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A survey on Immersive learning approach towards current education system

Rashid Ali[1], Raj Kamal Dubey[2], Srijan Mishra[3], Pooja Yadav[4], Ranjeet Singh[5]

Department of Computer Science & Engg. Buddha Institute of Technology, GIDA, Gkp

ABSTRACT

In today's society, technology has become an important part of our lives. It has changed how people think and implement knowledge. One of the newest developing technologies is augmented reality (AR), which can be applied to computers, tablets, and smartphones. AR has the ability to overlay images, text, video, and audio components onto existing images or space.

AR technology has gained a new following in the educational market for its ability to fill out gaps and bring a more improved approach towards learning. Student-cantered activities are improved by the incorporation of virtual and real-world experience. Throughout this literature review on AR the following aspects are discussed in full length: research explored, theoretical foundations, and applications in education, challenges, reactions, and implications. AR has the potential to change education to become more efficient in the same way that computers and Internet have.

Keywords: augmented reality, science education, self-determination theory, flow theory, situated learning theory, just-in-time learning, constructivism

1. INTRODUCTION

Technologies are ever changing and ever growing. One of the newest developing technologies is augmented reality (AR), which can be applied to many different pre-existing technologies, such as: computers, tablets, and smartphones. AR technology can also be used through wearable components, for example, glasses. Throughout this literature review on AR the following aspects are discussed: research explored, theoretical foundations, and applications in education, challenges, reactions, and implications. Several different types of AR devices and applications are discussed at length, and a deep analysis is done on several studies that have implemented AR technology in an educational setting. This review focuses on how AR technology can be used, the issues surrounding the use of this technology, viewpoints of those who have worked with AR applications; it also identifies multiple areas to be explored in future research.

2. RESEARCH

Research conducted for this literature review mainly focused on educational applications of AR. The keywords included educational applications, science or STEM focus, and augmented reality. Journals with a concentration in technology and education that held significance to AR within the classroom setting were sought. References were included that explained the concept of AR as well as studies that implemented AR. Most of the references for this analysis were published within the past years; however, a few articles included were published as early as 2001. The majority of the research found focused on applications in a middle or secondary level. AR appears to have potential extending into lower elementary grades. Researchers often choose students at a middle school level because of the critical time period it is for increase in science interest and building self-confidence [Bressler & Bodzin, 2013].

Several studies seemed to take a collective methods approach combining both quantitative and qualitative analysis. Researchers noted that providing case studies and opportunities for participant feedback extended the wealth of knowledge available and provided key insights to the quantitative data

[(Bressler & Bodzin, 2013; Enyedy, Danish, Delacruz, & Kumar, 2012; Iordache & Pribenu, 2009; Morrison et al., 2011; Serio, Ibanez, & Carlos, 2013]. Qualitative data was also thoroughly inspected, specifically acknowledging the positive and negative impacts of AR that both students and teachers experienced [Arvanitis et al., 2009; Billinghurst & Dunser, 2012; Bressler, & Bodzin, 2013; DeLucia, Francese, Passero, & Tortoza, 2012; Iordache & Pribeanu, 2009; Morrison et al., 2011; Serio, Ibanez, & Carlos, 2013].

One of the quantitative research studies used a design-based approach with interviews to put the engagement of high school students under the microscope.

The studies were conducted over the 2006-07 school year and used data from three schools in order to determine if Argumented Reality technologies help in the learning process. Jefferson High School, Wesley Middle School, and Einstein Middle School are all located in the north-eastern United States. Through the collective collaboration of MIT and the University of Wisconsin at Madison, a hand-held Argumented Reality program known as Alien Contact Was created. This game was designed to focus on various educational aspects such as mathematics, language arts, and scientific literacy [Dunleavy et al., 2009]. Students used this device throughout the study to participate in roles and collaborate as a team. The authors found that there was a high level of engagement.

Engagement was also found while using augmented books through a qualitative research study. Billinghurst and Dunser (2012) surveyed user studies concerning elementary and high school students to determine if Argumented Reality improves the learning experience. The authors found that, "AR educational media could be a valuable and engaging addition to classroom education and overcome some of the limitations of text-based methods, allowing students to relate the material according to their preferred learning style" [Billinghurst & Dunser, 2012, p. 60].

3. THEORETICAL FOUNDATIONS

AR educational programs are student-cantered and related to student interests. It allows students to explore the world in an interactive way.

Constructivism also encourages students to work collectively, and AR provides students the opportunity to do this in a traditional school setting as well as in distance education. We believe that the engagement of the student as well as their identity as a learner is formed by participating in collective groups and communities. Constructivism has also changed the role of the teacher to become a facilitator, where the responsibility to organize, synthesize, and analyze content information is in the hands of the learner warns that because AR follows a constructive learning theory it does not generate consequences for students' actions as needed, Compared to a behavioural learning environment; however, AR can be used to fill out the gap between practical and theoretical learning practices along with real and virtual components being combined together to create a unique learning experience.

AR also relates to the just-in-time learning theory. This theory suggests that students learn information that they need to know now. We stressed that teachers should "reconceptualize" how they view learning and "rethink" what they should teach. AR allows them to do both of these things by letting educators use a new and emerging technology to view aspects of the real world in a different way.

According to Dunleavy et al. (2009) research discussed the possible connection between the old learning theory and AR. According to old learning theory, learning occurs naturally during activities. Some AR situations, allow students to use real-life experiences to enhance learning. Some learning will occur naturally, as they go through their problem-solving environment. Students will use social interaction and collaboration to learn from one another.

Research by [Rigby and Przybylski] identified that AR can be linked to the self-determination theory (SDT). SDT defines learning that occurs through motivation. People have the natural tendency inculcate things what are healthy, interesting, important, and effective. The virtual learner hero situation created in the virtual world

focused in this study determines that students are engaged because they are in charge of their own learning. The same concepts can be applied to an educational setting.

Flow theory describes how people who are engaged in meaningful activities are more likely to stay focused. Researchers investigated a science gaming

experience in relation to flow experience. Their study had a mean flow experience score of 82.4%, which indicates that the average student experienced flow throughout the science mystery game that they played on an iPhone. This particular type of AR, as well as various others, connects their real-world surroundings to learning in a new and engaging way.

4. APPLYING AR IN EDUCATION

AR allows flexibility in use that is attractive to education. AR technology can be utilized through various mediums including desktops, mobile devices, and smartphones. The technology is portable and adaptable to different scenarios. AR can be used to improve content and instruction within the traditional classroom, supplement instruction in the special education classroom, extend content in the world outside the classroom, can be combined with other technologies to improve their individual applications.

4.1. TRADITIONAL CLASSROOM USES

In any educational setting, there are often various limitations in various resources available. This is often seen foremost in the traditional classroom. Due to budget restraints or constraints on time, the means to teach students in scenarios that allow them to learn by doing can be a challenge. Desktop AR allows students to combine both real and computer-generated images. Different models used desktop AR that combined a screen, glasses, headphones, and a pointing device that allowed students to conduct a hands-on exploration. Of a real object, in this case a flat torso, with superimposed virtual images. It would not be feasible to explore the digestive process interactively as these students were able to do along with visualizing the nutrient breakdown and absorption in a classroom setting without the AR technology. Computer images could show the process, but the pointing device allowed students to guide their learning.

Classrooms can be shifted from the traditional lecture style settings to one that is more improved and student-oriented. A case study conducted with a visual arts class noted that allowing students to freely explore a room that was set up with webcams and desktops encouraged more activities while the students perceived that they were more motivated to teach [Serio et al., 2013]. Instead of receiving information via images and lecture, students had access to multimodal representations including text, audio, video, and 3D models.

Quick response (QR) codes can also provide opportunities to have a mixed reality setting within the actual classroom [DeLucia, Francese, Passero, & Tortoza (2012)].According to the researchers conducted an evaluation study on collaborative classroom environments in a university setting. Studentshad access through mobile devices to information provided directly from the instructor and other students. The QR codes within the classroom allowed for location determination, which was necessary because the information was not available online. Having the virtual environment access in a single location encourages consistency and active participation in person instead of just the virtual environment. The learning experience of the old classroom was enhanced by the content sharing of both instructor and peers.

4.2. SPECIAL EDUCATION USES

With the ability to improve learning and physical barriers, AR has the potential to bring value and high quality educational experiences to students with learning and physical disabilities as well as the special education classroom. [Billinghurst and Dunser (2012)] found that using augmented storybooks have led to more positive results as students were able to relate with the stories and have

better reading comprehension. Augmented storybooks could especially help students who were not able to comprehend only text-based materials. Physical movement is often a component and consideration for AR tasks. A student who have difficulties to engage under normal circumstances can become more actively involved in the kinaesthetic nature employedby augmented tasks. Dunleavy et al. (2009) found in their interviews that teachers felt that students who were identified as ADD as well as unmotivated students were 100% engaged in the learning process with AR simulation.

Because of the variety of tools that can be overlaid in an augmented environment, students with physical disabilities are benefitted from the potential learning aides that could be incorporated. Something as simple as overlaying audio for those with visual impairments ortext for those with hearing disabilities can be effective tools when considering disability access [Forsyth, 2011]. Physical limitations can make handheld AR devices more difficult to work with. Head-mounted displays (HMD) can provide a hands-free device to project the overlay visuals to a student and adjust the images based on the orientation of the student while other devices enable students to interact with the environment via voice recognition, gesture recognition, gaze tracking, and speech recognition [Van Krevelen& Poelman, 2010].

By bringing this technology to the classroom provide a new potential to allow for differentiated instruction and enrichment of the learning experience of students with special needs.

4.3. OUTSIDE THE CLASSROOM

Mobile applications can extend the traditional classroom beyond the physical walls. [Annetta, Burton, Frazier, Cheng, and Chmiel (2012)] reported that the percentage of 12 to 17 year olds who have their own mobile device is 75%, compared to 45% in 2004, and regardless ofstudent's socioeconomic status, the number of students having their own mobile devices are growing exponentially every year. Camera phones and smartphones allow users to gather information in a variety of locations. QR codes and GPS coordinates can be used to track and guidemovement of the students. Although several researchers chose to take students off campus and conducted various investigations in a field trip setting, others chose to remain within the grounds of the school.

In an off campus setting, the AR technology needs to be portable and relatively easy to use. Students traveling to a local pond have the ability to study water quality at specific locations while having access to overlaid media about the pond from the AR device. This type of experience opens up a world of opportunities to mesh classroom information into the real-world environment.

Real paper maps and GPS coordinates in a treasure-hunt-style game that allowed for group collectiveness. Participants in the game were aware of their surroundings and chose to work together on a task that fostered small group collaboration. An important point to note from this research is that GPS will not work inside the buildings. Therefore, any indoor activity is needed to be conducted without a location-based AR technology.

Using QR codes allows individuals a means to avoid relying on location-based technology and focus on the augmented experience. [Bressler and Bodzin (2013)] chose to use vision-basedmobile AR within the confines of the school campus. Students used iPhones that are Wi-Fi enabled to collaborate in small groups to complete a science inquiry game. Not only did the technology enable the students to move freely about the campus, but also the design of the game fostered a social constructivist approach by using a jigsaw method in which students had different roles that relied on one another to complete the task.

4.4. COMBINED LEARNING

The technology employed with AR does not need to be exclusive to the AR experience. Motion sensors that modeled force and motion during Learning Physics through Play (LPP) activities and AR in the form of QR codes enabled students to use, visualize ideas and share them with others for discussion [Enyedy et al., 2012]. Combining the technologies helped to enhance the learning experience, which is similar to researches done by

different researchers who pointed out that the combination can help to enhance the learning experience in a way that neither could do alone.

If an educator is looking to model scientific practice, AR provides a great opportunity to support the multifaceted world of science exploration. As a general rule, scientific researchers typically do not use a single tool for evidence to come to a conclusion. Likewise, a literature review that embodies just research from one scientific journal does not begin to tap the wealth of knowledge widely available. Using probeware and sensors to collect data and AR technology to guide and visualize helps to bring a more student-cantered dynamic to a learning experience, resulting in gains in student engagement and content understanding [Enyedy et al., 2012; Kamarinen et al., 2013].

Applications beyond Science Research shows that the use of AR, regardless of grade level or subject area, allows students to actively engaged in the learning process. "Building and using AR scenario combines active complex problem solving and teamwork to create engaging educational experiences to teach science, math, or language skills, and studieshave found that this activity improves student's

motivation, involvement, and engagement" [Billinghurst & Dunser, 2012, p. 60]. Though most research shows the use of AR in education through

middle school science, there are some implementations in other subject areas and age groups.

Outside of old school setting, AR has many uses and can be applied to other fields of interest as well. The medical field can utilize this technology to see information about the body systems without having to leave the sight of the patient. In addition, families can see what furniture will look good in their house before purchasing them, contractors are able to design different components and see how they will fit together before construction, and tourists can find information about the area without a tour guide. Different researches [Van Krevelen and Poelman (2010)] determined that AR can be particularly helpful in industrial situations in designing and assembling vehicles as well as military applications for combat training. Companies such as Volkswagen and BMW have already started to use AR technologies in their assembly lines [Van Krevelen & Poelman, 2010]. Therefore, AR has many benefits other than the educational field.

5. CHALLENGES

5.1. TRAINING

Training is an important aspect of AR. "Most educational AR systems are single-use prototypes for specific projects, so it is very difficult to generalize evaluation results" [Billinghurst & Dunser, 2012, p. 61]. Each AR situation researched was unique and required a different program and requirements of the educator. Due to this uniqueness, training is needed for both educators and students to understand how to utilize each AR program to its full potential. AR lesson, teachers expressed a concern for more support. Teachers did not feel confident when setting up or implementing this program. In addition, teachers who are normally lecture focused had a hard time letting go and allowing students to explore the learning environment on their own.

A training should be given to the teachers to learn a constructive approach with their students and show them how this approach of teaching will fulfil an effective learning environment. The fear of not knowing what is on each student's device can be elevated according to the authors through the process of allowing the students more control over their learning. In addition it was also found that teachers felt that they would be unprepared to manage the same experience over again if they were by themselves without the researchers present. Training should be provided to the educators from the researchers if continuous use of the AR technology is expected to be implemented.

Many AR applications require the use of the environment to set up areas for study. Students walk around and use their AR technology devices in order to gather information. The information must be triggered by either GPS coordinates or other methods when students get near the correct locations. The developer, as well as the educator, must be aware of the environment in order for this to work effectively. Therefore, teachers need to either train themselves or attend training sessions on the environment that they can use. For example, if an AR

applicationis specifically designed to be completed in a school where students get close to fire alarms, information appears on their device about fire safety, and the educator or developer must be aware of where all the fire alarms are located.

5.2.RESOURCES

Different studies provide the facts that there are many aspects of AR that are considered to be difficulties when trying to implement this type of technology in the classroom. Many teachers do not have the skills to program their own AR learning experience and therefore must rely on the ability to create this AR environment through earlier made creation tools, which are very less. This was slightly contradicting to the Annetta et al. (2012) statement that there are many free resources available for teachers use but stress that because teachers are not properly trained they are unable to use these available resources.

AR tools are becoming more user-friendly and require less programming skills making them more attractive to the common educator. We focused our work around providing individuals with a resource for basic skills that would enable them not only understand how AR applications run but also to get started with creating AR content. Researchers pointed out that AR platforms could be employed that allow "an author to create augmented reality games and experiences with no programming experience required" In addition it was predicted that by the year 2030, students will be building AR educational content on a regular basis to connect collaboratively with the outside world from within their classroom.

5.3.TECHNICAL PROBLEMS

Researches [Billinghurst and Dunser (2012)] predicted that the GPS failed 15-30% during the study. A GPS error refers to either the software of the GPS itself or incorrect setup. This was considered the "most significant" malfunction. Other malfunctions identified in this study were the ability for the devices to be effectively used outdoors. The glare from the sun as well as the noisy environment could impair the learning of the students.

Researchers identified that students who collaborate in teams score higher than students who worked on their own. These multi-user teams need to share information with each other. Therefore, one of the challenges identified in this study is the need for developers to create places for collaboration among team members. Without this additional platform, the successfulness of the AR environment can be compromised.

There are many different kinds of devices that can be used when implementing AR in the classroom. Glasses, hand-held devices, and headwear are ways for the user to see computer-generated images imprinted on their reality. Researches determined that the cameras that students were using should be hands free and that they should be set at table level for the maximum results. Carrying around large devices can make ARinconvenient and frustrating. Students wear a backpack as part of their AR technology device. The study showed that students felt that it was hard to wear and made them feel embarrassed. If AR technologies hinder the self-esteem of the students, this can also affect how much information the student can retain within each lesson. Van Krevelen and It was also identified that certain AR technologiescan be uncomfortable and embarrassing to wear. Gloves, backpacks, and headgear can all cause a student to become uncomfortable and distract them from the purpose of the assignment. In addition, such items could potentially discourage students from trying AR in the first place.

According to the researches it was identified the need for the AR technologies to be designed effectively and with high usability. For instance, the video display must make sure that the images shown do not appear more closer or more farther away than they really are. This problem can lead to misconceptions if dealing with location-specific tasks. Some devices may require combination, and this can potentially be very difficult to do. Acquiring devices that are calibration free or auto-calibrated can be beneficial to the user as to avoid malfunction and user frustration.

It was found that players involved in gameplay within the building did not fully utilize the GPS on the mobile device, since the students were familiar with their surroundings. This seemed to reduce the overall load; however, location-based AR can add a new level of frustration when students are placed in an unfamiliar place, where they must rely on GPS navigation to complete gameplay. Using AR technologies that include both audio

and visual components can allow students to use their cognitive abilities to retain information more efficiently based on cognitive load theory.

5.4.STUDENTS ISSUES

One issue identified that some AR situations can be dangerous. In this particular scenario, students must look at their handheld devices to participate. When engaging in activities outdoors the students are unable to work on their devices and watch where they are going simultaneously. Therefore, students were found to be wandering into roadways and needed to be redirected to safety by teachers.

Some of the AR learning experiences require the student to be mobile. Exploring the world is not an uncommon task; however we were concerned with gaining approval from school administration for students to travel outside of the classroom. Without this component the teachers and students would be very limited in their use of the AR technologies. The authors found that classroom management is an important part ofusing AR technologies with students.

Certain health problems can arise from using AR devices if they are not properly designed. Tunnel vision can be a side effect of using poorly designed AR devices, and this should be avoided. Developers and educators should be aware of the method and the amount of information being presented. This could prevent the brain from being overloaded. In addition, when the user feels overwhelmed, stress and other frustration can arise, which will distract the student from the objective of learning.

AR learning environments are often designed to have many roles in order for students to work in teams and collaborate with each other. [Dunleavy et al. (2009)] stated, “As is, if one of the rolesis absent, it severely restricts if not disables the game” .Student absences are a natural occurrence but affect the learning environment drastically. In addition, students who are working without constraints can rush through or skip information depending on the AR program, teacher assertiveness, and intrinsic motivation. Researches also found that students might rush through the activity without fully comprehending the information presented in that part. Therefore, though AR leads to a high engagement level students should be monitored to stay on task and on pace as well.

As AR scenarios are developed for the classroom the developers must be aware of their target audience.

6. IMPLICATIONS FOR RESEARCH

The importance of this literature review is that it not only showcases the current trends in AR technology but also its focus on the increased research and potential further application in the educational setting. Several components remain to be explored. When using AR outside of the classroom, teachers and students are able to use this as a tool for physical activity [Dunleavy et al., 2009]. Linking learning with exercise and activity in an educational way can improve the perception that technology creates a non-interactive environment [NAEYC & Fred Rogers Center, 2012]. Since AR varies in the amount of room required, there is a concern for how much space is needed in order to make implementation successful. Particular interest within AR is that it has not expanded to fully utilize other learning styles, such as audio and kinaesthetic. Another is that the amount of visual information that can be displayed on the screen can be overwhelming to students. Studies should further explore the effects AR has on cognitive load in the brain and how much information should be displayed before it turns from a beneficial device into a distracting device. Many educators are already concerned with how to hold students’ attention to keep them engaged throughout the lesson and maintain focus beyond the novelty of the technology. In one study, it was discussed how AR could potentially increase memorization and concentration skills and suggested that further research should be conducted to validate these claims.

Educators must be digitally literate with an understanding of child development theory to select digital tools that are age specific and avoid the potential negative impact on learning [NAEYC & Fred Rogers Center, 2012]. Researches pointed out the challenges of using AR before students have collaborative problem solving skill sets and behaviours that arenecessary for learning, the tendency for student competitiveness, and the infancy of

effective instructional design. How these challenges factor into placement of AR materials in a single classroom or broad age level warrants extensive focus by future researchers. Although muchof the research focuses on student or teacher reactions to AR in the classroom and how it can be used, the technology itself has not allowed for long-term studies on the appropriate guidelines to implementation that will assure student growth and achievement of learning goals. The long-term effect of AR past a single classroom or group of students needs to be evaluated and compared. It was suggested that the effects of their AR system be evaluated over a longer period oftime. Supplementary research could explore what is the most appropriate range of members utilizing AR in groups and when is the best time for AR to be introduced. To further expand upon possible future research, additional studies would need to seek out if students using AR communicate more effectively and frequently compared to students who are not exposed to AR platforms. Throughout the multiple studies that were examined, many of them suggested further analysis in what types of AR platforms would be the best fit for educational purposes [(Azuma, Baillot, Behringer, Feiner, Julier,

& MacIntyre, 2001; Dunleavy et al., 2009; Forsyth, 2011; Iordache & Pribeanu, 2009].

7. CONCLUSION

AR has already begun to help students learn more efficiently as well as increase their knowledge retention [Billinghurst & Dunser, 2012]. However, before AR becomes mainstream in education, like desktops, laptops, tablets, and even cell phones have become, special consideration must be taken into account on the usability, cost, power usage, visual appearance and the like, in order for content AR simulations activities to become part of the regular academic curriculum [Van Krevelen & Poelman, 2010].

AR has proved to be an engaging way for students to participate in their learning. This new technology allows the learning to be student-cantered and create opportunities for collaboration that fosters a deeper understanding of the content. AR is on the way to becoming an important part ofeducation, and its use will continue to grow.

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