Augmented Education: Using Augmented Reality to Enhance K-12 Education

Alexander M. Teichner

University of West Georgia
1601 Maple Street
Carrollton, Georgia 30118
678-839-6485
alexanderteichner@gmail.com

ABSTRACT

Many students have trouble visualizing topics they learn in class. This can lead to discouraged students who stop intellectually engaging in their education. Still other students are put in classes that do not fit their intelligence level because although they do care about their education, they can't grasp the concepts taught to them. In order to facilitate learning, we could include augmented reality (AR) in a student's curriculum, enriching the student's educational experience by transcending a regular education and creating an augmented one. Therefore, the question driving this research is how to introduce AR into a student's education so as to enhance that experience and encourage student interest and participation, as well as understanding of difficult topics. By including AR in the classroom, we could increase student engagement and retention.

Categories and Subject Descriptors

H.5.1 **[Information Interfaces And Presentation]**: Multimedia Information Systems – *Artificial, augmented, and virtual realities*

H.5.2 **[Informational Interfaces And Presentation]**: User Interfaces – *Graphical user interfaces (GUI), Input devices and strategies (e.g., mouse, touchscreen), Prototyping, Screen design (e.g., text, graphics, color), User-centered design.*

B.4.2 **[Input/Output And Data Communications]**: Input/Output Devices – *Image display.*

General Terms

Design, Human Factors

Keywords

Augmented Reality, K-12 Education, Mobile Devices

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1. INTRODUCTION

Although AR has been readily accepted in situations such as marketing and military usage, it has yet to make a large impact on a child's education [1]. Although several studies have been conducted to try to apply the technology in a very specific field, such as chemistry, we have not been able to find any study that attempts to cover all educational subjects with a versatile solution [2][3][4].

2. PROBLEM AND MOTIVATION

There are some topics students simply have a tough time visualizing [4]. This ranges from abstract concepts in geometry, the sciences, to the social sciences [3] [4]. For example: students can't actually see the double-helical structure of DNA. Instead, they must look at an illustration in an attempt to understand what DNA is composed of [5]. Another example would be the complicated process of covalent bonding in chemistry. Students are actually taught a *scientifically inaccurate* model of the atom, the Bohr Model, in order to aid their understanding of the concept. This is because there simply is no other way for the students to understand the material being taught to them; the correct model is three-dimensional in nature, and thus extremely hard to grasp intuitively [6].

This motivated us to begin to develop an application to help combat this problem. We believe if implemented into the classroom, AR will help students learn concepts easier and quicker. Furthermore, the application will help to capture and keep students' interests in the subject, especially if teachers can explain to students how the subject is useful.

3. BACKGROUND AND RELATED WORK

3.1 Background

The author in [7] does an excellent job of describing AR: "…augmented reality is the material⁄virtual nexus mediated through technology, information and code, and enacted in specific and individualised space⁄time configurations."
In short, augmented reality is the overlaying of digital or virtual information on top of physical information. Augmented reality is the logical technological progression from virtual reality, which dates back to the 1960's when Morton Heilig created the Sensorama, a device that gave users the experience of riding a motorcycle through 1950's Brooklyn [8]. The term "augmented reality" is credited to Thomas Caudell, who while working for Boeing created a system that trained users on how to repair portions of Boeing aircraft which blended the physical world with virtual interactions [2].

3.2 Related Work

Although there have been studies conducted into the usefulness of augmented reality, they do not address the problem of implementation in a general enough fashion for augmented reality to be easily and quickly implemented into the classroom without regard to the subject being taught. For example, although there has been an investigation into the usefulness of augmented reality to teach chemistry [4], this research did not include mobile devices (so-called "smart" phones) due to the period in which it was written, 2006. In addition, the research conducted for that paper only focused on using augmented reality to teach a single subject, and therefore limited the technology's potential as a teaching tool. Another paper, written in 2012, focuses on the hardware aspect of the technology [9]. This paper both brings up a valid concern, and provides a solution to said problem. The paper states that in order for augmented reality to be effective as a learning tool, the students must be able to interact with the content with their hands. It solves this problem by proposing the use of KINECTs, cheap depth-sensing cameras, to track students' hand movements. There are several problems with using the KINECT to solve this problem. To begin with, the KINECT currently does not have a way to distinguish background movement from the movement of the user, thus making it impractical in a classroom setting. Not only that, but this requires students to be tethered to computers to learn a lesson, which also makes the technology impractical for general classroom usage, as well as requiring students to take turns using the KINECT. Thus, to correct this, perhaps we should shift our focus to the use of mobile technologies, such as "smart" phones, to deliver the augmented content to the students. As mobile devices become more prolific, many schools around the nation are now allowing, and in some cases requiring, students to use the school's internet with their smart devices. This leads us to believe the best approach for integrating AR into the classroom is the creation of an Android application. This allows students to learn the content all at the same time, which allows teachers the ease of knowing their lesson won't be pressed for time due to the "take turns" model of the KINECT.

4. APPROACH AND UNIQUENESS

Our approach was to provide a tablet-based AR environment that could recognize AR tags on physical objects (books, maps, etc.) and present additional 3D interactive information to students. One example comes from biology, and more specifically, the introduction of DNA: most students currently are explained the structure of DNA simply by looking at a picture. They never truly are able to understand the 3-dimensional nature of DNA as it is being explained to them by the textbook. AR could facilitate a greater understanding of the topic by displaying a 3-D model of DNA on top of an image in a textbook.

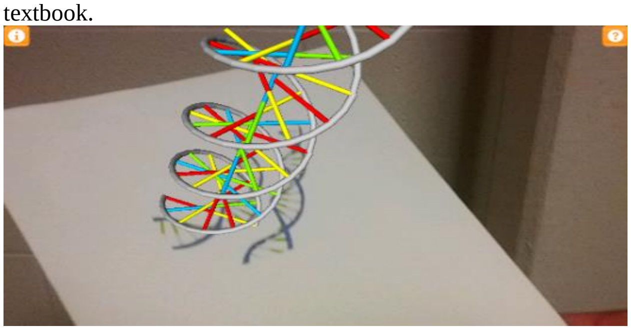

Figure 1. An example of a possible lesson, in this case, DNA.

4.1 Working with Local Educators

Before beginning development, we discussed the possibility of implementing augmented reality into the classroom with local educators in order to gain valuable opinions on the technology's usefulness as a teaching tool. The reasoning behind this was to see if teachers determined any value to the interactivity augmented reality provides. All of the teachers responded positively, as well as provided feedback as to improvements and features they felt should be included to maximize the application's success.

For example, Genny Greco of Riverside Elementary School in Suwanee, Georgia suggested the application may find use in subjects such as geometry, the sciences, and the social sciences. She also recommended adding in some form of user interaction to keep students interested in the topic as well as help them understand the truly three-dimensional nature of some of the topics. Her suggestions were echoed by Mrs. Karen Johnson, a teacher at the same school. Furthermore, Mrs. Johnson felt public school teachers, especially those teaching in the primary and secondary levels, are too busy to develop augmented reality-based lessons on their own. Therefore, if the teachers attended a conference and decided as one unit what content should and should not be augmented, the teachers will know the augmented content will always apply to what they're discussing. These opinions were both valuable, as they both shaped the way our application was designed as well as future research ideas.

5. RESULTS AND CONTRIBUTIONS

The final result of this inquiry is an Android application which is easy-to-use, flexible in the types of content it can deliver. This portion of the research is simply the first step in a long-term project regarding the testing and updating of the application to make it easier to use, and include more content and features.

Currently, all data the application uses is stored on the device and accessed instantly within the application. Although this provides a fast response time with regards to recognizing the targets, it is impractical for general use due to the large amount of data involved. Therefore, before any changes are made to the front-end (the portion of the application the user sees), the application will be changed to make use of cloud storage. This will reduce the overall size of the application. This won't be very difficult, as the API powering the application includes methods to allow developers to store their targets online and download the associated data only when necessary. Storing the content online allows for the use of one application across multiple subjects, as the content is downloaded only when necessary.

The front-end changes will include a screenshot function, which allows the user to save the information displayed onscreen so they can use it at a later date. Other features may be the inclusion of using GPS coordinates for the display of augmentations instead of physical targets. This allows teachers to create augmented scavenger hunts, which not only are a fun way to educate students about a topic, but also a great way to include some physical education into the child's education as well.

Ways to include additional user interactivity would be the implementation of finger tracking to allow the user to control the digital information with their hands, as well as using "virtual buttons," or areas of the target image that have event listeners associated with them. When the user interacts with the virtual button, the augmentation displays a new set of information not previously available. This could be used to create interactive puzzles to teach students problem solving skills.

The third stage of this research will be to implement the application into actual classrooms where its effectiveness and ease-of-use will be truly tested by students and educational professionals who will give feedback about their experience with the application. This is the most important step in the entire process, as it will prove whether or not augmented reality is truly useful in the classroom.

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