces. Furthermore, the orientation, height, and size of masses considered the natural resources such as wind, natural light, rainwater, etc. as well as the choice of sustainable materials and various shading elements. The design expected to save 25% in annual energy consumption and 30% in CO_2 emission.

Figure Z.2: Bornova Culture Center, Bornova, Izmir. By “Ezgi Çam” 1

Figure Z.3: Bornova Culture Center, Bornova, Izmir. By “Ezgi Çam” -2

The conceived sustainable concept of Culture Park by “Ece Güleç” was about creating a building like a park in a gated community-housing neighborhood that lacked green spaces (Figures Z.4 & Z.5). The open courtyard provided interactive atmosphere open and semi open space as well as natural light and natural ventilation into the building. The sustainable design was enhanced by the use of green roof, rainwater harvesting, and PV panels. The design offered 23% in annual energy saving and 23% in CO_2 emission reduction.



NAME OF BUILDING COMPONENT FOR REVIT BASE CASE		U VALUE (W/m².K)
EXTERNAL FLOOR	Lightweight Concrete	0.7
BASEMENT FLOOR	Lightweight Concrete	0.7
INTERNAL FLOOR	Gypsum Wall 0.79	0.6
EXTERNAL WALL	Brick	0.55
GLAZING	Curtain Walls- 25mm	2.4
ROOF	Earth	0.54

Figure Z.4: Culture Park, Bornova, Izmir. By “Ege Güleç” -1

Figure Z.5: Culture Park, Bornova, Izmir. By “Ege Güleç” -2

The Bornova culture center design idea by “Okan Türkcan” was creating a high structure mass that was inspired by young users to experience the city from higher perspective (Figures Z.6 & Z.7). This mass had internally split level floors that was created around central atrium to provide an easier movement and visual contact among spaces’ users as well as natural light and natural ventilation. The use of landscape elements, sustainable materials, shading elements, insulating materials, and PV panels provided 16% decrease in annual energy consumption and 16% reduction in CO_2 emission.

Figure Z.6: Bornova Culture Center, Bornova, Izmir. By "Okan Türkcan" -1

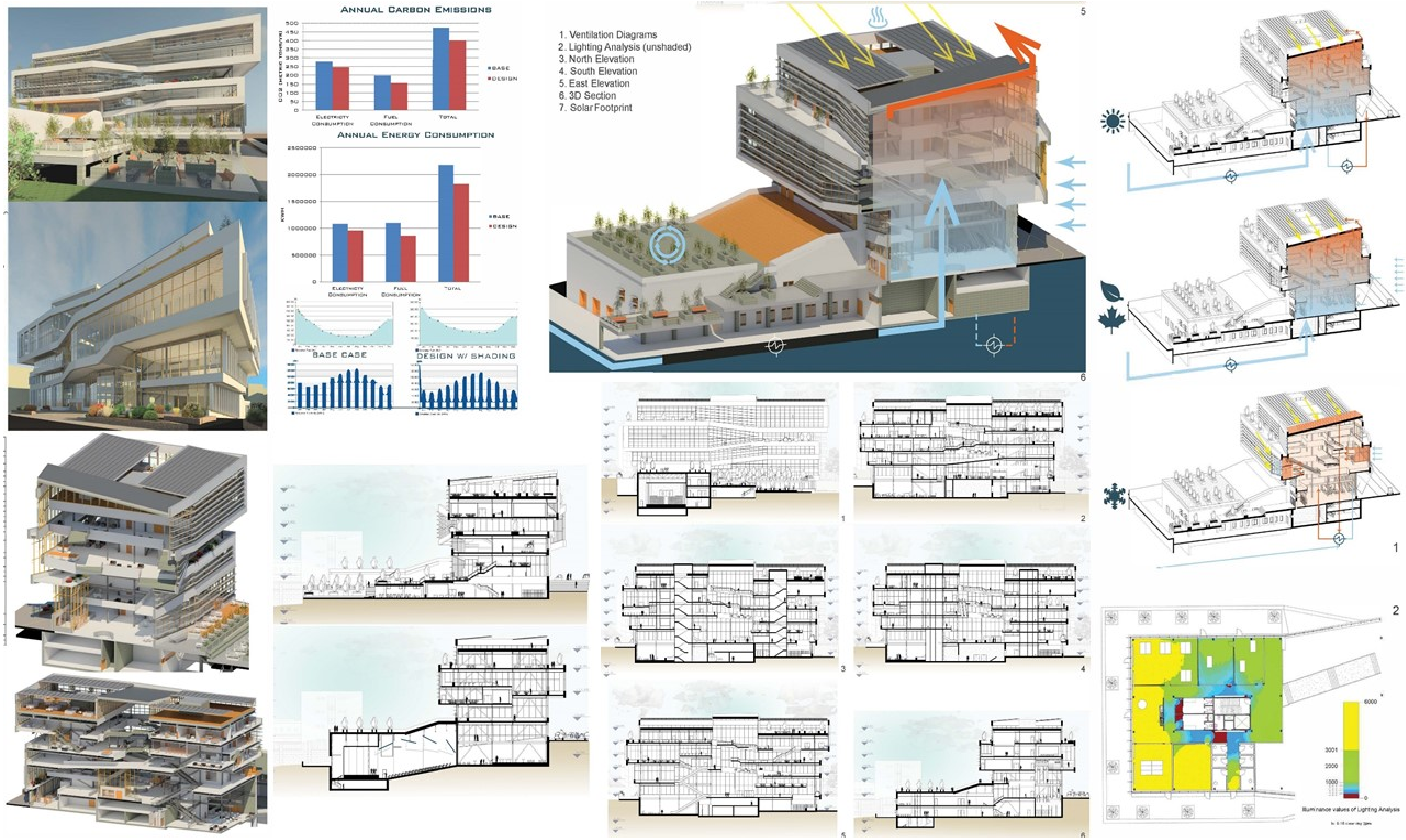


Figure Z.7: Bornova Culture Center, Bornova, Izmir. By “Okan Türkcan” -2

Bornova culture center by “Tuğba Yetiş” concept was based on creating visual contact among spaces so that the users can perceive spaces totality easily (Figures Z.8 & Z.9). The orientation and the height of the center mass provided great opportunity of natural light and natural ventilation to most spaces. Double skin facades and skylights elements maximized the natural light and natural ventilation to the building as well as control the heat transfer between internal and external spaces. The rainwater collection, PV panels, gray water reuse, and façade shading elements enhanced the sustainable design. The design proposed 28% saving in annual energy consumption and 22% reduction in CO_2 emission. The student integrated 19 sustainable design elements in the project (Mohamed and Durmuş Arsan 2016).

Figure Z.8: Bornova Culture Center, Bornova, Izmir. By "Tuğba Yetiş" -1

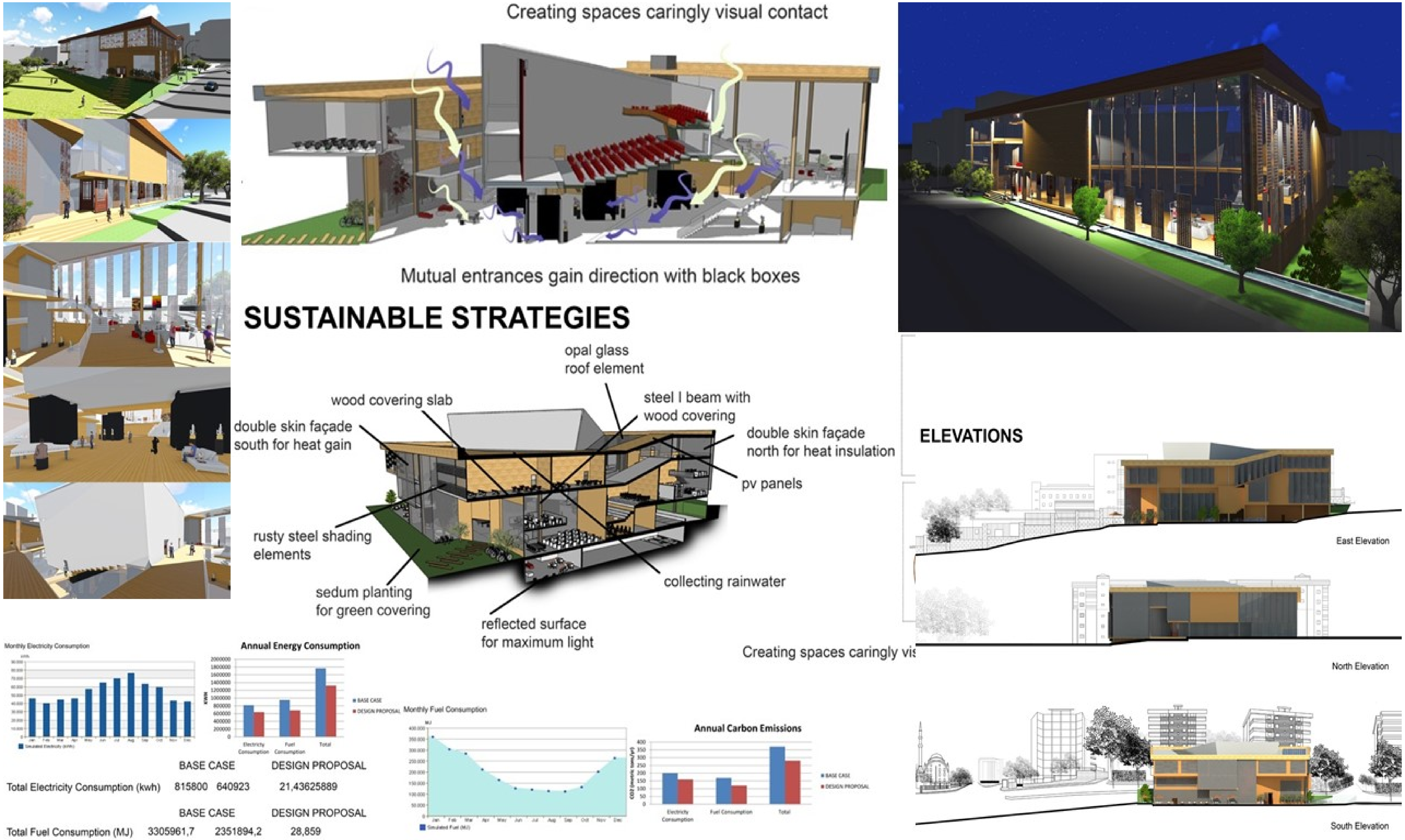


Figure Z.9: Bornova Culture Center, Bornova, Izmir. By “Tuğba Yetiş” -2

Third experimental studio

Hereunder three projects introduce the final work of sustainable design proposal of housing project in Bayrakli, Izmir. The students provided these design proposals to Izmir Municipality to replace a slum residential area in Bayrakli. Projects were based on the concept of sustainable design principles with various approach and design strategies trying to provide housing design respond to the existing slums residents, not to follow the existing housing trend of recent time in Turkey. The students made survey using questionnaire forms and personal interviews to the existing residents. The data collected were used to create a sustainable design responding to the need of the existing slum residents. Furthermore, projects were tested using energy simulation program to evaluate the houses energy consumption and CO_2 emission.

The proposed design of secret garden and terraces houses by “Dilan Yılmaz” was established on the consideration of the three elements of sustainable design (Figures Z.10 & Z.11). Environmentally, the garden and terraces provided good daylight and natural ventilation quality. Socially, the garden and terraces (Turkish sofa; open and semi-open) responded to the existing users need and their daily living style as well as the strength of their social contact. In addition, ‘The Secret Garden' concept was purposed to emphasize the relation between public-semipublic and private areas of the design responding to the Turkish culture way of living. Economically, the use of exiting local material and design modules lower the cost of the project. Secret garden design proposal provided 26% saving in annual energy consumption and 23% reduction in CO_2 emission.

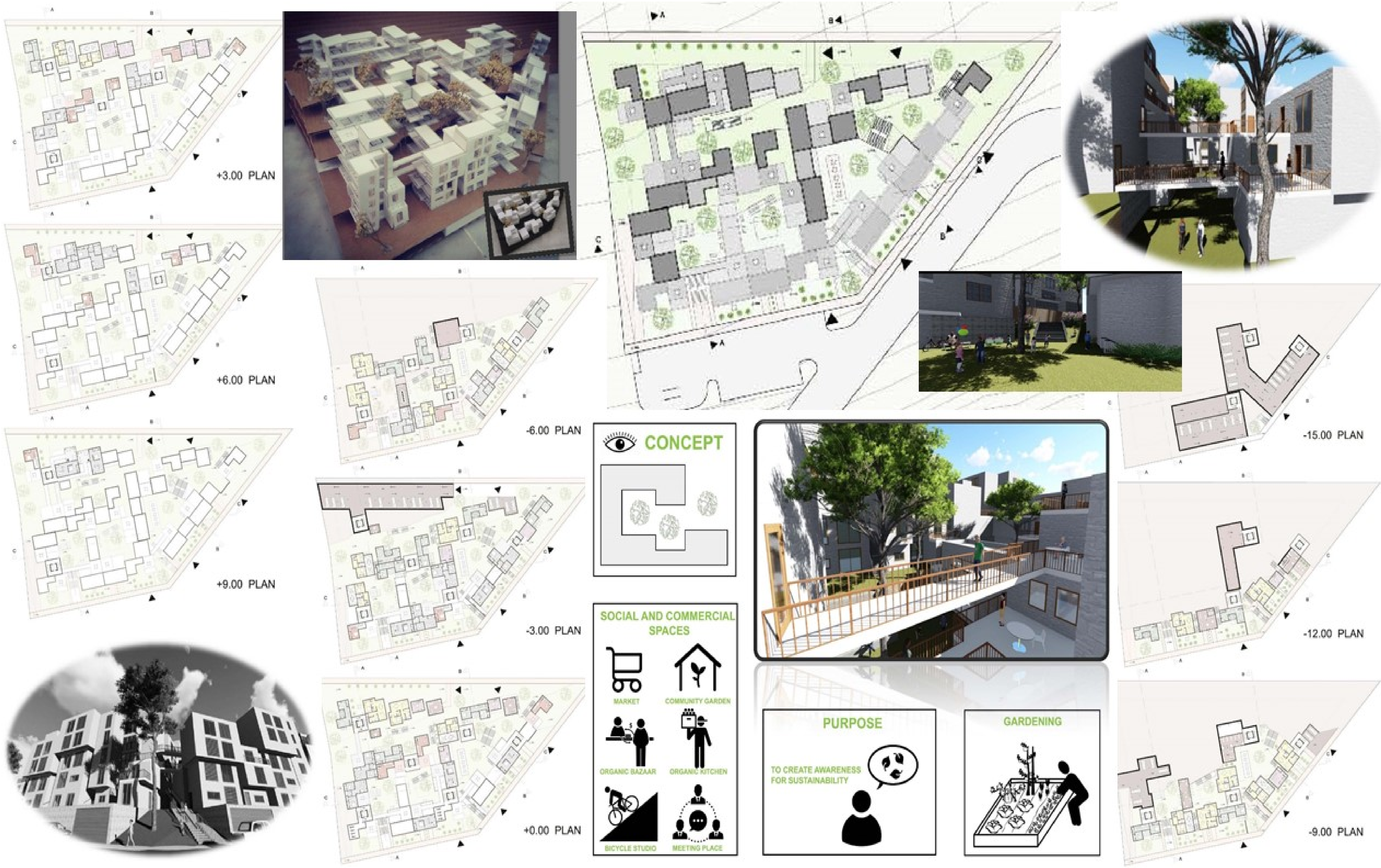


Figure Z.10: Secret Garden and Terraces Hosing Design “Dilan Yılmaz” - 1

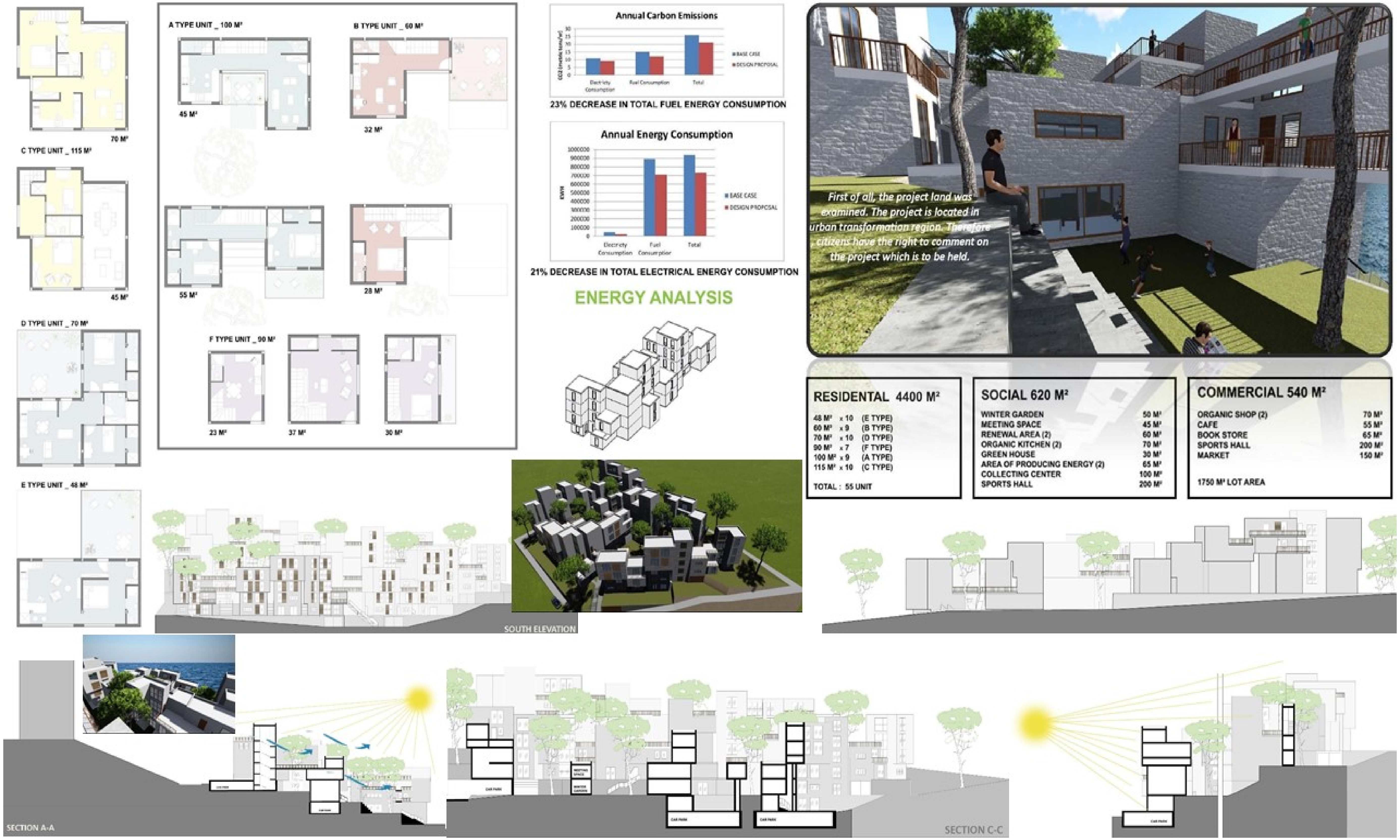


Figure Z.11: Secret Garden and Terraces Hosing Design "Dilan Yılmaz" -2

Sustainable meaningful livelihoods in the city by “Ece Güleç” design concept was built on minimizing city pollution, genetically modified foods, and the lack of the green spaces in Izmir (Figures Z.12 & Z.13). The permaculture city concept was the design guideline. The design asserted the sustainable urban living by providing abundant food, energy security, and knit communities that respond to the environmental, economical, and social sustainable design. Residents can grow their own foods in their private gardens or big terraces with vegetable pots or in common agriculture zones. Furthermore, residents can learn gardening in workshops as well as keeping their products in the cold room storages to sell it in the organic market that will sustain the social and economic life. Sustainable and recyclable materials were used such as local stone and wood. Moreover, the design combined the rainwater, gray water, PV panels, and green roofs as sustainable design tools. The design proposal achieved saving 26% of energy consumption and 24.5% CO_2 emission reduction.

Figure Z.12: Sustainable Meaningful Livelihoods in the City “Ece Güleç” -1

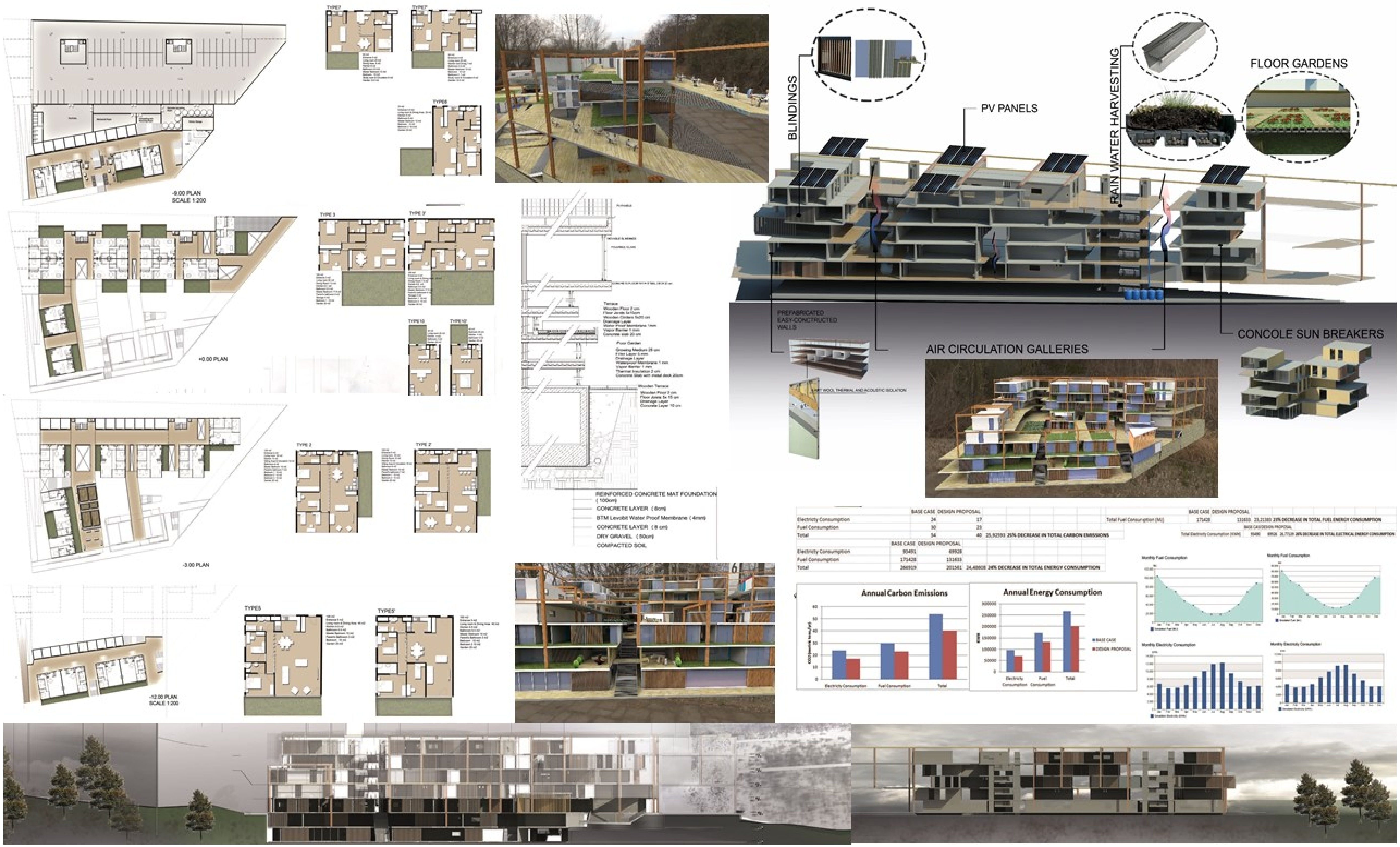


Figure Z.13: Sustainable Meaningful Livelihoods in the City “Ece Güleç” -2

Organic housing ‘grow your health products’, Bayrakli by “Ezgi Çam” main concept was based on the permaculture principles that was a direct respond to the existing local residents in Bayrakli where they adapted to grow their healthy products (Figures Z.14 & Z.15). Houses, social, and commercial areas included spaces at various level allowing residents to plant, grow, collect, store, and sell their products. The three aspects of sustainable design principles were exploited in the proposed design. Courts, gardens, and terraces provided suffusion natural light and natural ventilation to internal spaces. The use of local natural materials combined with manufactured sustainable materials provided lower level of energy consumption and economic cost. Rainwater were used to grow the plants and sun energy PV panels provided energy for the community. The social aspect of sustainability were accomplish throughout sharing all activities among the residents. The proposed design managed to save 25% in energy consumption and 25% in CO_2 emission reduction.

Figure Z.14: Organic Housing - ‘Grow Your Healthy Products’, Bayrakli, Izmir “Ezgi Çam” - 1

Figure Z.15: Organic Housing - ‘Grow Your Healthy Products’, Bayrakli, Izmir “Ezgi Çam” - 2

CURRICULUM VITAE

KAMAL ELDIN MOHAMED

Nationality: Egyptian
Place of Birth: Cairo - Egypt
Instructor of Architecture Design & Building Construction
Department of Architecture
Faculty of Architecture
Izmir Institute of Technology
Gulbahce Koyu, Urla, Izmir 35430
W (232) 750 7091
kamalmohamed@iyte.edu.tr

EDUCATION

Degree	Institution	Year of Graduation
MS	Dept. Arch., Clemson University, SC, USA	1994
BS	Dept. Arch., Alexandria University, Egypt	1987

WORK EXPERIENCE

Year	Place	Enrollment
2004 - Present	Izmir Institute of Technology	Instructor
2000 - 2004	Campus Design, Florida State University, Tallahassee, FL, USA	Project manager
1997 - 2000	National High Magnetic Field Laboratory, FSU, Tallahassee, FL, USA	Architecture designer
1995 - 1997	Virginia Commonwealth University, Richmond, VA, USA	Construction inspector
1993 - 1994	Clemson University, SC, USA	Research assistant
1991 - 1993	Brooklyn , NY, USA	Freelance architect
1987 - 1990	Elsaiid Contractor, Alexandria, Egypt.	Architectural Engineer

FOREIGN LANGUAGES

Arabic, English, and Turkish

PUBLICATIONS

1. Mohamed, Kamal Eldin; Ozkan, Soofia Tahira Elias 2017. "Sustainable architectural design education: A pilot study in a 3rd year studio." Al Azhar 14th

International Conferance (AEIC) on: Engineering, Architecture & Technology, Cairo, Egypt, 12-14 December 2017.

2. Mohamed, Kamal Eldin, and Zeynep Durmuş Arsan. 2017. BIF Ideas for Bornova: Municipality of Bornova Yuoth Hub Design Project / BIF Bornova için Fikirler: Bornova Belediyesi Gençlik Merkezi Tasarım Projesi. Izmir, Turkey: Bornova municipality.

3. Mohamed, Kamal Eldin, and Zeynep Durmuş Arsan. 2016. BIF Ideas for Bornova: Municipality of Bornova Culture Centre Design Project / BIF Bornova için Fikirler: Bornova Belediyesi Kültür Merkezi Tasarım Projesi. Vol. 2. Izmir, Turkey: Bornova Municipality.