

## **Integration of building information modeling into the undergraduate curriculum: case of Eastern Mediterranean University**

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### **ABSTRACT**

One of the essential requirements of construction education is to remain up to date and current. It is quite important for universities to adopt new technologies in construction education curriculum. Building Information Modelling (BIM) as a new technology and tool is one of the latest developments in construction industry. The function of BIM as an advantageous course and also an educational assistant in Civil Engineering education at universities is not completely understood to date. Many construction companies prefer to employ BIM enabled graduates nowadays. Thus the question is to what extent students are aware of BIM and are ready to begin learning such a new technology.

In order to answer this question, a survey was conducted among different undergraduate students at Civil Engineering Department of Eastern Mediterranean University. Focus of the survey was on AutoCAD knowledge and students' abilities together with their awareness of BIM. Adding BIM as a standalone course in the curriculum of the Civil Engineering Department was also studied. The outcomes of the survey proved students' interest in integrating BIM as a separate course in undergraduate curriculum. Details of such an integration including how and when to consider BIM were also proposed. The authors suggest including BIM in the Civil Engineering undergraduate curriculum to have knowledgeable and up to date graduates while it is also recommended to be used as an educational assistant in other Civil Engineering courses.

**KEYWORDS:** *Building Information Modeling, Civil Engineering, Eastern Mediterranean University, Undergraduate Curriculum*

## **INTRODUCTION**

Smith [1] defined BIM as “a digital representation of the physical and functional characteristics of a facility and shared knowledge resource for information about a facility, forming a reliable basis for decisions during its life-cycle from earliest conception to demolition.” It is essential to consider that BIM should not be goal; it is just a tool to help project members to achieve their goals [2].

After the ruler and oblique era and there after Autodesk’s famous tool AutoCAD, it is time to go toward using new technologies [3]. New easy to use and multi functional software based on new technologies are being used in construction industry in developed countries like United States nowadays. One of the latest improvements in the construction industry is using various types of Building Information Modelling enabled software. Building Information Modelling (BIM) is technology of applying a primary and fundamental digital model of all building information, for different stages of the construction project. It creates a considerable change in the procedure usually done during the design and construction of a new building. Improved project construction results, smaller errors, reduced amount of exclusion and clashes, are advantages of BIM [4].

Beside health and safety issues and since lower cost, better quality and finishing the project in scheduled time are three sides of iron triangle for a successful project; BIM technology is becoming more popular relatively. BIM enabled construction companies in the United States and some are rapidly growing [3].

The era of using CAD in construction companies is declining under the influence of the BIM technology and software like Revit. Advantages like considerably faster drawing of the building views and elements beside the significantly reduction on inaccurate estimations for the BIM technology, and its software packages, make construction industry to go toward it [5]. Abovementioned advantages make demands in construction industry for BIM educated civil engineers to involve them in their BIM enabled projects.

Nowadays, using BIM in construction industry is highly estimated to be applied in countries other than United States and Canada [6]. Construction companies are looking for BIM enabled engineers. Engineers with BIM skills have a better chance to be employed in such companies. Therefore, insertion of BIM into the Civil Engineering undergraduate and graduate education curriculum might be effective [7]. Construction educational institutes and Civil Engineering departments in universities should have strategies and plans in order to have graduates with BIM capabilities for construction industry [4].

In most of the Middle Eastern countries, application of BIM in construction industry is not yet common, and there is not specific demand for it. Since majority of Eastern Mediterranean University’s students are from Middle Eastern countries, and in order to have some share in improving the construction industry of these countries, applying BIM to the curriculum seems to be advantageous.

The main purpose of this paper as part of a larger research is to study on including BIM into the undergraduate curriculum at the Eastern Mediterranean University’s Civil Engineering Department. Main research covers a questionnaire survey that was conducted among undergraduate Civil Engineering students and graduate Master and PhD construction management

students together with a number of structured interviews with lecturers of the Civil Engineering department. Aim of the investigation was to find out when and how BIM can be integrated into undergraduate and/or graduate curriculum. Moreover, awareness and readiness rate of the academic staff and students to BIM integration was studied.

## **Background**

It is obvious that BIM education is required in schools teaching architecture, engineering, and construction [8]. Eastman et al. claimed that learning BIM is much easier in comparison with learning CAD tools [9].

To adopt BIM toward construction industry, universities and construction institutes should be responsible to breed BIM enabled civil engineers. Some research studies have been conducted on this issue to identify the strong and weak points of introducing and integrating BIM into the curriculum of the Civil Engineering departments and construction institutes.

Gier concluded that BIM seems to be an effective educational tool to teach construction estimating and take-off skills. He also stated in another research that BIM will be make greater contributions to construction management students plan reading skills and their better understanding of construction methods, materials, and processes [10].

Livingston stated that use of BIM in architecture schools as a course is similar to its usage in real projects and it is essential to consider this course in university curricula [11].

Sabongi conducted a survey on AutoCAD and BIM. He asked whether BIM should be offered as stand-alone course or as part of other courses. Also he made some questions to identify the obstacles in the approach of including BIM in the curriculum [3].

Clevenger et al. studied and focused on the development of “BIM teaching modulus” in the construction management department of Colorado State University. They suggested developing construction management curriculum to facilitate better learning and understanding throughout the use of BIM [4].

Cooksey and Schiff recommended inclusion of BIM into Civil Engineering curriculum in different levels. They stated that “The students need to have knowledge of the capabilities of BIM and how to effectively use the tool as they enter the profession” [12].

Liu and Killingsworth stated that “visual illustrations significantly contribute to teaching construction topics by improving the demonstration of complicated concepts such as building components” [13].

Review of the literature proves the need of Civil Engineering departments for a course related to Building Information Modeling. This need can specially be observed in Middle Eastern universities and in case of this study, Eastern Mediterranean University since it is and international university which provides service to most Middle Eastern countries and its graduates have a considerable share in construction market.

## Methodology

To bridge the gap and achieve research objectives, a questionnaire survey was conducted among Civil Engineering undergraduate students of Eastern Mediterranean University.

The questionnaire included 17 close-end questions. The first part was about students' academic semester and job experiences. The second part asked their skills in hand drawing, 2D CAD, and 3D modeling. The aim of third part was to address knowledge of students about BIM and their opinion in offering a course based on BIM usages.

Total number of 254 students responded. Distribution of respondents in terms of their academic semesters is shown in Figure.1.

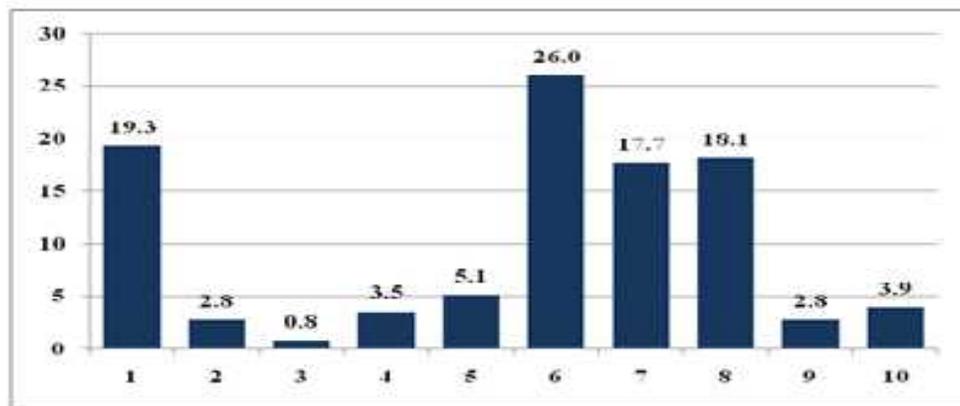


Figure 2 Percentage of Respondents in Terms of Academic Semester

To distinguish between experienced and inexperienced students, respondents were asked to answer "Did you work in any civil engineering technical office?" Figure.2 shows the percentages of experienced and inexperienced respondents.

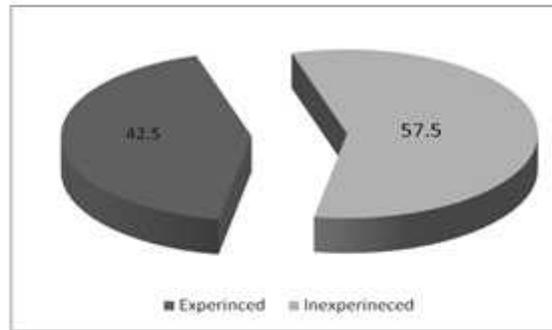


Figure 3 Percentages of Respondents in Terms of Work Experience

Regarding the Figure.1, students in second academic year (3rd and 4th academic semesters) have the lowest number of respondents because the target population was selected through participants of three courses. These three courses were: Civil Engineering Drawing, Civil Engineering Construction & Economy, and Construction Management which are offered in first, third, and fourth academic years respectively. The reason of selecting this population as sample was relevance of these courses with design and management of construction, which are two main areas of BIM usage.

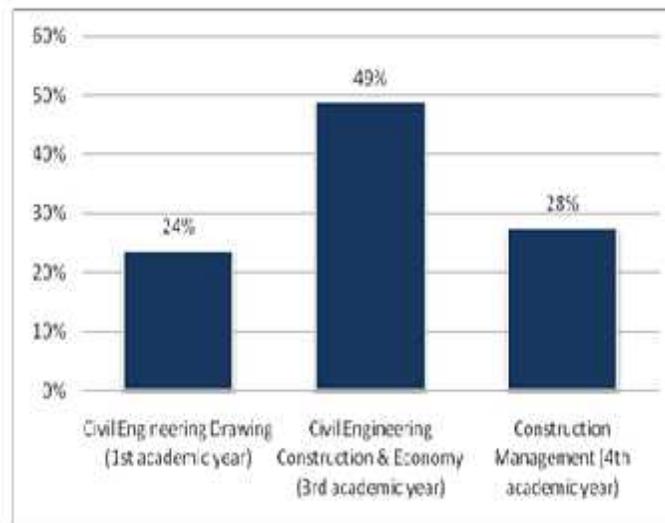


Figure 4 Percentages of Respondents in Terms of Participated Course

## RESULTS AND DISCUSSION

According to the questionnaire structure, results of the survey were divided into the following main categories: ability and skills in drawing, knowledge about BIM, opinions and

viewpoints about applying BIM-based course in undergraduate curriculum, and finally barriers which lead to lack of such course from students' point of view.

### Drawing Abilities and Skills

Although the hand drawing was bypassed while CAD drawing became popular, according to hand drawing usefulness in better understanding of design concept, hand drawing course is offered for freshmen by most of Civil Engineering departments worldwide. In Eastern Mediterranean University, hand drawing and CAD drawing are offered together as one course.

Respondents answered three questions to determine their skills in hand drawing, 2D CAD drawing, and 3D modeling. Regarding these answers, students approximately had same ability in hand drawing and 2D CAD drawing. Considering hand drawing and 2D CAD drawing, about 38 percent of respondents were in beginner level and students with intermediate, advanced, and no skill were in next positions with about 35%, 15, and less than 8 percent respectively. Less than 6% of students claimed that they are in expert level. The trend for 3D modelling is as same as hand drawing and 2D CAD drawing with the exception that non-skilled persons were largest population with 40%, and by increasing the level of skill in 3D modelling the population being smaller constantly (Figure.4).

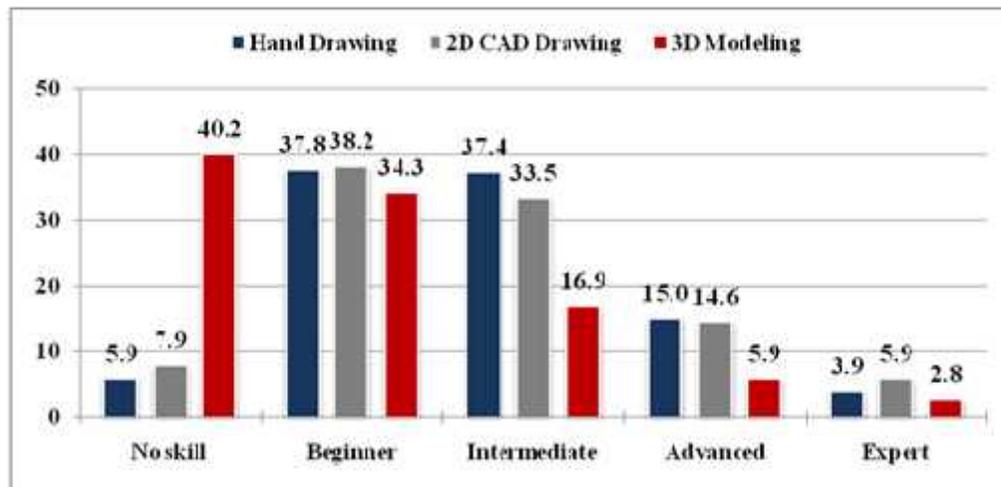


Figure 5 Students' Skill in Different Types of Drawing

Regarding to Figure.4, lack of BIM training between freshmen's courses is obvious. Since understanding the concept of BIM for freshmen is incomprehensible, a brief introduction about BIM even amongst design tools (although the BIM is much more a managerial tool than design tool) seems essential.

To evaluate the usefulness of the drawing courses, students were asked a question that "Can you draw a plan for a 1 storey building with AutoCAD?" Only 71 percent of students

answered “YES”. The first thing that comes to mind is that despite teaching hand drawing and CAD drawing as a course “Why 29% of students even cannot draw a plan for a 1 storey building with AutoCAD?” The reasons might be that the course is not effective or students cannot employ their skills in drawing into building design. According to characteristics of BIM in using real elements such as walls and windows instead of lines which are used in hand drawing and 2D CAD for design, implementing BIM will lead to better understanding and imagination of students about building elements.

## **BIM Knowledge**

Even though the concept of BIM is introduced to construction industry by academia, but BIM is in its infancy and needs more efforts to become well known among students, especially in undergraduate level.

To obtain the students’ level of awareness about BIM, they were asked a question as “Did you hear about BIM?” Answers to this question had unexpected variety. Less than half of the seniors (about 46%) answered “YES”, but juniors had little knowledge of BIM and just 29 percent of them had heard about it. Freshmen were placed in the middle of seniors and juniors and 35 of them answered “YES” (Figure.5).

3D model awareness was very similar to BIM knowledge, totally 44 percent of students claimed that they have seen construction details in 3D modelling at any course and 56% had not seen. Regarding to this results, this question arises that “Why level of knowledge about BIM by increasing the academic semester has a fluctuated trend?”

The changes in staffs and syllabus of courses in recent semesters can be a reason for this issue. Students were not notified about BIM in design courses, so level of knowledge among juniors is low unlike seniors and freshmen who BIM is recently introduced to them. With

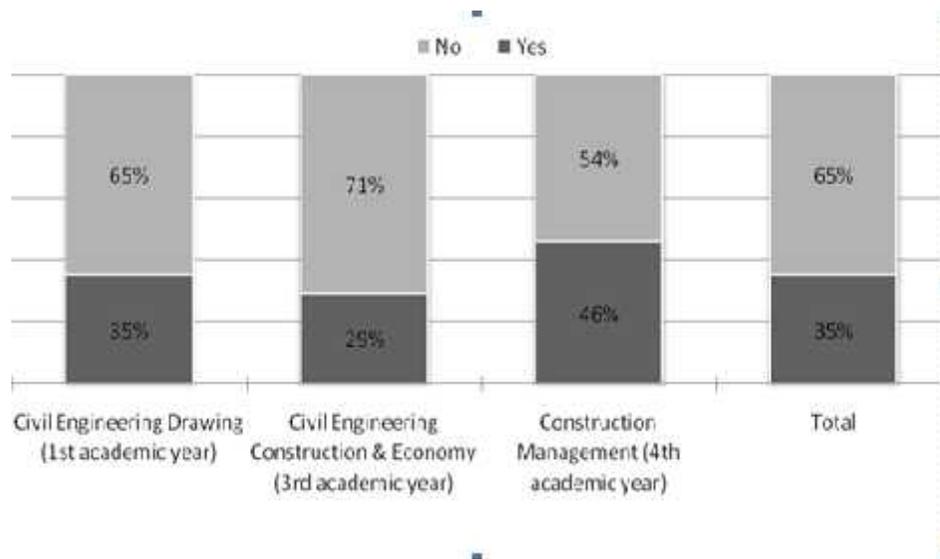


Figure 6 Percentages of Participants in Different Courses in Terms of Answer to Question: “Did you hear about BIM?”

introducing BIM in first and fourth academic years, new students will briefly be familiar with BIM during design courses in initial semesters and will be trained to use BIM in advanced as a tool in managing project in their last semesters, also old students will gain profit by being trained in BIM at least during one course in their last year of study.

According to low number of students with knowledge of BIM (35%), a brief definition of BIM was presented to students then they were asked to answer further questions.

### **BIM Based Course**

One of the main advantages of using BIM in undergraduate courses is to understand the details of construction better by 3D model. Students’ opinions about extent of the usefulness of 3D modelling for better understanding of details in courses were asked. About one third of the students thought that it is useful by 50%. 21% claimed that 3D modelling is useful by extent of 70% and 18% believed it is 100% useful. The percentage of students which supposed extent of 3D modelling usefulness to understand details in courses are zero and twenty five percent were 17% and 14% respectively. (Figure 6)

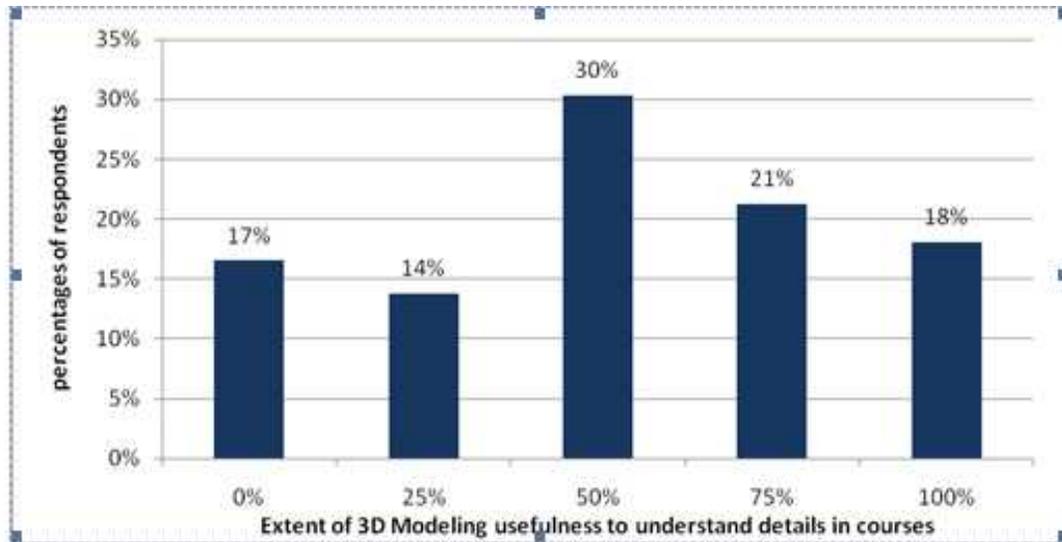


Figure 7 Extent of 3D Modeling Usefulness for Better Understanding of Details in Courses

Since in previous research by Ahabab et al. which conducted among Civil Engineering graduate Students of Eastern Mediterranean University, more than 72% percent of respondents mentioned “Undergraduate Level” as their preferred level for offering BIM as a course [7], to find out importance of including BIM as a course from undergraduate students’ point of view, they answered following question: “If BIM offered as a course in the next semester, will you take it?” The freshmen were more interested in taking a BIM based course with about 77%, seniors and juniors were in next levels with 64% and 45% respectively. Higher number of students which were interested in BIM course among freshmen stated that offering such course in first academic year will be more effective (Figure.7).

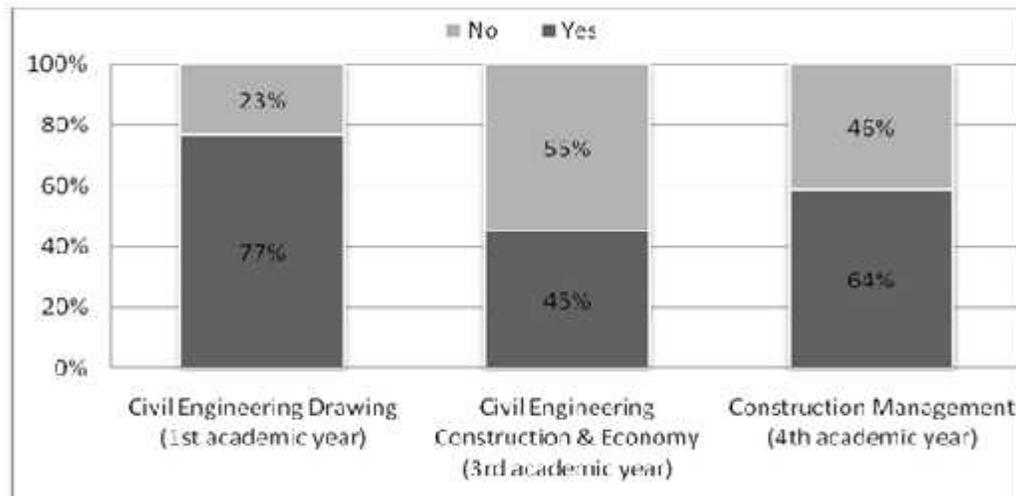


Figure 8 Willing to Take BIM Based Course in Next Semester

65% of students declared that they think offering BIM as an elective course is more appropriate and 35 percent preferred it as mandatory.

Students' viewpoint about the academic year which BIM course must be offered was different. 20% believed that first academic year is the best time for this reason, while second, third, and fourth academic years were equal with about 27 percent.

## CONCLUSION

The aim of this research was to build up advices for including BIM into Civil Engineering undergraduate curriculum of Eastern Mediterranean University. To reach to this aim, a background study and a questionnaire survey over undergraduate students were conducted. The purpose of questionnaire was to determine in what extent undergraduate students are aware of BIM and ready to learn it. Moreover, it was carried out to emphasize the importance of adding BIM into the curriculum even as an elective course.

It is suggested to include "an introduction to BIM" course in the first or second semester to make students familiar with this technology. Since students already learned the AutoCAD in the first year, it is also suggested to include a BIM related software course in the 3rd or 4th year of their study.

A BIM enabled student will have a better understanding of construction details. Therefore the quality and scientific literacy of graduated students will increase relatively. BIM training in academia will give opportunity for students to get themselves ready to enter the work easily and with more confidence

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