Impact of pairing an augmented reality demonstration with online video lectures… Does it improve students' performance?

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Abstract: Due to the increased shifts in recent technologies, the education sector has also started to reshape itself to face the future. Augmented Reality (AR) and Virtual Reality (VR) are among the few recent trends that drive this shift forward. This study was set to study the impact of pairing a video lecture course with an AR presentation. A class of multimedia students (N=33) from Vellore Institute of Technology, Vellore, India; underwent an experiment of watching a video lecture module and attending a quiz. The same class again went through a similar test where they had to watch video lectures, get to experience what they learned in Augmented Reality for 10minutes, and then appeared for the quiz. The paired t-test conducted on the two sets of scores obtained by the class indicates a statistically significant increase in the average final scores when AR experience is paired with the video lectures. The feedback from the students was also positive on the AR experience.

Keywords: Augmented reality, Education, e-learning, Video lectures

1. Introduction

Online video lectures are rapidly growing in recent times as the improvements in communication technology such as high-speed Internet connections and high-quality streaming are readily available for everyone. Collective video lectures are delivered online by several service providers and the courses that are '*open to everyone*' in nature are categorized as Massive Open Online Courses (MOOCs). MOOC has become one of the most sensational e-learning methods that gathered a lot of popularity (Hew & Cheung, 2014) among aspiring learners. Though the video lectures carry many advantages, they do have their limitations.

Due to the latest technological improvements such as real-time data analysis, online proctoring systems, pattern recognition algorithms, etc; it is now easy to see the performance of an online learner and check the correlation of their learning with the affection (Souza & Perry, 2019) they have with their course. Though MOOCs sound exciting and carry a lot of advantages, several researches suggest that only a very few percentage of enrolled population successfully finish their course (Watted & Barak, 2018). There are several factors that affect the students' longevity with their course but learning differs according to the learning styles of the individuals.

Generally, video lectures demand self-motivation, engagement, and self-direction from learners (Delen, Liew & Wilson, 2014) and it's not easy to monitor learners' self-regulatory behaviors. Several studies also insist on having a high level of interactivity in video lectures to keep the learner engaged (Durrington, Berryhill & Swafford, 2006) and to expect increased motivation (Diegmann, Schmidt-Kraepelin, Van den Eynden, & Basten, 2015). This study experiments the effect of introducing a high-level interactive presentation (In AR) post video lectures and studies the change in learners' performance at the final quiz

2. Related Work

Inclusion of AR into the education of course opens up new possibilities for educators and AR does mix the real world with virtual information which excites students as well. Due to its unique characteristics, AR has proven to be one of the factors that can increase students' motivation in learning (Diegmann et al., 2015). Though AR does have a lot of benefits, we need to see the side-effects of its usage. When a student is exposed to an AR environment, the amount of simultaneous information such as complex practical tasks, multimedia content (visual and auditory), etc., may overload the learner cognitively (Wu, Lee, Chang & Liang, 2013). So, while planning for an AR based class, the educator should consider the potential challenges that might arise and set the teaching plan accordingly. Also, the faculty who embark on an online teaching environment should look for ways that will increase the level of students' interactivity. Because, students show a higher level of participation and maintain a positive attitude (Durrington et al., 2006) when the online lectures are greatly interactive. Also, recent studies found that AR does increase the learners' engagement with the subject content (Nizar, Rahmat, Maaruf and Damio, 2019)

AR-based presentations are also welcomed by the students due to their fun-filled content. Studies that compared AR presentations with traditional methods in education revealed that students want to go for an AR demonstration rather than a slide-based presentation (Di Serio, Báñez & Kloos, 2013). Another advantage of AR is that it can be used to teach the curriculum in various fields ranging from Physics, Chemistry, Mathematics, Medicine, Engineering to Astronomy (Saidin, Halim & Yahaya, 2015). In recent years, thanks to the developments in the IT sector, AR can now be enjoyed in mobile phones. Before this time, AR and VR experiences required a lot of peripherals connected to a desktop computer and were not easy to set up for an end-user. Now, smartphones have made AR/VR experiences portable (Yuen, Yaoyuneyong, & Johnson, 2011) and don't need any additional apparatus to enjoy these interactive contents. This shift in technology has made AR tech to reach wider audiences. However, as indicated by Abd Majid in his article, while employing VR/AR simulation technology for education, it is important that the course facilitator / lecturer should be well-versed in the simulation technology to deliver a quality experience to his/her students (Abd Majid & Mohd Shamsudin, 2019).

Since almost every student has their smartphone, now it has become easier for educators to reach them with AR contents. As more and more education platforms have started incorporating AR/VR, education researchers are also attracted to it in finding more possibilities for teaching and learning (Sural, 2018). Moreover, AR strongly supports Constructivism in learning. One of the major characteristics of constructivist theory is that the learner constructs the knowledge actively and not just perceives it passively (Sjøberg, 2010). According to this, in video lectures, the learners need to be passive most of the time and the highest level of interactivity they may have is *playing* or *pausing* the video. AR has been answering for this and proven to boost confidence, concentration, and attention among learners (Bacca, Baldiris, Fabregat, Kinshuk & Graf, 2015) not only in theory-based curriculum but in vocational training too.

3. Objective

The main objective of this study was to assess whether the introduction of AR presentation in a video lecture leads to increased students' performance (test score). So, the hypothesis of this research has been formed based on our main objective, as follows:

H_0 – Pairing AR presentations with video lectures do not influence students' test scores. (H_0: $\mu_1 = \mu_2$)

H_a - Pairing AR presentation with video lectures influences students' test scores. (H_a: $\mu_1 \neq \mu_2$)

4. Method

4.1 Samples

The population for this study was the class of 2nd-year students (N=33) pursuing their bachelor's degree in Multimedia at the School of Design in Vellore Institute of Technology, Vellore, India. The class had a digital assignment component under the additional learning module in their curriculum and the students can fulfil their assignments by watching video lectures and attending quizzes to earn their credits.

Table. 1 Population Frequency Table

	Frequency	Percent
Male	20	60.6
Female	13	39.4
Total	33	100

The frequency distribution of the samples is shown in Table.1 and we can see; the class had a greater number of male students (N=20) than that of females (N=13).

4.2 Video Lectures

The video lectures that were presented to the class had been produced specially for this purpose. The content of the video lecture was completely new to the whole class (N=33) and it was not discussed any time before in the lecture hours. The authors had split the total video lecture content into two modules. Each module has three video lectures and the run-time of each lecture is under 5 minutes. The video lectures are just recordings of a faculty who talks about a new type of digital camera that was manufactured by *Yi Technologies*. The environment for the video lectures was kept simple to minimize distractions and the camera angle was stationery throughout the lectures. Everything about the video lectures in both the modules was similar including the lecturer. The topic that was spoken by the faculty differed a bit, as listed below:

Table. 2 Video Lectures' content delivered by the faculty

Module 1 Lecture Topics	Module 2 Lecture Topics
What is Yi cam?	Maintaining the cam.
Parts of Yi cam.	Mounting and Unmounting lenses
Applications of Yi cam.	Operation procedure

4.3 Quizzes

The class went through an online quiz post watching each module. There was a total of 30 multiple choice questions for each module from which 5 questions were randomly assigned to each student. Quiz management was done using the *Schoology Quiz manager*. The authors made sure that the questions were only derived from the spoken content in the video lectures. Each question carries one mark and the maximum score a student can attain for one module was five.

Here's some question samples from the quiz,

How many individual cameras were in there? *

Mark only one oval.

- 19
- 21
- 17
- 15

Maximum Resolution supported? *

Mark only one oval.

- 8K x 8K @ 40FPS
- 8K x 8K @ 30FPS
- 8K x 8K @ 90FPS
- 8K x 8K @ 60FPS

What is the duration of the Portable battery support? *

Mark only one oval.

- 60mins
- 90mins
- 30mins
- 20mins

4.4 Research Design

The researchers were to study the mean differences in students' scores before and after pairing AR with video lectures. Hence, one group pretest-posttest model was followed and the obtained data had been analyzed with *Paired samples T-Test* to check for differences in mean.

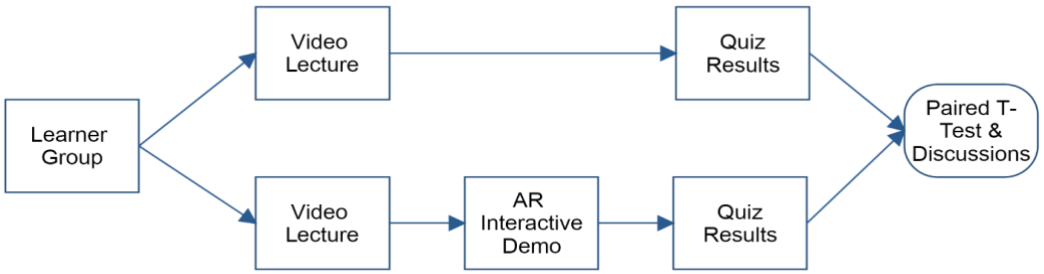

Fig. 1 Research Design that explains the overall flow of the study

Since the authors had decided to conduct a *paired samples t-test*, the samples (N=33) for the study are the same for both pre-test and post-test. Figure 1 shows how the research has been designed. In the first trial, the learner group was exposed to a video lecture (module 1) that was a part of their curriculum and at the end of lectures, the learner group attended a quiz that had 5 questions in total. The questions were derived randomly from a question bank that had 30 questions. The questions were

related to the video lectures and *www.Schoology.com* was used as the platform for the quiz. The same learner group was exposed to another similar video lecture which was the continuation of the previous module. This time, the learners were exposed to an AR presentation right after the video lectures. The marker-based AR presentation was installed on a smartphone and the learners' scanned the provided marker sheet and experienced the AR presentation. The presentation rendered a 3D-360^{o} view of the camera that was discussed in the video lectures and the learners interacted with it by rotating, zooming, disassembling, and assembling the camera parts. Each student had a time limit of 10mins for the AR experience.

4.5 AR Experience

The AR experienced by the students was built by the authors specifically for this study. A detailed 3d model of the camera has been designed in *Autodesk Maya* software and exported to the *Unity3D Game engine*. The authors then created an interactive AR experience and exported it as an *app* for android phones.

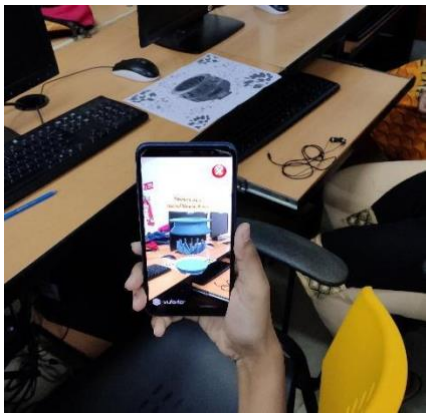

Fig. 2 Student's experiencing marker-based AR

The created *APK* package was installed in a smartphone (*Xiaomi Redmi Note 7 pro*) and was circulated among the students for experiencing. The students were not allowed to install the app on their phones, to maintain the similarity of AR experience, across the class. The AR experience was marker-based, which means, the students need to scan a unique marker to render the 3d view on top of it. The marker was just a picture of the camera printed on a regular A4 sheet. The authors had already designed the *app* in such a way that when the provided marker is scanned, the AR render starts.

The quiz scores obtained from the Schoology quiz manager were downloaded and made ready for further analysis using the SPSS statistical tool. The authors received two sets of test scores from the same samples, one set was the results obtained without AR experience and another set of scores obtained with the AR experience module. The nature of the data obtained was numerical so, authors injected the data straight into SPSS. For the scores, the type of measure was set to *scale* in SPSS and a *paired sample t-test* was performed.

Table. 3 Video Lectures' contents' paired-samples statistics

	Mean	N	Std. Deviation	Std. Error Mean
Score without AR module	3.33	33	.95	.16
Score with AR module	3.87	33	1.14	.19

As per the data obtained from the t-test, Table.3 shows us how the quiz scores' mean value differs. Each quiz had been conducted for 5 marks and the mean score of the class when video lectures are used alone was 3.33. After pairing the video lectures with AR, we are able to observe that there's been an increase in the mean score of the class that read 3.87. Though the increase in the mean indicates that the intervention of AR into video lectures turned fruitful, the difference in mean needs to be checked for statistical significance.

Table. 4 Paired Samples Correlations – First set data and second set data relationship

	N	Correlation	Sig.
Score without AR module & Score with AR module	33	.640	.000

In paired tests, the correlation value plays a major role because it indicates the relationship between the rankings of first and second sets of data. In our case, Table. 4 shows the correlation value as .640 which is in a positive direction and moved towards 1. This indicates that the chances of having standard error was less when testing the hypothesis and will support rejecting the H_0 statistically.

Table. 5 Paired samples t-test statistics results

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper	t	df	Sig.(2-tailed)
Score without AR module - Score with AR module	-.54	.90	.15	-.86	-.22	-3.46	32	.002

Table. 5 shows the actual statistical test results obtained from paired t-test analysis in SPSS. The authors have assumed the confidence interval at 95% for the test. The mean difference between the two sets of data is given as -0.54 with a standard deviation of 0.90. The p-value obtained in the test is 0.002. The authors have set the usual statistical demarcation criterion of the p-value as 0.05. Since the obtained p-value (0.002) is less than the criterion ($p < 0.05$) the authors chose to reject the null hypothesis (H_0) and accept the alternative hypothesis (H_a). The authors interpret the test data as:

The paired t-test conducted to compare the impact of pairing AR with video lectures resulted in a significant difference in the scores for without AR (M=3.33, SD=0.95) and with AR (M=3.87, SD=1.13) conditions; t(32)=-3.46, p=0.002. The obtained results suggest that pairing AR with video lectures does influence the learners' test scores and results in an average increase in the marks scored by the class.

5. Conclusion

Upon comparing the means of scores obtained before and after the AR demonstration, the authors have statistically accepted that the AR intervention does have a positive impact on the learners' scores. Apart from the test, the authors had verbal feedback from the students as well, where they mentioned that the AR presentation does excite them, in return; increasing their involvement with the content. A few students also mentioned that the high level of interaction with the camera allowed them to remember things more easily and reproduce it at the time of the quiz. The authors are intrigued by the feedback from the students and set to have a more detailed study in the future, on the effect of motivation and involvement that may arise from incorporating AR into lectures. This study also believes

that AR might help to build involvement and motivation among students in existing e-learning platforms. However, more detailed studies in future will provide evidence to declare the actual impact caused by augmenting a video course.

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