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A "LEARNING BY DOING" APPROACH IN THE DELIVERY OF STRUCTURAL ENGINEERING COURSES OF ARCHITECTURE

Assist Prof. Dr. Gökhan YAZICI
Istanbul Kultur University
İstanbul- TURKEY

Assist Prof. Dr. Yasemin ERKAN YAZICI
Istanbul Kultur University,
İstanbul- TURKEY

ABSTRACT

A through understanding of the principles of structural system design is particularly important for architects practising in Turkey where over 90 percent of the population reside in seismically active regions and the structures built must withstand the damaging effects of severe earthquakes. However there are problems incorporating the classroom based structural engineering courses into architectural design curriculums which are largely centered on the architectural design studio. The students of architecture are accustomed to the "learning by doing" approach used in the design studio and have a hard time adjusting to the classroom delivery of structural engineering lectures which largely use mathematical abstraction to communicate concepts of physics. This paper presents the findings of a study conducted at the Faculty of Architecture of Istanbul Kultur University to investigate the use of a "learning by doing" approach at the Building Mechanics course to increase the motivation and the academic performance of students.

Key Words: Architectural Education, Building Mechanics Instruction, Learning by Doing.

INTRODUCTION

Structural system design is a complex process which involves the multidisciplinary collaboration of architects and structural engineers (Yazıcı and Erkan Yazıcı, 2012). In practice, architects start out by developing a conceptual design of the structure based on the client's demands, spatial constraints, building program, aesthetic concerns and various other factors. Afterwards, architects then pass the conceptual design to structural engineers and ask them to develop a structural system that will safely carry the loads acting on the structure. Usually architects suggest an idea for the structural system based on experience from "similar" design projects and designate the preferred locations and approximate dimensions of the structural system members on the architectural plans. Architects may also prefer to leave the design of the structural system entirely to structural engineers. In the first case, structural engineers examine the system suggested by the architect, design the structural members and connections according to structural design codes and communicate their structural design back to the architect. The problem with this approach is that it may lead to design fixation resulting in generic designs based on mental solution templates developed over years of experience. In the second case, structural engineers come up with a variety of structural system configurations while considering the formal and functional constraints shown on the architectural plans and communicate their design ideas back to the architect. Although, this may result in more efficient structural designs, this approach can increase the duration of the project development phase, particularly if the communication between the engineers and architects is weak. In any case, structural system design is an iterative process and

the duration of this process largely depend on the strength of the communication between the architects and engineers.

Architects require a thorough understanding of the principles of structural system design in order to communicate efficiently with structural engineers. This is particularly important for architects practising in Turkey where over 90 percent of the population reside in seismically active regions and structures must withstand the damaging effects of severe earthquakes. Therefore it is vital to provide a solid understanding of the fundamental concepts of mechanics, the mechanical properties of structural materials and other important concepts related to structural design at the undergraduate level of architectural education. Incorporation of the structural engineering courses into the curriculums of architectural design which are largely centered on the architectural design studio, is not an easy task. The students of architecture are accustomed to the "learning by doing" approach used in the design studio and have a hard time adjusting to the classroom delivery of structural engineering lectures which largely use mathematical abstraction to communicate concepts of physics. Hence, various studies have been conducted to find appropriate ways of conveying essential structural engineering knowledge to students of architecture (Erkan Yazıcı & Yazıcı, 2011), (Rodrigues, Rodrigues and Werner, 2008), (Schön, 1988), (Coskun, Aygün & Özgen, 1998).

This paper presents the findings of a study conducted at the Faculty of Architecture of Istanbul Kultur University to investigate the use of a "learning by doing" approach at the Building Mechanics course to increase the motivation and the academic performance of students.

EMPRICAL STUDY

The Building Mechanics course for the students of architecture at the Istanbul Kultur University is a condensed synthesis of the courses of statics and strength of materials. Statics and strength of materials courses are perhaps the most important courses in civil engineering curriculums and lay the theoritical foundations for a wide range of structural design courses. The students of civil engineering go through these classes in 3 semesters. The building mechanics course at the department of Architecture only covers the fundamentals of mechanics in the context of structural design. The statics component of this course focuses on developing a solid understanding of the behaviour of rigid bodies under forces and moments as well as the mechanical abstraction of the structures and structural loads. The strength of materials component of this course focuses on the behaviour of deformable bodies. The concepts of stress and strain, the mechanical properties of materials as well as the fundamentals of the design of beams, columns and and structural connections are covered within the scope of strength of materials.

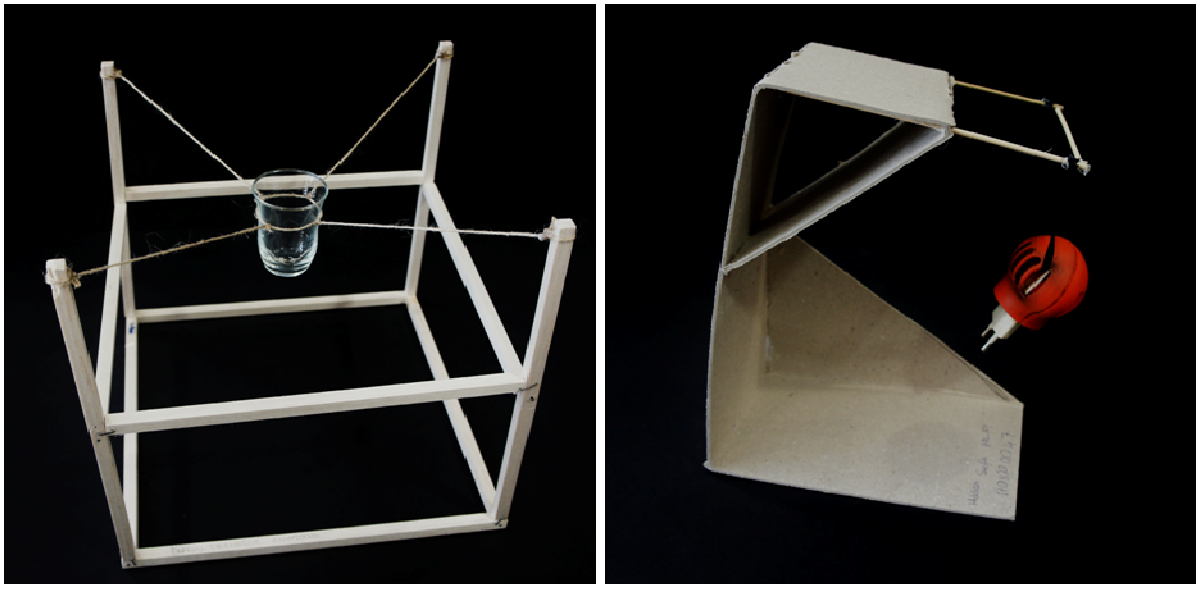
Delivery of the building mechanics course cannot be and should not be expected to be identical to the delivery of the mechanics courses at civil engineering curriculums due to constraints on time and the differences in the objectives of the courses. However, students of this course should be have a basic understanding on the overall design of structural system components and be able to exchange their design ideas more efficiently with structural engineers.

An emprical study has been conducted with 57 freshman students of the building mechanics course at the Department of Architecture of Istanbul Kültür University in order to increase their motivation towards the course and to facilitate the understanding of the theoretical concepts of mechanics. The study presented here has been initiated after the students were introduced to the concepts of forces, moments and equilibrium.

The students who have participated to the study were given the task of holding an object with a mass of at least 150 grams in the air without a direct support from underneath. Students were allowed to use the materials of balsa wood, string and cardboard, which are commonly used in architectural models. The largest dimension of the models was limited to 50 centimeters. Students were asked to consider the aesthetic aspects

just as well as the structural aspects of their design. The instructions were kept as vague as possible in order to avoid the effects of design fixation (Erkan Yazıcı, 2011) through examples or guidance. Students were given two weeks to turn in their models along with a brief written report describing the difficulties they have encountered in assembling the parts and making the model stand up. Examples of the models created by the students are presented in Figure 1.

Brief interviews with a limited number of students were conducted on the working principles of their models at the end of the study. Students were given information on the weaknesses and the strengths of the sytems they have come up with during the course of these interviews. Throughout the course of the discussions, students were encouraged to explain the working principles of their structural models as well as the possible reasons for the difficulties they have referenced in their written reports by using the concepts of forces, moments and equilibrium. Feedbacks from the interviews indicate that creating simple physical models and orally communicating their design process had a positive impact on the motivation of the students towards the course.



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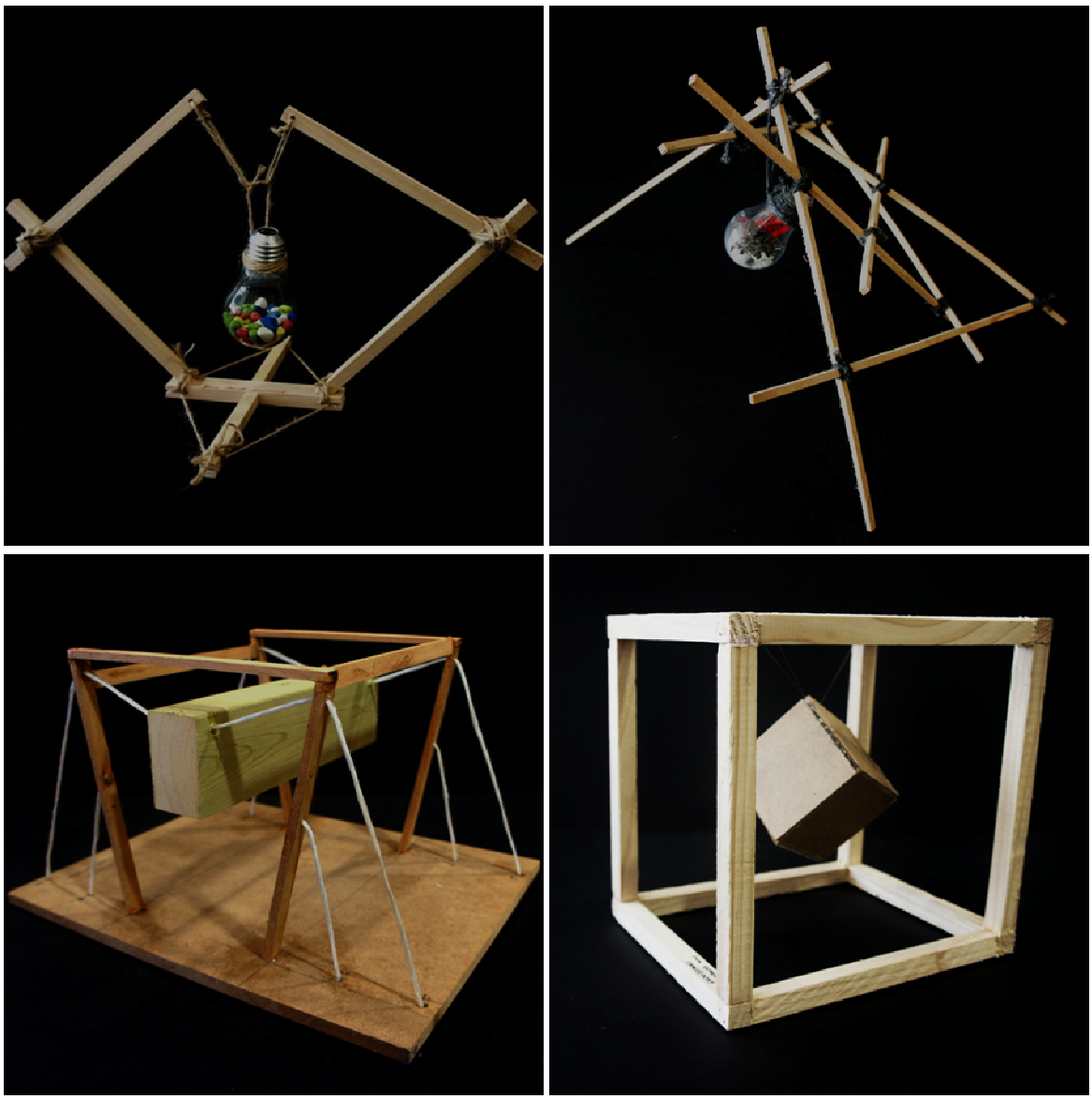

Figure 1: Examples of the Structural Systems Developed by the Students

CONCLUSIONS

Students of architecture are introduced to working within a design studio, starting from the first year of architectural education. The design studio is a unique learning environment which is built on the principle of 'learning by doing' where all the architectural knowledge obtained is put into practice. However, the integration of architectural knowledge obtained from classroom teaching environments, particularly the theoratical knowledge from structural engineering, is a very challenging task. One of the challenges is due to students' difficulties in switching back and forth between different modes of instruction (Erkan Yazıcı & Yazıcı, 2012). Design studio is the core of architectural design education and is based on the principle of "learning by

doing" whereas structural engineering courses such as structural mechanics is based on the use of mathematical abstraction to communicate concepts of physics in a classroom environment.

First and foremost, a classroom based treatment of the concepts of mechanics through mathematical abstraction is absolutely essential for the delivery of the key concepts of this course. However, making use of a "learning by doing" approach such as the one described in this study to supplement the classroom teaching with active experimentation can facilitate the integration of the concepts of mechanics to design studio work.

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BIODATA AND CONTACT ADDRESSES OF AUTHORS

Gökhan YAZICI is an assistant professor of Civil Engineering at the Istanbul Kultur University. He completed his BSc Degree in Civil Engineering from the Yildiz Technical University (1998), and received his MSc (2000) and PhD (2008) Degrees in Structural Engineering from the Istanbul Technical University. He has experience in teaching structural engineering courses in the Departments of Civil Engineering and Architecture. His research interests in the field of undergraduate education include the enhancement of the collaboration between architects and engineers in the design process and the use of finite element modeling tools in the architectural design education.

Assist. Prof. Dr. Gökhan YAZICI
Faculty of Engineering
Istanbul Kultur University
Bakirkoy, Istanbul- TURKEY
E. Mail: gyazici@gmail.com

Yasemin ERKAN YAZICI is an assistant professor of Architecture at the Istanbul Kultur University. She received her BSc Degree in architecture as the valedictorian of her class from the Trakya University (2000) and afterwards pursued a graduate degree in project management at the Istanbul Kultur University (2002). She has received her PhD Degree in Architecture from the Yildiz Technical University (2010). Her teaching activities concentrate on architectural design studio, architectural drawing methods and computer aided architectural design. Her research interests include first year architectural education, computer aided architectural design and the effects of cognitive styles on the architectural design process.

Assistant Prof. Dr. Yasemin ERKAN YAZICI
Faculty of Architecture
Istanbul Kultur University
Bakirkoy, Istanbul- TURKEY
E. Mail: yaseminerkanyazici@gmail.com

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