Exploring a Method of Enhancing Student Engagement When Teaching a Large STEM Cohort in Higher Education Context

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Abstract. Lecturing is generally the most common mode of delivery for complex engineering concepts to a large student cohort. The delivery method has evolved from traditional blackboard to more sophisticated presentation using computer software. With a blackboard, relatively static material is developed live by lecturers whereas through a computer-based presentation, most teaching material preparation is done prior to a lecture and relatively little is done while delivering the lecture. Consequently, it is feasible to generate sophisticated animations in a classroom. However, developing a media rich content is still a time-consuming process. Effectiveness and efficiency of this mode of lecture delivery is analysed in this article. Primarily, the paper explores various animation techniques and delivery that can be used to teach a large cohort. Additionally, student engagement and learning improvement as result are also examined in this study. Therefore, a survey was carried out on undergraduate engineering students at a Malaysian university and data from two different student cohorts were analysed. Consequently, one cohort was taught traditionally, but an animated content was used to teach the other to collect a different set of data. The result shows that student engagement was improved by the animated lecture delivery, but it could not be established whether student learning also got improved or not.

Keywords: Animation Slide · Education · Lecture Presentation · Student Engagement · Software · Teaching · University

1 Introduction

Lecture presentation is one of the most common mechanisms to deliver information. Many lecturers use whiteboard, document projector, slides, or transparencies using an overhead projector to teach a large cohort of students, traditionally. However, with advent of advancement of technology, modern classroom has more sophisticated methods to deliver complex mathematical and scientific content in engineering education. The delivery methodologies have gradually evolved from using traditional techniques, such as

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blackboard and whiteboard to sophisticated computer software. Some commonly used modern presentation software are PowerPoint, Keynote and Prezi [8].

The PowerPoint software is being used for more than 30 years since its launch by the Microsoft Company in 1990, and it is installed in more than 250 million computers worldwide [1]. Another commonly used presentation software known as Keynote was created when Apple Inc required a software for presenting new products in the Apple conference in 2003 [2]. Information is broken down using the software into a series of slides, and material is then generally organised and presented in a sequential fashion, but Prezi takes a different approach. It uses a spatial metaphor where information is placed on a big virtual whiteboard and the presenter accesses information seemingly in non-sequential manner from different parts of the whiteboard.

Data available in the open literature shows that there are various advantages and disadvantages for using multimedia material. On the negative side, research have shown that computer presentation slides that include too many texts or irrelevant material on one slide are very ineffective [9, 3]. Evidence also shows that students lose interest very quickly in that lecture as a result. Similarly, data collected by Bartsch and Cobern (2003) indicates that average marks of quizzes are slightly lower, if texts, pictures and sound effects are included in the computer presentation as compared to a basic presentation with only text-based information. However, the standard deviation (SD) is small if texts, pictures and sound effects were used. Since the SD is small, the lowest mark of the student is increased compared to a group of students with a larger SD value. Hence, the result for weak students can be improved, if the presentation is more media rich. Based on this information, the researcher concluded that computer presentation can be beneficial to the audience, but unrelated graphical material can distract student from the important content. Another major obstacle of using animated content is that it takes a lot of time to develop slides with appropriate animations. Consequently, motivating lecturers to dedicate time to create the animated slides is not an easy task.

Besides, lectures delivered using software assisted presentations are usually more organised and systematic [10, 11]. Savoy et al. (2009). The researchers also stated that students prefer computer-based presentation, but they retained 15% less information delivered through the lecturers. Hence, to capture student attention, the course material and objectives must be specially designed meeting the subject-matter requirements. This can develop a learning environment that increases student performance and attitude towards learning. Likewise, Hongpaisanwiwat and Lewis (2003) have found that computer-based presentation is very effective in capturing students' attention, if some animated character with synthetic voice is included in the presentation. This was concluded in study that analysed student understanding of course material that used animated characters with a synthetic voice. Their data show that the participants can easily recall the materials that appear in lecture notes. Moreover, computer animations are very efficient if used as a vehicle to teach a complex topic especially for explaining difficult procedures [4]. Can (2013) investigated student understanding of medical surgical procedures using slides with animations. Their result shows that the average marks of the evaluation on student understanding using computer animations is about 9 where 10 indicating the best. This demonstrates that computer animation is very effective for explaining processes or procedures.

The literature illustrates that although animations can be very effective in delivering and explaining complex concepts, this may also have a negative effect if the technology is not applied correctly. Consequently, a good lecture slide presentation needs to be specifically designed to suit different audience. This paper presents a study on how graphical computer animations can be used in lecture presentations to increase student attention, engage and inspire them to learn complex mathematical concepts in engineering science. Many students have short attention span and find engineering and technology topics challenging and difficult to grasp. This research presents that the appropriate animations used in lecture presentation can ease and crystallise the understanding of relevant engineering concepts and engage students to learn effectively.

This paper therefore provides an insight into how graphical computer animations can be used for presenting a lecture to increase student attention while engaging and inspiring them to learn complex mathematical concepts of engineering and sciences. This study argues that appropriate animations used for a lecture can ease and crystallise the understanding of complex engineering concepts and engages students in learning. Therefore, the paper examines how various animation techniques available in modern presentation software can be effectively used for a large engineering student cohort. Subsequently, many examples with their pedagogical advantages are discussed in this study. Therefore, each presentation was specifically designed to suit the targeted audience and the Keynote software was used for this study.

2 Methodology and Data Collection

This project was conducted on a numerical method using a computer modelling study topic of undergraduate engineering students at University A in Malaysia. Results were collected from two different student cohorts named as cohort 1 and cohort 2. The class size for cohort 1 and cohort 2 were 84 and 76 students, respectively. This experiment was conducted throughout the 14 weeks of a semester and analysis was done about the student performance in continuous assessments and tests. Students were also surveyed at the end of the semester to gauge their views on different content delivery mechanisms. Consequently, the results of the survey from the cohort 2, which was taught using animated slides and the cohort 1 taught using non-animated material, were compared. Finally, advantages and disadvantages of the two different approaches are evaluated.

The experiment includes presentation slides prepared using Keynote. Each presentation specifically designed to suit the targeted audience covers animated and non-animated slides. It was found that using some conventional computer software, slides can be created where information is presented using a simultaneous or a contiguous mode (Table 1).

For the simultaneous mode, all the information including text and graphics are present at the same time, but information is slowly revealed as and when needed in the contiguous mode and there are two types of methods in contiguous mode known as Type 1 and Type 2. Both Types reveal the content in a contiguous manner with Type 1 spreading the information over 3 slides and Type 2 having the info on 1 slide but revealing them sequentially. In addition, it has been found that simultaneous display of both textual and graphical information is not beneficial for student learning, because it leads to a

Table 1. Information being presented on the slides [7]

Simultaneous display of textual information		
Type A Font 11 Type C		
Slide 1		
Contiguous display of textual information: Type 1		
Type A	Type A Font 11	Type A Font 11 Type C
Slide 1	Slide 2	Slide 3
Contiguous display of textual information: Type 2		
Type A	Type A Font 11	Type A Font 11 Type C
Slide 1		

Table 2. Presenter slide using keynote

Contiguous display of textual information: Type 3				
Type A	Type A *Font 11*	Type A *Font 11* Type C	*Font 14*	*Equation* *Font 14*
Slide 1			Slide 2	

cognitive overloading. It is better to present them in a contiguous manner, if both visual and textual information must be conveyed on one slide [7].

In Keynote, a transition called magic-move smoothly transit relevant information, such as scale, move, rotate, etc. on slide 1 to slide 2 (Table 2). This visual transition will allow relevant textual and visual information from the previous slide to smoothly transition to next slide and be available to students while the lecturer is talking about new information on slide 2. Students tend to retain and understand the material, if they are exposed to a particular visual information and animations while the lecturer is talking about the topic and not having to refer to previous slides [6].

The slides with animations are created using Keynote software employing the contiguous mode of Type 3 methodology and magic-move" is applied to move information from one slide to another to ensure smooth transition of relevant information. The slides are also converted to use more visual information to increase student attention to the lecture material.

Table 3. PDF format with/without step-by-step guide

Contiguous display of textual information: Type 3					
Keynote file	Slide 1			Slide 2	
pdf format: WITHOUT step-by-step guide			Type A *Font 11* Type C		*Equation* *Font 14*
			Page 1		Page 2
	Type A	Type A	Type A		*Equation*
pdf format: WITH step-by-step guide		*Font 11*	*Font 11* Type C	*Font 14*	*Font 14*
	Page 1	Page 2	Page 3	Page 4	Page 5

Likewise, students are also provided study notes in two versions of PDF files. One version had the intermediate steps while all the data were displayed on one page in the other version (Table 3). Likewise, there are differences in the presentation mode used for the two cohorts. For example, continuous mode of Type 3 is used for the cohort 2, but simultaneous mode is used for cohort 1. Similarly, cohort 2 study notes had a choice of two versions either with or without a step-by-step guide. Student's reaction to the two versions were divided. One of the high marks achieving student believed that the animated slides have kept them engaged during the lecture, but they prefer the WITHOUT step-by-step PDF copy version. However, students on the other spectrum still prefer the WITH step-by-step version of the lecture notes.

At the end of the semester, both cohorts were given a questionnaire asking for the end-of-semester course evaluation (Table 4). Each question has a score from 0 to 5, where 0 = Worst and 5 = Best. Among these evaluation question, only Q2 and Q4 are analysed in this study.

Student understanding of the lecture material is evaluated using progressive assessments and a final examination. The questions were categorised according to the Bloom's taxonomy to measure student understanding, conceptual comprehension and high-level understanding on the taxonomy level of creation. In this module, the assessment is divided into 6 learning outcomes (LOs) and each learning outcome assesses student understanding. Each LO is specifically crafted based on the requirement of this module and the Bloom's taxonomy difficultly levels, implies that (a) easy/low levels – knowledge and comprehension; (b) moderate/mid-levels – application and analysis; and (c) hard/high levels – synthesis and evaluation. The LOs are also simplified into difficulty levels of easy, moderate, and hard. For example, question 1 is designed as easy, question 2, 3, 4 moderate and question 5, 6 are considered as hard. Therefore, each LO is addressed by one question. Although the questions for two cohorts are different, the levels of difficulty still follow Bloom's Taxonomy theory.

Table 4. Question set for the survey

Question	Description
Q1	The outline and expectations for this course as supplied by the lecturer were clear
Q2	The lessons were organised and prepared
Q3	The lecturer was knowledgeable about the course content
Q4	The course content was effectively presented
Q5	Opportunities were provided for student participation
Q6	The homework and classroom assignments were helpful
Q7	The textbooks and/or recommended materials were useful
Q8	The lecturer was available for consultation and was helpful
Q9	The assessment was fair
Q10	This course met my needs and goals for future study and/or employment

3 Results and Discussion

In presenting the results and discussion here, we have done all we can to limit the number of control parameters in this study. However, it is acknowledged that there could be variation in the results quoted below due to circumstances beyond our control. We have tested two different groups of students; hence the quality, ability and motivation levels of the student cohorts would be different. For the assessments (both continuous and final exam), even though they follow Bloom's Taxonomy, the questions are different for these cohorts. These factors could have an influence in the results presented below.

Figure 1 shows the results of the end-of-semester course evaluation for the tested topic. Data from two different cohort semesters are compared. The student participation rate in the course evaluation for cohort 1 and cohort 2 are 82% and 60%, respectively. Putting effort into preparing the animated lecture slides gave the impression to the students that the lessons were more prepared and more organised. Figure 1 show that there is an improvement in cohort 2 when animated slides were used to deliver the content. Improvement in the response to Question 4, indicates that students believed that animated slides improved the delivery of the subject content. A minor improvement in Question 2 also noticed. Overall mean and SD for cohort 1 and cohort 2 are 3.77 and 0.20, and 3.94 and 0.02, respectively. A better overall average and smaller SD indicate that that students in the cohort 2 had a better study experience with the subject probably because they had animated lectures.

Likewise, Fig. 2 show that the student performances of cohorts 1 and 2 using non-animated and animated slides, respectively.

Comparing student performance and question difficulty level, a significant improvement in the continuous assessment for all the questions is noticed, except for questions 3 and 4 when the marks for these two cohorts are compared. This shows a general trend that using animated slides has improved student learning in the class. This is especially evident for questions on the easier and harder end of the scale. For example, there is

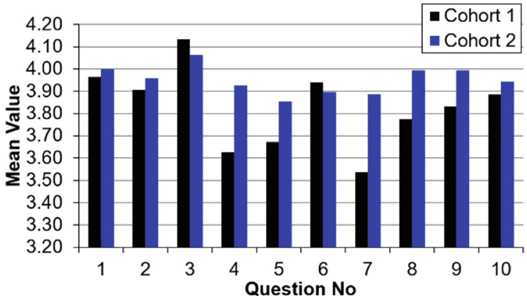

Fig. 1. End-of-semester course evaluation

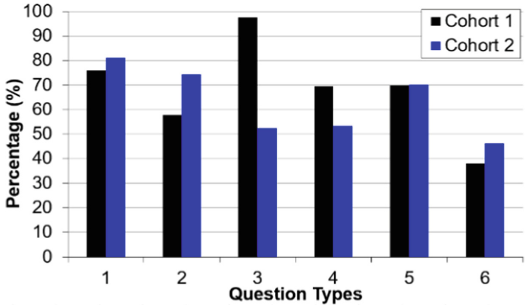

Fig. 2. Continuous assessment performances

around 8% increase in student performance for question 6 compare with a previous semester. This indicates that students engage more in class when this topic is delivered using animated content. However, there is a dramatic reduction from approximately 95% to 55% in the student performance for questions 3. The reason for this is not clear, but it is possible that students found the animated slides for this material too lengthy and difficult to comprehend, or the question could have been more clearly worded. A student commented that he did not fully understand the question.

Similarly, Fig. 3 show student performance in the final examination, where the mean and SD for cohort 1 and cohort 2 are 63.23 and 17.51, and 63.00 and 15.70, respectively. Although the mean percentage is reduced slightly, this does not suggest that the performance is worse. From this data, the SD of cohort 2 is significantly lower as compared to cohort 1 by about 10%. This denotes that the performance of the weaker students has improved slightly. It can be argued that the weaker student(s) are engage in their learning and understand the concept of the topic through the animated slide with/without step-by-step guided student notes in pdf format. Students did report that the notes were useful especially during the examination period. An improvement for the moderate and hard questions is indicated. However, there is significant reduction in the marks for questions 1 and 6 by approximately 25% and 15%, respectively. This indicates that there is no clear improvement for the questions classified as easy, but marks for the moderate questions show approximately 5%–15% improvement.

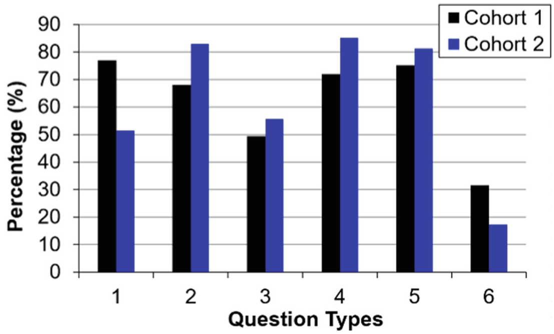

Fig. 3. Final examination performances

4 Conclusions

This study examines the effectiveness of using appropriate animations in lecture presentations in terms of student engagement in an engineering classroom of a large cohort. An attempt was also made to relate the animated lecture material and student understanding of the taught subject-matter. The data obtained through a survey conducted at a university in Malaysia show that using appropriate animations in slides can increase student engagement with the subject material. Likewise, students are more likely to stay focused, if the animations are included during a lecture presentation. Whether or not this increase in student engagement leads to an improved learning of the lecture material is inconclusive. Some questions in the assessment demonstrate an increase in performance while others show a decrease in the mean marks. The data seem to suggest that animated lecture content help improved the level of understanding of the weaker students in the subject though.

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References

1. Alley, M., and K. Neeley. 2005. Discovering the power of PowerPointTM: Rethinking the design of presentation slides from a skillful user's perspective. In *Proceedings of the 2005 American Society of Engineering Education Annual Conference and Exposition*, Portland, Oregon, 12–15 June.
2. Awbrey, A., and N. Sequeira. 2003. Apple unveils keynote: Professional-quality presentations for everyone. Apple Inc. https://www.apple.com/newsroom/2003/01/07Apple-Unveils-Keynote/. Accessed 18 Feb 2022.
3. Bartsch, R.A., and K.M. Cobern. 2003. Effectiveness of powerpoint presentations in lectures. *Computers and Education* 41: 77–86.
4. Can, C.C. 2013. Computer animation in teaching surgical procedures. *Procedia – Social and Behavioural Science* 103: 230–237.
5. Hongpaisanwiwat, C., and M. Lewis. 2003. The effect of animated character in multimedia presentation: attention and comprehension. In *System, Man and Cybernetics, 2003, IEEE International Conference*, vol. 2.

6. Mayer, R.E., and R. Moreno. 2003. Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist* 38 (1): 43–52.
7. Park, J. 2013. Does contiguous effect matter in PowerPoint presentations for effective instruction? *Journal of Teaching and Learning with Technology* 2 (1): 69–72.
8. Prezi Inc. 2022. Captivate, motivate, educate - online or in person. Prezi Inc. https://prezi.com/education/?click_source=logged_element&page_location=above_fold&element_text=educators&element_type=cta. Accessed 20 Jan 2022.
9. Savoy, A., R.W. Proctor, and G. Salvendy. 2009. Information retention from PowerPoint and traditional lectures. *Computers & Education* 52: 858–867.
10. Susskind, J.E. 2005. PowerPoint's power in the classroom: enhancing students' self-efficacy and attitudes. *Computers & Education* 45: 203–215.
11. Szabo, A., and N. Hastings. 2000. Using IT in the undergraduate classroom: Should we replace the blackboard with PowerPoint? *Computers & Education* 35: 175–187.