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Creating Interactive Classrooms with Augmented Reality, a Review

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ABSTRACT
Augmented reality (AR) is becoming an uprising technology that is still being applauded as a top-notch innovation in education and that helps teachers improve their classrooms. Thanks to one-to-one program support and the development of apps (apps), it is considered an affordable technology that gives teachers access to new ways of both supporting and teaching. With AR, teachers can have the support provided by multimedia while using the environment inside the classroom. There are multiple free cross-platform apps available for teacher usage. This article answers clearly what AR is, how it can be used to support students in schools, evaluates its educational utility.

Keyword: Augmented reality

INTRODUCTION

AR helps students understand all phenomena by providing a combination of real and virtual media that constitute exceptional graphical and collaborative experiences that help convey abstract concepts to learners. AR allows programmers to place virtual animations and objects on real objects, allowing digital content to be manipulate through physical movement and gestures, resulting in a clearer interpretation of space and time concepts, and a good representation of the relationship between physical and virtual objects. For example, students can understand the abstract concept of the position of the Earth relative to the sun by reading text and viewing 2D images, but by visualizing the solar system in 3D, they can better learn the distinctions of that position. Animating dynamic processes into models and enabling direct physical interactions, providing an instinctive way to interrelate with digital content is at the heart of AR [1]

AR can enable new forms of face-to-face and distance teaching technologies and education practices. Multiple users can be in contact with 3D objects and share insights from different views, making learning a team-based experience. These techniques can form the basis of a range of up-to-date educational practices.

AR provides a superior learning environment due to its advanced visualization and interaction capabilities. However, before AR can be more widely used in the classroom, researchers need to answer important questions about the application of the AR in educational settings, such as: does AR improve education at different levels, is comparable to other learning technologies, What is the advantage over?

WHAT is AR?

About 30 years ago, the concept of mixed reality models was introduced to support the use of technology [2]. Augmented reality (AR) exists on one end and virtual reality (VR) on the other. While these technologies may seem similar, they each provide a different experience for students. VR typically uses a computer and a head-mounted display (such as a headset) to provide users with a three-dimensional experience in an immersive, all-digital environment. Through these capabilities, VR conveys the sensation of being in a non-physical world by surrounding the user with pictures, video, voice, motion, and other stimuli [3]. While VR looks promising as a personal teaching tool, it is considered limited and expensive due to head-mounted displays and similar technical requirements.

AR, on the other hand, has similar attributes to VR and implants it in the physical world without many technological necessities (such as headgear). Traditionally, AR attributes are defined in the related studies as follows:

Mix of physical and digital content (e.g., text, audio, video, links)
Real-time interaction with digital content.
A fluid integration of the digital content with physical content [4]

Although current definitions of AR vary among researchers, they approve that AR is a way of viewing virtual content in the physical world [5]; [6]. Authors in [7] research further defining AR as dynamically superimposed physical and digital content. Once-expensive AR technology is now affordable for the school industry thanks to an improved technological environment. In this paper, AR is practical, a tool that represents a field that allows users to create virtual content (3D models, voice, video, and text) on images or video of their real setting using cameras and applications. Classrooms today are beginning to use their particular types of AR [8] from the simplest QR codes to more complex interactive 3D models. While not as clear-cut as the AR technology, interactive QR codes (where a

QR code is the markup that brings videos, comments, and hyperlinks to life) meet the minimum attributes of the AR definition presented in the literature.

3. IMPLICATIONS OF AR

The growing interest in AR and its capabilities in the outdoor world provides teachers with a source to invent ways to create simultaneous scenarios in the classroom. AR offers schools, teachers and parents a cost-effective and achievable way to leverage evolving technology to support each student's learning outcomes. It works on district laptops as well as students using smartphones, and provides a way to support all students using its features.

There is no doubt that the greatest benefits AR can offer are seemingly infinite, but it is imperative to understand what can be used effectively and what such technology has to offer. AR is capable of transforming a static environment into an interactive one. AR enables multiple types of multimedia support (such as video, audio, images, hyperlinks, and avatars) and provides an environment to overlay them with real-world objects and places. While the concept of AR itself is visually interactive digital content, it is imperative to include all the capabilities the technology has to offer. This combination of physical and digital content can create a thrilling, interactive and related environment for students and teachers to "bring energy" to the learning experience [9].

Upcoming technological developments continue to provide educational stakeholders with creative solutions to support pupils. AR capabilities offer opportunities to improve productivity, impact effectiveness, and address common learning requirements that traditional classroom cannot. AR appears in multiple formats on so many platforms and environments [9], and it is gaining more and more commercial traction.

4. EFFECTIVE USAGE OF AR

Simply offering AR technology doesn't necessarily make people more efficient at learning. As with any technology, there are some important considerations when using AR in the best way possible in an educational setting.

4.1 Mixing AR with traditional learning

AR works best when combined with traditional learning methods. Augmented books can be used alongside normal physical books to teach storytelling. In a study sponsored by HIT Lab NZ [10], children aged 10 to 14 could see a copy of an extended book by Gavin Bishop called Giant Jimmy Jones. The books have animated virtual scenes floating over physical pages with audio effects, including an audiobook track featuring the author's voice. Students then learned about storytelling, narration, 3D modeling, graphic design and animation, using a combination of printed materials and technical equipment. Finally, they were asked to work in groups to create their own version of the story.

AR technology is only a small part of the storytelling course, but it is this chapter that encourages students to investigate more related issues. Although many of the students in the workshop had little experience with modelling software or computer graphics, they were able to write storyboards and invent their own 3D scenes, which they presented in augmentation books. Figure 1 illustrate some of the projects.

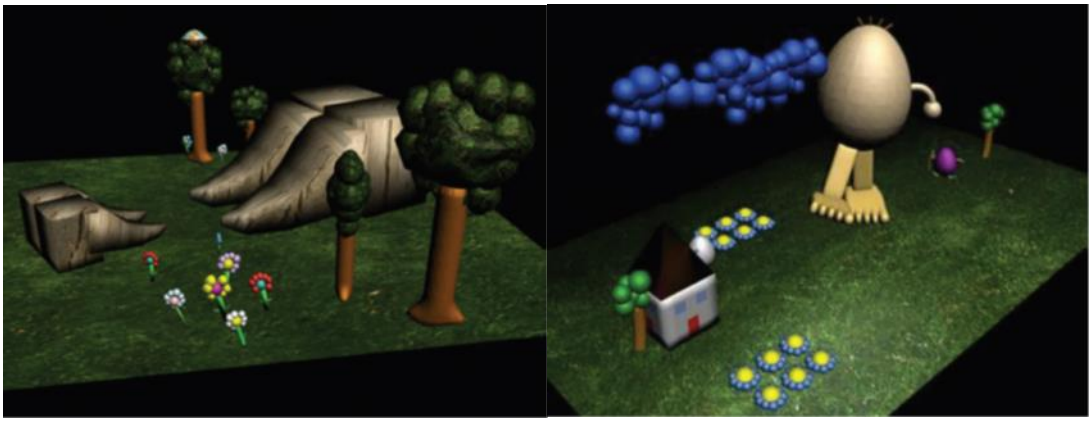

Fig.1: In a storytelling workshop, students create 3D scenes after reading the giant Jimmy Jones' expansion book. Students have little or no experience with modeling software or computer graphics. Source: [1]

The joy of the students after the workshop was beyond words, and they were enthusiastic about AR. Teachers witnessed the entire workshop and loved how the technology supports a wide variety of skills learning. As one Witness teacher noted, "[Augmented book technology] provides a multi-sensory approach to learning that blends text, images, sound and movement in an engaging form of communication."

The teacher report concluded that the activity improved the children's problem-solving skills and "there is no doubt

that AR will prove to be a very effective standard for entertainment and education." Since the workshop, HIT Lab NZ has arranged a number of comparable workshops, similar outcomes.
Another study, [11] found many successful usages for AR in biology learning by having students conduct field trips with AR support. Students travel to a local watering hole to collect samples from several predetermined locations in the AR environment, providing them with digital information and instructions. At the end of the study, teachers reported positive progress in biological knowledge and increased student engagement.
Additionally, authors in [12] created AR flashcards using scientific vocabulary and found that this approach had a significant impact on vocabulary acquisition when using AR flashcards. This approach provides students with interactive, repeatable, and easily accessible multimedia support.

4.2. Authoring tools

Another educational experience to consider is creating AR scenes, as students need to learn how to use the tool to apply complex ideas. For example, let's say students are tasked with creating an AR model of the solar system. First, students need to understand the planets and their motions, then they need AR content making tools to generate the model. To this end, simple authoring tools were developed to enable students to create AR scenes without any programming knowledge.
These tools allow users to design simple AR scenes using a graphical user interface without writing any code. Users can load virtual digital content (text, images, video, or 3D content) and combine it with tracking markers or printed materials to quickly create AR scenes. They can select their own tracked materials and place digital content on top of them using an advanced 3D mouse-driven interface. Teachers and students are even able to add AR content to existing print courses [1].
Students as young as 7 can successfully create AR scenes using AR software. They use a variety of skills like problem solving, mathematics, drawing, generating 2D and 3D digital content, and storytelling. Teachers can use this type of software to support a series of exercises that combine AR. The tools are so simple that users can emphasis on learning the content without worrying about interface or programming issues.
Research on the experience of creating AR content with tools in the classroom shows that even young students can develop AR scenarios, and at its core, the creation process can be a powerful educational experience. To develop AR scenarios, students need to understand the processes that drive learning. Content creation is an engaging creative skill that teaches hands-on 3D design skills while engaging students with AR content and problem solving.

5. Evaluating AR benefits in education

Despite these positive experiences in creating AR content, one important question remains: Can AR technology improve the learning process? Creating and using AR scenarios combines active complex problem solving and teamwork to create engaging learning experiences that teach skills in each subject, an activity that research has found increases student engagement, engagement, and motivation [13]. But what are the real benefits of using AR in education? Answering this question can be difficult because the quality of education depends on many factors, some of which are not easy to quantify.

5.1. Teaching topics with a spatial component

AR is more effective when schooling subjects with a robust spatial factor. In one study, researchers compared learning outcomes with traditional plain-print texts on electromagnetism and AR-enhanced books with the same content. As shown in Figure 2, AR-enhanced books contain 3D digital models of electromagnetic concepts and have students interact with them, such as by pointing at a magnet to change its polarity.

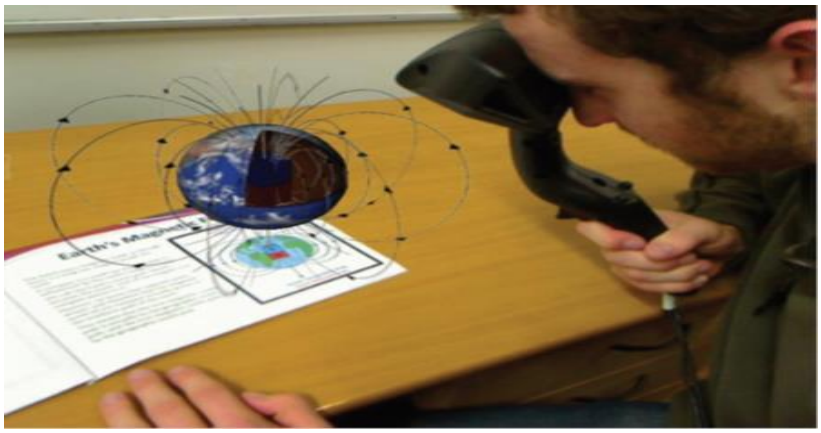

Fig .2: Teach electromagnetism with interactive advanced books. The user sees a 3D model of the Earth's magnetic field. Source: [1]

In a test taken immediately after class for both books, the AR group gave more correct answers, reasoning, and factual by an average of 72 percent, compared with an average of 60 percent in the non-AR group. In a follow-up test four weeks later, the AR group's score improved significantly again, reaching 55 percent, compared with 45 percent for the non-AR group. It is clear from these results that the added interactivity and visual illustration of the AR interface improves topic learning [1].

Reading comprehension

Positive educational results have been seen in story recall and reading comprehension. In Figure 3, students are reading an AR-enhanced storybook and using paddles held by hands to solve simple puzzles by moving virtual characters. The students work in groups of two, which enables cooperative problem solving and grows their odds of discovering new solutions.

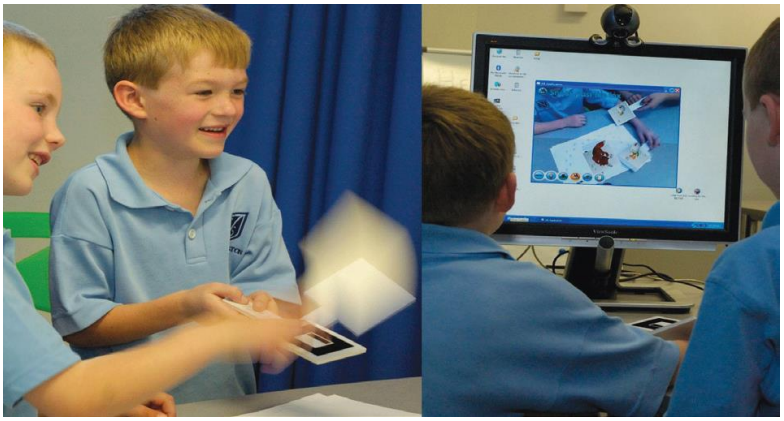

Fig.3: Using an augmented book in a collaborative setting. Working in pairs, students use paddles to move virtual characters and solve puzzles. Source: [1]

This AR-enhanced book has both text-based and interactive AR sections. With the help of the teacher, the students were divided into strong and weak reader classes. The researchers compared how much each group remembered from the two types of sections. From the text-based narrative portion, the genius group was able to retell more key points of the story than the low-genius group [14]. On the other hand, the two groups showed no measurable difference in retrieving key points of the story from the interactive AR part. The researchers believe that augmented reality books can help students who cannot understand text-based learning materials (currently a major educational medium) because these books provide opportunities to engage with the content interactively.
Interactivity seems to be essential for interacting with content. The students mentioned the AR-enhanced book to be a game, and when asked which parts were their favorite, they unanimously chose the collaborative activity. AR media can be a treasured and attractive addition to classroom instruction and can surbase some of the problems of traditional approaches by permitting students to learn the material according to their favored style.

Overall value

Most educational AR systems are models of detailed individual projects, making it problematic to achieve comprehensive evaluation results. Overall, augmented reality-enhanced books are a promising informative technology, equally in labs and in real classrooms. They can improve their outcome using only textbooks or traditional media by providing new ways to view educational materials. The interactive possibilities , spatial modeling of 3D content provided by AR- books seem to benefit the learning process. AR can also help clear topics that students cannot experience in the physical world. For example, students use AR to understand the Earth's relative position and axial tilt to the Sun, which AR augmentation books show as actual physical props [15].
Findings from reading comprehension studies suggest that AR appears to primarily help students who have problems in traditional learning environments based on text books. These results support previous studies showing the role of interplay between different representation and interaction models in enhancing engagement and engagement and overall learning support. Some researchers believe that interactivity can facilitate gaining knowledge by triggering certain intellectual processes [16]. Interactivity can help bring back information stored in long-term memory . allow the brain to combine it with new information. Students who experience interacting with the AR materials likely to retain it than students who only learn the information from the abstract text book. They are also better able to transfer what they have learned to new areas. Interactive students work harder to understand and show greater interest in the material.
However, a handful of user studies have explored the educational importance of AR in the classroom. Important findings call for more thorough experiments with educational AR and how it can enhance learning. The vast majority of studies test learning only immediately after exposure. In an ideal future, studies will also examine long-term effects .

Student Interest and Engagement through AR

Although many tools have been used by the education sector, the success of any educational tool largely relies on its ability to engage and interest students in the educational process. Some research has been done on these augmented reality areas. Authors in [17] found in a study of 9th grade biology students that while the researchers observed such a small difference in academic outcome between the control and experimental groups using AR-enabled materials, there was an interest, however, increased over time in the experimental group. In another study [18], investigated the use of AR as a cognitive technology to support third-grade anatomy. Students in this study said they favored the AR tool and did better in the classroom because of AR. Other studies have also concluded that AR increases interest in the learning process [19], [20] and [21].

When a student's interest in a tool or technology is piqued, it happens and expands student engagement in the educational process. Numerous studies have explored the concept of student engagement through AR with promising outcomes. Authors in [11] used the geo-location ECOmobile app during field trips to study student learning and engagement, where students learn about water quality in puddles. When students reach specific points around the puddle, the app activates questions to explore. Throughout the experience, teachers reported high level of student engagement. Likewise, authors in [22] demonstrated the high level of engagement of middle school students in learning about planetary motion and gravity. In this study, AR provided a giant environment to interactively simulate spatial fields and project full-body interactions into the classroom. Students use their bodies to load simulated asteroids onto the device and expect their orbits in space and planets in the AR classroom.. There were significant improvements in four areas of participation between the experimental group using AR and the control group using the same simulation on the screen. High levels of engagement have also been noted in other papers using AR as an educational technology [23] and [24].

Challenges with AR

There are some issues with using AR in the classroom. One problem could be the maintenance requirements of the equipment used in AR. Device malfunction, such as software delays or GPS errors, can be stressful for students and teachers. Authors in [25] state that “AR-related learning activities often involve innovative approaches such as participatory simulation and studio-based pedagogy”. This method differs from teacher-centered education and also minimizes the amount of content to be covered. In addition to substantive instruction, students must also be instructed in the use of new technologies. Students with no previous AR experience are often overwhelmed, which can lead to misunderstandings among them.

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