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Enhancing Student Motivation with use of Augmented Reality for Interactive Learning in Engineering Education

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Abstract

In Engineering Education, learning by doing is of paramount importance for supplementing the theoretical concepts with technical introduction to maximize the learning outcome. However, in many fields, the students are not able to apply their knowledge in practical ways in spite of having theoretical understanding of the fundamentals. This can be mainly attributed to the lack of motivation due to absence of interactive course content required for proper visualization of the concepts through student engagement in the classroom. As a result, deep understanding of the concepts is not possible for those who are unable to grasp the delivered content using traditional ways of learning. If the students are provided with such tools that they are able to visualize and interact with what is taught in the classroom, their motivation towards learning can be enhanced. Augmented Reality, being a visualization technology, can be adopted in classroom settings to fulfill this goal. This paper is focused on the use of Augmented Reality as a tool for interactive learning in various fields of engineering education, and its contribution towards student motivation in classroom scenarios.

Keywords: Augmented Reality; Interactive Learning; Student Motivation;

1. INTRODUCTION

Education Technology is observing constant improvement in instructional practices and Augmented Reality (AR) is one such visualization technology which is capable of enhancing the human perception through computer generated data superimposed on real objects, which are also available for user interaction [1]. In-spite of having many application areas, the technology can help the learners as an efficient educational aid by involving the student interaction and engagement in the classroom. AR technology provides innovative and interactive ways of learning a particular concept. At first sight, the materials used for AR look identical to the normal figures/books. However, use

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of an AR device renders the virtual content in real time by creating an illusion of the real models coming out of the pages. According to Y. Chen [2], there are some concepts which the students find tough for visualization. This includes few topics from geometry, the sciences, and engineering education. The problem arises when there is a need of visualization of the concept which is otherwise hard to grasp intuitively. Considering the example of ray optics, if a student wants to visualize the type of image formed using different focal lengths of concave/convex lenses, with objects placed at different distances; it difficult to visualize and remember. But existence of such a system which not only overlays virtual images by detecting the type of lens used, but also provides size of the image formed depending upon the distance of object from lens, makes it easier for the students to remember. Moreover, if the system is made interactive in a sense that user is able to change the distance of object, focal length of the lens or type of the lens; real time data can be obtained by the user in the form of image formed. Other examples are: studying the covalent bonding of molecules in chemistry, DNA structure in biology, electron movements during current flow in electronics, open and closed loop analysis for control systems, transistor action for electronic devices, visualization of memory while programming in computer languages and many more. Such cases prompt the adoption of AR technology in education for interactive learning involving the student engagement to improve their motivation towards learning.

2. AUGMENTED REALITY AND STUDENT MOTIVATION

Researchers believe that the students, who are motivated for learning, engage more in a task for completion than the unmotivated students. Motivation can be defined as an empowering property of individual to initiate and control the behavior for a particular task. There are many research works found in the literature that point towards utilization of Augmented Reality for enhancing student motivation by improving the visualization of course material for better understanding [3, 4, 5]. Thus, to utilize the inception of this idea, a real time interactive learning system has been developed for electronics and electrical engineering students to help them visualize various theoretical concepts; which they would otherwise find difficult to understand in a traditional teaching-learning environment [6, 7]. This system was implemented on a group of undergraduate students to check their motivation towards use of AR as a teaching–learning tool in educational settings. The system implementation process in the classroom is represented by Figure 1.

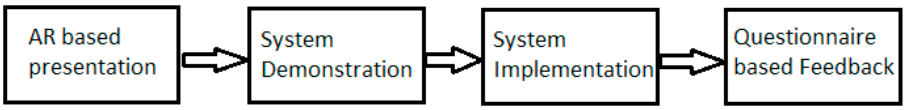

Figure 1: Implementation of AR based environment for learning

After the delivery of content using AR based environment, a questionnaire-based survey was conducted using the ARCS model [8] to find out the level of student motivation on the parameters measuring attention (A), relevance (R), confidence (C) and satisfaction (S) of the students for using the developed system for interactive learning. Table 1 presents the questionnaire filled by the students to investigate their motivation for learning using AR for Engineering Education concepts. It was on the basis of a 5-point Likert rating (with 1 being strong disagreement and 5 being strong agreement).

Table 1: Questionnaire to investigate Student Motivation using AR for Engineering Education

Sr. No.	Question	Motivation Factor
1	“There was something interesting at the beginning of the AR lesson that caught my attention”	A

2	"After the introductory information, I felt confident that I knew what I was supposed to learn from this lesson"	C
3	"It is clear to me how the content of this material is related to things I already know"	R
4	"Augmented reality technology is attention-grabbing"	A
5	"There were images, videos and texts that showed me how this material could be important to some people"	R
6	"As I worked on this lesson, I was confident that I could learn the content"	C
7	"After the introductory information, I felt confident that I knew what I was supposed to learn from this lesson"	S
8	"The content of this material is relevant to my interests"	R
9	"I really enjoyed studying this lesson"	S
10	"The content and the audio visual material in this lesson convey the impression that its content is worth knowing"	R
11	"I learned some things from the augmented reality that were surprising or unexpected"	A
12	"After working on this lesson for a while, I was confident that I would be able to pass a test on it"	C
13	"The wording of feedback after the exercises, or of other comments in this lesson, helped me feel rewarded for my effort"	S
14	"The variety of audio visual material helped keep my attention on the lesson"	A
15	"It was a pleasure to work on such a well-designed lesson"	S

3. RESULTS AND DISCUSSION

The questionnaire was designed with 15 items with an acceptable reliability score of 0.923 (Cronbach alpha) as given in Table 1. A total of 34 undergraduate students from electronics and electrical engineering took part in the survey after learning a topic using AR in classroom settings using the developed AR based learning environment. Table 2 shows that the mean score of all the factors, which may have an impact on motivation of students, viz. attention (4 questions), relevance (4 questions), confidence (3 questions) and satisfaction (4 questions), came out to be more than 4 (on a scale of 5).

Table 2: Average mean of the factors of ARCS model

Factor	N	Mean	Std. Deviation	Std. Error Mean
Attention	136	4.19	.907	.078
Relevance	136	4.09	.907	.078
Confidence	102	4.20	.809	.080
Satisfaction	136	4.26	.819	.070

Figure 2 shows the bar chart for average mean score of all the four factors pertaining to measure the motivation of learners. The analysis has been done using one sample t-test for all the questions used to find the response of students for the different factors from the ARCS model.

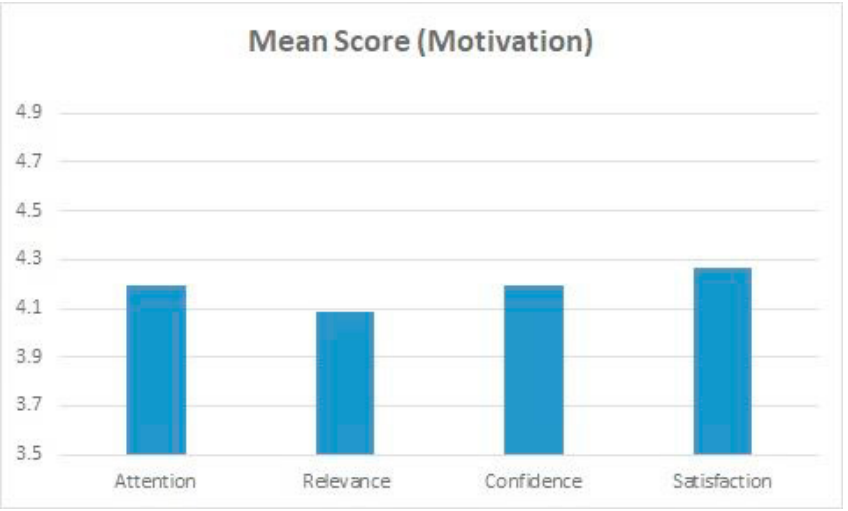

Figure 2: Mean score for Motivation of learners (ARCS) towards ARLE treatment

The results with high values indicates that students were highly satisfied with use of AR environment for interactive learning by agreeing to the fact that use of ARLE improves their attention, relevance, confidence and satisfaction for the learning material.

4. CONCLUSION

The response from the feedback shows that there were high levels of motivation in terms of Attention (A) with mean score 4.19, Relevance (R) with mean score 4.09, Confidence (C) with mean score 4.20 and Satisfaction (S) with mean score 4.26 among participants for use of AR while learning. The mean scores with values greater than 4 (on a likert scale of 5) for each parameter related to all items of the questionnaire indicated that use of AR for interactive learning was well received by students with enhanced motivation. Thus, AR technology provides innovative and

interactive ways of learning a particular concept and has an edge over the traditional styles of teaching and learning in classroom settings as it has a significant impact on the student motivation while performing a particular task.

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