Augmented Reality Based Computer Science Learning

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ABSTRACT

Education is the cornerstone upon which civilized societies are built. For thousands of years, education has been improving using various technologies. From word-of-mouth and stone tablets to books and computers, people are always trying to find innovative new ways to pass on information to the next generation using the technology of their time. Well, technology has progressed by leaps and bounds over the last half century, and people are just now catching up antiquated educative practices to better mesh with existing technologies. In 2022, online learning and online school are already commonplace, but is this the end-all of technology in the classroom? This project is aimed to discover what new possibilities are out there with the cutting-edge world of Augmented Reality (AR) and especially how it relates to education and teaching people more effectively.

1 INTRODUCTION

The technology to achieve AR even for the modest consumer has been around for over a decade by now. However, very little progress has been made as far as a mainstream adoption of AR technology in the classroom is concerned. AR technology has tremendous potential for "rapid information transfer" [6] which is essentially the textbook definition of education. AR technology may also be considered more exciting by students than a typical textbook reading and so it has the possibility to boost students' interest and interactions in a classroom. [4] Not only this, but assignments and exercises can be made that were previously unthinkable. Think of a geography assignment that is trying to teach you about the Great Pyramids of Giza. A textbook may have a few pictures and many paragraphs of text about these pyramids, their cultural significance, and their colossal size. But an augmented reality assignment could theoretically allow a user to place the Great Pyramids right in their own backyard, possibly allowing a student to internalize the sheer size of these pyramids better than if they were to thumb through a textbook. In this way, students can compare what they are already familiar with in their everyday environments to a famous landmark such as the Great Pyramids of Giza. This ability to have a reference point to things already existent in the environment is a major selling point of AR, and one reason that AR was chosen over VR for this project. This project will aim to allow students to place 3D objects using AR to assist with education. This project will contribute a free, open-source way for teachers to increase interactivity in their lesson plans. It is the hope of this project that increasing the interactivity of lesson plans through the use of AR will cause an increased amount of interest and knowledge retention in students.

2 RELATED WORK

There has already been many applications and experiments concerning AR in an educative environment. As discussed by Kesim and Ozarslan, there are many different technologies in which AR or VR can be delivered. Head-mounted displays, handheld displays, and pinch gloves are all common ways of interacting with these

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technologies [3]. This paper discusses the possibility of "textbooks [becoming] dynamic sources of information." [3] With the technology available, "any existing book [can be] developed into an augmented reality edition." [3] This idea to take a traditional form of information dissemination and add on to it is using AR technology is what this project is based on.

A study performed in 2008 by Freitas Campos showed that AR in children's education suggested that it "is effective in maintaining high levels of motivation among children and has a positive impact on the students' learning experience, especially among the weaker students." [4] This study followed 54 students between 7 and 8 years of age, and broke them into 2 groups, one who would be given a traditional lesson and one who would be given a lesson with the help of the AR technology. This study found that students' motivation was extremely high when using the AR technology, and students who were in the group that used the AR technology had a larger increase in test scores before versus after the experiment. This type of experiment is very similar to what I will be performing to determine if my application helps to increase knowledge retention and motivation.

AR in education has already been applied to a wide range of topics. Topics including astronomy, chemistry, biology, mathematics, and physics have already had applications developed that incorporate AR learning into a traditional educative environment. [2] It was found that in most of these cases, AR learning provided an increase in interest into a topic by would-be learners. It is thought by Kangdon Lee that AR in education has a vast potential to engage students moreso than other traditional ways of teaching.

In an experiment done by Liu and Chu in Taiwan on English-learning students, it was found that an AR game app called HELLO engaged students moreso than the traditional way of teaching English at the school. [5] There were 2 groups of students, one who would be learning English the traditional way taught at the school, and one group that would be learning English with the help of an AR app. This app allowed students to use a phone to practice listening and speaking in a way that interacted with their environment. One such interaction with the environment was using the phones in conjunction with HELLO to conduct a treasure hunt game. The map on their phone would update in real time as the students walked around to find a 2D barcode to scan which would prompt the next bit of instruction based on what was scanned. The user would take a picture of the 2D barcode and then practice English that was related to the object that was scanned. In this way, students were able to contextualize English words into their already familiar environments, which Liu and Chu argue may increase knowledge retention. After the English practice that occurred due to the barcode, the students received a virtual gold coin. Any student who managed to get all virtual gold coins were eligible to receive a special real-life prize.

The next interaction in this same experiment done by Liu and Chu was using phones in conjunction with HELLO to conduct a relay race. [5] The students were grouped up into groups of 5, and each member picked a zone on the map to write a compelling story about in English. After one member was finished, they were to pass the "baton" (phone) to the next group member and have them write a story about their zone. Upon completion, a survey and in-depth interviews were conducted to understand the students' experiences. The researchers used both qualitative and quantitative

data to examine the impact of AR in conjunction with education. Quantitative data included tests before and after the experiment involving the HELLO app was conducted. Qualitative data included surveys, interviews, and instructors' comments about the activities. The results found were that the experimental group outperformed the control group by 8 percentage points, a statistically significant amount.

These experiments with the HELLO AR app used by Liu and Chu were very inspirational as far as this project goes. The usage of a phone and a fun AR game to motivate young students in education is exactly what this project is all about. This experiment occurred over 10 years ago when phones and smartphones were far less ubiquitous than they are in today's world. So, the students had to share phones that were loaded with the special technology that allowed the AR app to run, and there was only one phone per group of students instead of one phone per student. An experiment today could utilize the students' own personal phones and allow the teacher to engage the students in this AR education app without excessive cost to the school or the student. In addition, since each student will have their own phone, they will likely have more time using the AR app than if they had to share phones as a group.

The qualitative analysis done by Liu and Chu will be quite similar to the qualitative analysis done in this experiment. Their qualitative data collection involved a survey of the students, and found that there was a significant difference in students' interest in the learning activities provided by the HELLO app, as compared to a textbook. [5] The survey performed by Liu and Chu serves as a form of inspiration for the survey that will be performed to see if the app in development better facilitates learning than more traditional forms of teaching.

3 METHODOLOGY

For this project, I will be performing a questionnaire after allowing 2 groups of adults to learn a concept. One group of adults will be learning a concept in a traditional fashion, through watching a lecture. Another group of adults will be learning in a more modern fashion, a lecture in conjunction with the AR application that is being developed. After each group of adults has finished, a questionnaire will be given that tests their understanding of the concept taught. This questionnaire will undergo statistical analysis using chi-square to determine if there is a significant difference in understanding between groups of adults.

The specific details of this user evaluation are as follows. Two groups of adults will be gathered to perform an experiment. These adults will not be compensated for their time. These adults will be taught a lesson on the Great Pyramids of Giza. One group of adults will watch a video on the pyramids and be given a worksheet, which is a more traditional form of teaching. Another group of adults will watch a video on the pyramids and be given the AR app in development to place a pyramid in their environment. These adults will then be qualitatively surveyed to determine whether there is a greater interest or engagement in the AR app instead of the worksheet. The hypothesis of this experiment is that the AR app will provide a higher rate of interest and motivation. The survey questions will be as follows: Answer the following questions on a scale of 1-5, 1 being lowest and 5 being highest.

1. How engaged were you during this lesson? Explain.
2. How impactful was this lesson? Explain.
3. How much did you learn from this lesson? Explain.
4. How memorable was this lesson? Explain.
5. How unique was this lesson? Explain.
6. Please select the image which best shows the scale of the pyramids compared to an average human.

With these questions, it will be seen if the novel AR experience plays a role in getting people interested in education moreso than a traditional paper-and-pencil worksheet will. Some confounding variables may be that adults are already knowledgeable about the pyramids and therefore are not as amazed when the see the immense size of the pyramids compared to objects in their world they are more familiar with. However, it is not feasible to perform this experiment on elementary school students (the app's target audience) as I would need much more time and parents' permission.

4 CONCLUSION

All in all, this project aims to serve students that are not engaged by traditional methods of teaching and show them that learning can be fun. The introduction of AR into educative environments provides a great potential for furthering lesson plans into the future. This application will be developed, and then an experiment involving 2 groups of adults will be done to determine if this app could possibly be a help to any teachers.

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