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An Implementation of Multi-Media Applications in Teaching Structural Design to Architectural Students

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***Abstract*—**Teaching methods include lectures, workshops and tutorials for the presentation and discussion of ideas have become out of date; were developed outside the discipline of architecture from the college of engineering and do not satisfy the architectural students' needs and causes them many difficulties in integrating structure into their design. In an attempt to improve structure teaching methods, this paper focused upon proposing a supportive teaching/learning tool using multi-media applications which seeks to better meet the architecture student's needs and capabilities and improve the understanding and application of basic and intermediate structural engineering and technology principles. Before introducing the use of multi-media as a supportive teaching tool, a questionnaire was distributed to third year students of a structural design course who were selected as a sample to be surveyed forming a sample of 90 cases. The primary aim of the questionnaire was to identify the students' learning style and to investigate whether the selected method of teaching could make the teaching and learning process more efficient. Students' reaction on the use of this method was measured using three key elements indicating that this method is an appropriate teaching method for the nature of the students and the course as well.

***Keywords*—**Teaching Method, Architecture, Learning style, Multi-Media.

I. Introduction

PRINCE SULTAN UNIVERSITY (PSU) presents architecture education as critical practice that integrates a complex array of social, ethical, and ecological concerns with the teaching program in the department of architecture. The program aims to "enhance student knowledge of procedures and properties of architectural technologies and materials through which building are constructed; knowledge of practice of building industry and their sites relations, as well as their social, political, legal, and economic influences on design and construction. It also aims to enhance knowledge of procedure and concepts of structural, knowledge of building systems and their integration for human comfort [1].

In line with the above, PSU introduces the course of structures for architects II for third year architectural students. At this level, students become familiar with structural analysis and a variety of architectural design aspects. The course aims to build students understanding in the behaviour and planning of structure as well as teaches students principles of structural behaviour and appropriate application of contemporary structural systems. The intention of the proposed course is not simply to deliver information, but to encourage and inspire students to acknowledge structural design as an important contributor to the nature and experience of architecture [2]. At the end of this course students shall be able to command behaviour and planning of structural system, command principles of structural behaviour, design structural systems on both the conceptual as well as computational levels by covering the standard considerations of designing steel and reinforced concrete structures according to the international building codes.

In achieving the program goals, PSU introduced a variety of methods in order to make learning effective. These methods include lectures, workshops, and tutorials for the presentation and discussion of ideas. According to many authors, including but not limited to [3]-[5], the above teaching methods cause a fundamental problem in teaching architectural students within academic architectural department, specifically talking about teaching structural courses. This is due to the fact that the nature of structural courses which requires a strong mathematical and engineering capabilities, does not match architectural student who do not have a strong mathematical background, but they do possess a strong facility for and training in three-dimensional visualization and can quickly absorb information through this medium.

This paper focused upon finding an appropriate educational method to teach architecture students the theory of structural design taking into consideration their visual learning style. According to [6] architectural students learn best through graphs, pictures, and images, since they need to "see" new ideas or concepts.

Current teaching methods and the selection of the most appropriate ones taking into consideration the learners learning style is covered in more details in the below section.

II. Teaching Method and Learning Style

Effective teaching requires flexibility, creativity, and responsibility in order to provide an instructional environment able to respond to the learner's individual needs [7]. The activity of teaching is more than just information transfer [8]. What is critical is that lecturers should ensure that students understand concepts, and that they can reason and process information in order to apply it in real-life situations [9].

The traditional teaching methods highlighted in the first part of this paper has become out of date and were developed outside the discipline of architecture from the college of engineering. According to [4] the use of such methods does not satisfy the architectural students' needs and causes them many difficulties in integrating structure into their design. The integration problems remained because of the tension between

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creative thinking (the artistic side) and technical aspects (the engineering i.e. science and technology side) [5]. This was further supported by [10] who indicated that there is a lack of integration of structural knowledge in architectural student design application.

Reference [11] noted in their study that many instructors had put emphasis on trying to help learners learn more effectively [12]. In order to facilitate effective learning for learners, [13] suggested that instructors could vary their teaching strategies. Selection of the most appropriate teaching strategy has to take into consideration preferable student learning styles. Reference [14] argued that students have different learning styles and the manner in which they receive and process information is influenced by their characteristics, strengths, and preferences. Learning styles differ from student to student; [15] points out that lecturers should take this into cognizance when preparing learning content or activities. Reference [16] has shown that teaching styles when matched with learning styles result in favorable learning outcomes [9]. Thus, teaching strategies need to engage learners and focus on active learning [17]. One of the ongoing challenges that university teachers face is related to matching the teaching strategies with the students' learning styles in order to improve the academic achievement [7]. This should make the instructor more effective in the classroom, make the student a more efficient learner, and make student-faculty interaction as effective and efficient as possible.

This paper focused upon addressing the problem of teaching architecture students the theory of structural design taking into consideration their different learning style. The problem lies in teaching architectural students- who place great emphasis on synthesis, imagination, cultural context and planning- versus structural courses which emphasize on analysis and computational techniques.

Most architecture students do not have a strong mathematical background, but they do possess a strong facility for and training in three-dimensional visualization and can quickly absorb information through this medium. Visual learners learn best through graphs, pictures, and images, since they need to "see" new ideas or concepts [6]. Therefore, any approach, which is used to teach architecture students effectively and to promote an intuitive understanding of the subject, needs to be sensitive to these issues [4].

In light of the aforementioned discussion, it could be concluded that if architecture students are to effectively learn and apply structural analysis and design, teaching methods must respond to the students' needs, capabilities, and perspectives [4]. Particularly for architecture students, the instruction of structures should be visually and spatially grounded, so that it is understood as an integral part of the conceptual and theoretical aspects of design.

The problems with the current methods to teaching structures are, as mentioned earlier, rooted in the use of an engineering based model, which is founded on abstraction and reduction. In an attempt to improve structure teaching methods, the researcher proposed a supportive multimedia teaching/learning tool that seeks to better meet the architecture student's needs and capabilities and improve the understanding and application of basic and intermediate structural engineering and technology principles. This includes an Engi-Lab software and You-Tube Videos which uses a wide range of digital and graphic technology including computer generated three-dimensional models, interactive images, full motion video, audio narration, and hypertext functionality to improve the teaching and learning of structural concepts.

III. Data Collection and Analysis

The data were collected using a questionnaire survey which was distributed to third year students of a structural design course who were selected as a sample to be surveyed forming a sample of 90 cases. The primary aim of the questionnaire was to identify the students' learning style and to investigate whether the selected method of teaching could make the learning and teaching process more efficient.

The questionnaire commenced with the easy questions that student would enjoy answering; such as student's GPA. The more complex questions were presented within the middle and end of the questionnaire form and open question were kept at the end. This was recommended as good approach to gaining the commitment of the informants [18]. The questionnaire was designed, with the aid of literature as shown in Appendix B, to collect only information that was related to the research question. The questionnaire was two pages in length with eight questions. The variables of the questionnaire were measured using two measurement formats Likert scale and a checklist.

The collected data from the questionnaire were analyzed using Excel Spread Sheet. Each student was asked to provide details about her GPA. The responses to this question would enable classification of students in terms of their GPA into different categories. These categories are good, very good and excellent as shown in Table I.

TABLE I
Students' GBA

GBA	No of case	%
Good	0	0%
Very Good	35	39%
Excellent	55	61%

A. Methods of Teaching Structure Analysis

The students were asked to indicate their opinion on the methods that could be used to improve their understanding of the course material. These methods were, learning using TV/Video; learning using TV/Video in compensation with writing on the board; learning by relating what you have learned to practical or real life; and learning by giving more examples. Due to the limited number of cases agree and strongly agree categories were added, the same thing was done to disagree and strongly disagree. The descriptive statistics shown in Table II below indicated that 83% of the students prefer to learn by relating what they have learned to practical or real life and 78% of the students agree that using a combination of both TV/Video and writing on board is the

appropriate method of learning. This gives an indication that relating what the students have learned to the real life using TV/Video could be of a great effort in improving their understanding of the course material.

TABLE II
TEACHING METHODS TO IMPROVE STUDENTS' UNDERSTANDING OF COURSE MATERIAL

Method of learning	Using TV/Video		TV/Video and Board		Relating to real life		More examples	
	No	%	No	%	No	%	No	%
Agree	45	50%	70	78%	75	83%	75	83%
Neither Nor	25	28%	15	17%	15	17%	15	17%
Disagree	20	22%	5	5%	0	0%	0	0%

To establish whether there was a significant difference between the group of students classified based on their GPA and these methods of learning descriptive statistics was carried out indicated that 67% of the students who prefer to learn by relating what they have learned to practical or real life were students of excellent GPA. This strengthens the findings of the previous paragraph and gives the results more reliability.

B. Students Learning Style

The students were given three categories and were asked to rate how each of these categories contributes to their retention of information. These categories were: reading; hearing and seeing demonstrations (i.e. diagrams, pictures, or videos). The descriptive statistics shown in Table III indicated that 89% of the students agreed that seeing demonstrations like videos have the greatest contribution on their retention of information, followed by hearing 72% of the students agreed and reading 44% of the students agreed on. This indicated that Architectural students are visual learners and supported the previous findings by [6] who reported that visual learners learn best through graphs, pictures, and images, since they need to "see" new ideas or concepts and demonstrates the student need seen demonstrations to enhance their understandings and retention of information. No significant differences were found between the 3 different groups of students.

In order to investigate whether demonstrations (i.e. Videos, pictures, diagram……etc.) are the only need by students in order to retention information, students were provided with indirect question and were asked to provide information on what most likely they remember when seeing diagrams; the pictures or what the instructor said about. The descriptive statistic that was carried out on this question indicated that 50% of the students most likely remember pictures and the other 50 most likely remember what the instructor said about it, highlighting no significant difference between the two categories. This indicated that the students besides the demonstrations (videos, TV, pictures….etc.) the need instructors description and explanation on it and at the same level of importance. The finding of the question was supported by the next question where the students were asked to indicate whether they like the teachers who put more demonstrations or the teachers who spend more time explaining. The descriptive statistic carried out on this question shows very close percentages to the two categories, 56% of students like teachers who put more demonstrations and 44% of them like teachers who spend more time explaining.

TABLE III
CONTRIBUTION TO RETENTION OF INFORMATION

Method of contribution	Reading		hearing		Seeing demonstrations	
	No	%	No	%	No	%
Agree	40	44%	65	72%	80	89%
Neither Nor	40	44%	25	28%	10	11%
Disagree	10	12%	0	0%	0	0%

The students were provided with a direct question on the type of courses they prefer to have. 100% of the students indicated that they prefer courses that deal with facts and real life over courses that deal with ideas and theories. Finally, the students were given an open ended question on which courses they prefer the same teaching method to be implemented. The results showed that using this teaching method would be beneficial in surveying and construction courses.

C. Results Validation

New technologies in education can be used to energise the classes, making them more interesting and connected to reality and mainly to learning [19]. Nowadays it has become cardinal rule to use "Computer aided design" and Internet facilities to introduce innovations into the lecturing. In an attempt to properly equip the architectural department with a teaching methods that suitably integrate structure into architectural student design and relate what they learn to real life, [19] proposed a comprehensive Approach to Teaching Structures Using Multimedia which exposes the structure topics in an innovative instructional delivery system that utilizes high quality digital graphics, animation and audio narration to demonstrate the structural principles. Moreover, a project related to teaching called "Technology Initiative" carried out by Professor Kirik Martini from the University of Virginia also explored similar problems [20].

In order to validate the above findings students were provided with Engi-Lab (2D beam) and You-Tube videos. The advantages of using such application when teaching engineering are, but not limited to, applications are good to explain the concepts; they allow the simulation of abstract objects and concepts; they allow interactivity; they allow a fast update of the courses contents; they raise the productivity once the time for students at different places to participate in the experiences; they allow the development of new knowledge; the cost and maintenance is low.

Engi-Lab software is a programme to teach the structural behaviour of plane porticoes and it is an easy-to-use yet powerful engineering tool for the structural analysis of plane (2D) frames for Windows, using a3-DOFs (Degrees of Freedom) per node approach. It features a full Graphical User Interface (GUI) for pre- and post-processing and uses the Finite Element Method (FEM) for plane frames for its analysis needs

The students were provided with seven You-Tube videos showing a wide range of activities that took place in construction sites. The selected activities were the use of shuttering in order to cast the concrete, steel bars layout, casting reinforced concrete elements, and finishing the concrete surface. They have been chosen to reflect real life situations.

The impact of using multimedia on students understanding was verified using post-questionnaire, and an uploaded activity on the learning and management system LMS.

Students' reactions were measured throughout key elements. Firstly, students' ability in absorbing the information provided to them using multimedia applications was higher compared to their ability in absorbing similar information using traditional methods. This was measured by the low number of questions being raised by students and their better interaction. Secondly, to demonstrate this finding a short questionnaire was distributed. The questionnaire was formed of three questions. The focus was on students' opinion on using this method as an instructional tool to help in better understanding of the content of the course. 95% of the students agreed that this method is an appropriate teaching method for the nature of this course. Thirdly, the You-Tube videos were uploaded on the university learning management system LMS. The students were asked to answer one multiple-choice question on the related course material. The results showed that 90% of the students gave the correct answer which could be considered as a good result.

IV. Conclusion

In this paper, the problem with the current methods of teaching structures in architectural department was addressed. Architects think, learn and approach the design of structures differently than engineers. Hence, the method of teaching should meet architectural students' needs and improve their understanding of structural design. The reviewed literature showed that most architectural students have strong training in three-dimensional visualization and can quickly absorb information through this medium. This research focused on addressing students problems with the current teaching method and introduced a new visualization based method. However, for learning to occur, the individual must undergo new experience such as applying the new teaching method and reflect on the experience as reflection is the key to learning from experience. In line with this, this research implemented the use of You-Tube videos as one of the visual techniques as a new teaching method in order to improve students understanding. The development of technologies leads to the development of this new teaching methodology as using technology generally encourage active learning, increase student-faculty interaction and enrich the educational experience.

After using multimedia applications, students' reaction was measured using four key elements. Firstly, it was found that students' ability in absorbing the information provided to them and their interaction when using You- Tube was higher compared to using traditional methods, Secondly, the results from the short questionnaire showed that 95% of the students agreed that this method is an appropriate teaching method for the nature of this course. Finally, 90% of the students answered one multiple-choice question, using LMS, on the related course material successfully.

For future consideration, the researcher has a plan to distribute the questionnaire on a larger sample size. The sample will include architectural students as well as civil engineering students to enable showing the differentiation in their preferable learning styles and their preferable teaching methods. Moreover, this research will focus in the future plan on introducing more advanced technology such as new multimedia software that are being used to teach structural analysis and design.

In conclusion, the findings of this research highlighted that in order to enhance and improve the teaching and learning process students prefer to see the information visually using three-dimensional modelling as well as relating what they learn to real life aspects. This could be achieved by providing them with videos which show things in three-dimensional modelling and illustrate how what they are learning is linked to the natural life.

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