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AUGMENTED REALITY TECHNOLOGY IN TEACHING-LEARNING : POSSIBILITIES AND CHALLENGES

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Abstract

Twenty-first century is known as the century of information, knowledge, and communication technology. Therefore, many countries of the globe are in the process of integrating information and communication technology in their education system. ICT has become the focus of interest in all spheres education in present time. In recent years, momentum has been gathering across the education system, demanding technology-centered and learner-centered pedagogy in a diversified situation. Recent advances in technology and in ideology have unlocked entirely new directions for educational research. Realizing the importance of information and communication technology, National Education Policy 2020 strongly recommends for meaningful integration of Information and Communication Technologies in all stages of education and primarily on teaching, research and governance. The Augmented Reality app is a new pedagogical tool suitably designed to promote critical thinking, problem solving skills, analytical ability among students. It represents a unique combination of facts, concepts, principle, application and theories. Matters are delivered to students through electronic means and uses class time for practical application activities, may be useful for information literacy instruction. This dynamic complex environment allow students to think more about using technologies while teachers need to have more competencies to practice and design learning\teaching environment and situations based on those technologies and this diverse of components that motivates students to be more interactive. The AR integrate what is real within a virtual world where they achieve cognitive, affective, and psychomotor objectives by interacting with virtual objects to be performed through real world tasks while using the computer as a tool to make those tasks or problems to be solved much easier to perform without having risks of injury, limited time, or more costs especially in learning science such as physics or engineering. In this paper, an attempt has been made to highlight the rationale of augmented classroom along with the principles, challenges, and criticism in one after another.

Key Words: *ICT enabled learning, Instructional process, Augmented Reality Classroom, NEP2020*

Concept of Teaching Learning

Teaching is a set of events, outside the learners which are designed to support the internal process of learning. Teaching (Instruction) is outside the learner. Learning is internal to learners. You cannot motivate others if you are not self-motivated. Motives are not seen, but, Behaviors are seen. Is learning a motive or behavior? Learning is both a motive and behavior but only behavior is seen, learning is internal, and performance is external.

Learning is about a change: the change brought about by developing a new skill, understanding a scientific law, or changing an attitude. The change is not merely incidental or natural in the way that our appearance changes as we get older. Learning is a relatively permanent change, usually brought about intentionally. When we attend a course, search through a book, or read a discussion paper, we set out to learn! Other learning can take place without planning, for example by experience. Generally, with all learning, there is an element within us of wishing to remember and understand why something happens and to do it better next time.

The teaching and learning process can be defined as a transformation process of knowledge from teachers to students. It is referred to as the combination of various elements within the process where an educator identifies and establishes the learning objectives and develops teaching resources and implements the teaching and learning strategy. On the other hand, learning is a cardinal factor that a teacher must consider while teaching students. The paper evaluated various academic journals, pedagogy, and inclusive practices to assess the teaching effectiveness within the higher education setting. The objective of the research is to assess the teaching effectiveness in a higher education setting. The research used experimental research methods (primarily reflection) using literary forms to analyse the theory with the reinforcement of the practice from the university experiences. The research findings suggest that by providing positive and adequate formative and developmental feedback, the introduction of role-play has a profound positive impact on the students' confidence and self-esteem. It was also revealed that an active learning environment promotes inclusivity and improves the faculty and student academic performances. The research findings will enable the educators to help create and implement an inclusive teaching and learning environment to improve the learner’s expectations and academic performance.

Teaching Learning Process and Education Technology

Since computers are still not widely used in many schools, the teaching process is dominated by traditional methods. It is dominated by the frontal form of work where the teacher had enough interaction with students. Failure to thrive at their own pace and insufficient activity of students was one of the drawbacks of this type of learning. In class, we have children who are not uniform in knowledge and never pay enough attention to those who are not sufficiently mastered the material and those who are above their average. This difference is often hampered by teacher assessment work and how to transfer knowledge to a group of children with different knowledge. The teacher chooses to keep average to good teaching where children with insufficient knowledge would not get the necessary knowledge. The children with insufficient knowledge can progress smoothly without the unpleasant feeling of their ignorance, no frustration, and humiliation while for the most advanced children teaching will be boring. With the development of information and communication technology, especially computers, several researchers (Morrison et al., 2010) were trying to see the benefits and the effect of their use compared to older traditional learning. For many years, we tried to give answers to the question of the advantages and disadvantages between traditional and modern teaching and the prevailing educational technology. The period from 1967. to 1972. is considered to be a period of consolidation of educational technology, which has become the most commonly used term in the science of pedagogy and the educational process (Даниловић, 2004). With the application of educational technology, students can independently progress in mastering teaching materials, choose the pace of work, repeat the material that is not sufficiently clear, that after tests are performed immediately get results and track them their progress. Interactive, multimedia content provides a great advantage of modern learning over traditional learning. With the application of educational technology, we get feedback between the teacher and the student.

Among the first studies on the comparison of the traditional and modern ways with the help of educational technologies research was Clark Richard (Clark, R. 1983). He tried to compare research between lectures and computer guidance and instruction to determine which the better way of learning is. He concluded that they are both effective depending on the ways they are used. The same conclusion came from other authors (Dynarski et al. 2007; Kulik, 2003) and that is that there are some major differences in the use of educational technology and traditional teaching. On the other hand, research at the Center for Educational Research in Pittsburgh within Individually Prescribed Instruction showed that computers are

better tailored to the individual abilities of students, rather than teachers themselves. Educational technology must inevitably be integrated into classrooms and curricula (Clements and Sarama, 2003; Glaubke 2007; NAEYC and Fred Rogers Center, 2012). With the advent of educational technology in the classroom teacher, education are faced with the challenge that teachers integrating educational technology into their daily work. Numerous studies have shown that a small number of teachers are willing to integrate educational technology in their teaching activities (Becker, 2000; Hermans et al., 2008; Stošić and Stošić 2013; Wang et al., 2004). The reason is that there are two categories of teachers in the understanding of educational technology. Some of them have a thorough understanding of modern technical appliances and their operation while others think they must gain additional technical knowledge of the appliances and methods, teaching methods, student-teacher relationship... These two groups represent groups of teachers between older and younger teachers. Older teachers during their study did not have the possibility of training with modern technical appliances, did not have the information technology, educational technology... while the younger generation of teachers possesses the knowledge required for the use of educational technology. A better understanding of educational technology requires a set of computer science, pedagogy, psychology, cybernetics, informatics... The knowledge teachers possess is sufficient for the basic use of education technology. However, educational technology is one big system. First of all, teachers have a basic knowledge of the use of educational technology. It takes far more professional training through a variety of conferences, courses, professional literature, and seminars... to get a piece of better knowledge of the use of educational technology. The fact is that underuse of educational technology, primarily due to poor school equipment necessary resources, insufficient information and knowledge of teachers and the lack of interest and lack of motivation of teachers to use them. Teachers have to be motivated to use the same because the use of educational technology in teaching provides better interaction with students and better reception of information. After all, the students receive knowledge in a visual, auditory, and kinesthetic way. Among other things, educational technology motivates students to work independently and the student is more motivated to return to learning and working because modern technical equipment is widely available at any given moment.

Friendly environment for teaching and learning

Today, Itis being believed that schools are places of torture by stick, but now these are formed in a place of learning with fun. The schools of new generations are creating an

environment of happiness among learners and giving suggestions for the best performance. Teaching and learning are significant responsibilities, it's not merely jobs. Education is a mystery for the learners where the role of a teacher is not to open this mystery but to help to search for the proper ways of disclosing this mystery by the learner himself. Today, teaching is not an act. It is becoming an art of understanding the learner, his needs, his psychology, his functioning, his mental stages, his stress, his happiness, his weakness, his strong sides, and the science of learning. In his book, The Republic Plato wrote "That's what education should be," I said, "the art of orientation. Educators should devise the simplest and most effective methods of turning minds around. It shouldn't be the art of implanting sight in the organ, but should proceed on the understanding that the organ already has the capacity, but is improperly aligned and isn't facing the right way." It is believed that a teacher has the third eye by which he can see what a learner wants. Sometimes the teacher is called a future predictor due to his ability to know the strength and ways to increase the stamina of the learner. Alexander the Great (king of the Greek kingdom of Macedon) said to his great teacher Aristotle that "I am indebted to my father for living, but to my teacher for living well. Therefore, "Those who educate children well are more to be honored than they who produce them; for these only gave them life, those, the art of living well." The teacher must be taught such type that the learner can be able to create self-awareness to monitor other comprehensive difficulties of his subject. It was the past when "chalk with talk" method was used to teach. But in this continuously growing world, there is a compulsion to change the techniques of teaching by the teacher and learning by the learner. Here are some methods of impactful teaching and meaningful learning

Augmented Reality

Nowadays a new medium "Augmented Reality" offers us unique affordances, combining physical and virtual worlds. This is the new way of manipulating how we interact with that world. Without replacing the real world you're experiencing. this technology augments virtual information on top of the real world with continuous and implicit user control of the point of view and interactivity. It provides a composite view for the user with a combination of the real scene viewed by the user and computer-generated virtual scenes. This is an augmentation of the real world by engaging an ordinary place. space. thing or event in a way that is partly unmediated. We can offer learners seamless interaction between the real and virtual worlds by combining augmented reality interfaces with educational content. This new approach enhances the effectiveness and attractiveness of teaching and learning The

ability to overlay computer-generated virtual things onto the real world changes the way we interact and training becomes real that can be seen in real-time rather than a static experience.

Augmented Reality brings virtual information or object to any indirect view of the user's real-world environment to enhance the user's perception and interaction with the real world. Augmented Reality tries to augment virtual objects with real ones or scenes for maximizing natural and intuitive user experience in real-time. It is an interactive environment where real life is enhanced by virtual things in real-time. According to Azuma (1997). Augmented Reality must have three characteristics: combining the real and virtual worlds. having real-time interaction with the user, and being registered in a 3D space. Augmented Reality allows the user to see the real world and aim to supplement reality without completely immersing the user inside a synthetic environment.

Immersing learners in the real world and interacting with them in that world mostly cannot be convenient. Although the natural world is three-dimensional. We prefer to use two-dimensional media in education which is very convenient. familiar. flexible. portable and inexpensive. But it is static and does not offer dynamic content. Alternatively, the computer-generated three-dimensional virtual environment can be used but these scenes require high-performance computer graphics which are more expensive than others.

Although lots of opportunities virtual worlds may present for teaching and learning. it is hard to provide an adequate level of realism. When users are completely immersed in this environment they become divorced from the real environment. So. it gives you virtual things by modeling the real world you're experiencing

Augmented Reality in Education

Augmented Reality technology is not a new issue. It has been used in fields such as military; medicine; engineering design; robotic; telerobotic; manufacturing, maintenance, and repair applications; consumer design; psychological treatments, etc. (Azuma, Baillot, Behringer, & Feiner, 2001). Displaying information by using virtual things that the user cannot directly detect with his senses can enable a person to interact with the real world in ways never before possible. We can change the position, shape, and/or other graphical features of virtual objects with interaction techniques augmented reality supports. Using our fingers or motions of handheld devices such as shaking and tilting we can manipulate virtual objects, as well as physical objects in the real world.

Augmented Reality can be applied for learning, entertainment, or edutainment by enhancing a user's perception of and interaction with the real world. Users can move around

the three-dimensional virtual image and view it from any vantage point, just like a real object. The information conveyed by the virtual objects helps users perform real-world tasks. The tangible Interface Metaphor is one of the important ways to improve learning. This property enables the manipulation of three-dimensional virtual objects simply by moving real cards without a mouse or keyboard.

Augmented Reality can also be used to enhance collaborative tasks. It is possible to develop innovative computer interfaces that merge virtual and real worlds to enhance face-to-face and remote collaboration. These augmented reality applications are more similar to natural face-to-face collaboration than to screen-based collaboration (Kiyokawa. et al., 2002).

Web technologies and the internet are popular. In a practical situation, people still prefer reading books instead of facing screens, and textbooks are still widely used. Another interesting application of this technology is in augmented reality textbooks. These books are printed normally but pointing a webcam to the book brings visualizations and interactions designed. This is possible by installing special software on a computer. using special mobile apps or a website. This technology allows any existing book to be developed into an augmented reality edition after publication. Using 3D objects and views. miscellaneous and imaginative media. simulations with different types of interactions are the easiest ways of connecting the two isolated worlds. Through the use of Augmented Reality in printed book pages, textbooks will become dynamic sources of information. In this way, people with no computer background can still have a rich interactive experience.

Augmented Reality in Education

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Benefits of Technological Education

India is a global leader in information and communication technology and other cutting-edge domains, such as space. The Digital India Campaign is helping to transform the entire nation into a digitally empowered society and knowledge economy. While education will play a critical role in this transformation, technology itself will play an important role in the improvement of educational processes and outcomes; thus, the relationship between technology and education at all levels is bi-directional

Given the explosive pace of technological development allied with the sheer creativity of tech-savvy teachers and entrepreneurs including student entrepreneurs, it is certain that technology will impact education in multiple ways, only some of which can be foreseen at present. New technologies involving artificial intelligence, machine learning, blockchains,

smart boards, handheld computing devices, adaptive computer testing for student development, and other forms of educational software and hardware will not just change what students learn in the classroom but how they learn, and thus these areas and beyond will require extensive research both on the technological as well as educational fronts.

New circumstances and realities require new initiatives. The recent rise in epidemics and pandemics necessitates that we are ready with alternative modes of quality education whenever and wherever traditional and in-person modes of education are not possible. In this regard, the National Education Policy 2020 recognizes the importance of leveraging the advantages of technology while acknowledging its potential risks and dangers. It calls for carefully designed and appropriately scaled pilot studies to determine how the benefits of online/digital education can be reaped while addressing or mitigating the downsides. In the meantime, the existing digital platforms and ongoing ICT-based educational initiatives must be optimized and expanded to meet the current and future challenges in providing quality education for all.

However, the benefits of online/digital education cannot be leveraged unless the digital divide is eliminated through concerted efforts, such as the Digital India campaign and the availability of affordable computing devices. It is important that the use of technology for online and digital education adequately addresses concerns of equity.

Benefits of Augmented Reality

In this section, we present the groups of benefits as well as single benefits, which we identified and describe by citing examples from the reviewed literature.

State of Mind

a) Increased Motivation.

By Increased Motivation, we refer to users being more eager, interested, and engaged to deal with new technology as well as teaching and learning content compared to non-AR (NAR) methods. The benefit is described in quotations such as “the AR-style gameplay successfully enhanced intrinsic motivation towards the self-learning process”.“Participants using the AR books appeared much more eager at the beginning of each session compared with the NAR group” and “students have been satisfied and motivated by these new methodologies, in all cases”. The benefit can be further described by findings such as the users being “more proactive” or the will to continue learning using the AR technology after class. A more detailed description was found in Iwata et al. where physical interaction is explicitly identified as a driver to enhance emotional engagement.

b) Increased Attention.

This benefit is about the attention users pay to the technology and thus to the teaching and learning content. It is mentioned explicitly by Vote-ULan. In two other cases, we interpreted the quotations "felt it interesting using the AR-guide system" and "teachers noted that the smartphones [the AR-System] promoted interaction with the pond (of which the pupils should learn something about) and classmates" as indicators for increased attention.

c) Increased Concentration.

This benefit concerns users' concentration while using AR applications. Similar to the detailed description for Increased Motivation through AR application in Iwata et al. "physical interaction induced deeper concentration". Yen et al. and Ibanez et al. perceive a "higher degree of concentration" or a "higher level of concentration".

d) Increased Satisfaction.

Increased Satisfaction means that users experience higher satisfaction regarding the learning process or their educational progress, that is, regarding the learning process, students have more fun running through a library and solving tasks directed by an AR application than by a librarian. Martin-Gutierrez et al. state that "the students were quite satisfied with the [AR-]tools used to learn". A reverse statement is that the frustration level is higher using the manual way. This benefit is also mentioned by Ibáñez et al. and Redondo et al.

Challenges of Augmented Reality

Challenges with AR some issues are involved with using AR in the classroom. One issue could be the maintenance required for the devices using AR. Device failures such as GPS errors or software lag can become frustrating for the students and the teacher. Wu et al. (2013) explain that the "learning activities associated with AR usually involve innovative approaches such as participatory simulations and studio-based pedagogy" This approach contrasts the teacher-centered instruction and could also limit the amount of content that can be covered. Along with the content instruction, the teacher will also need to instruct the student on how to use the innovative technology. Often, students unfamiliar with AR can become overwhelmed and this may cause some confusion to them.

How does AR help us in Teaching?

Action Plan for Further Implementation In utilizing AR apps for education, the researchers summarized the actions a teacher could take in facilitating an interactive engagement classroom.

a) Lesson preparation

The researchers propose that for AR integrated lessons to be successful, significant preparation on the part of the teacher is necessary. The preparation of the teacher requires that he/she finds an appropriate mobile app, one that is (ideally) free and makes room for personalization, customization, and an easy-to-understand interface. Findings from this work also suggest that the teacher plan as well the part that the AR app will play in the implementation of the lesson. It is suggested that the app be initially used to capture the interest, and serve as motivation or sample visualization of the lesson. Beyond that, AR may not be very useful anymore. More teacher innovation is needed when promoting conceptual development, deepening the topic, and addressing other higher-order thinking skills. Although it was not done in this paper, the researchers suggest that AR be used as well for formative assessment.

b) Improving student learning attitudes

Student learning attitudes can be helped by AR integration by letting them develop a deeper appreciation of Chemistry as a subject. AR integration may give an impression to the students that the subject is fun and that even though there are challenging topics, all can be simplified when one can easily visualize the behavior of atoms and molecules. This paper suggests that AR should be integrated into Science classes when the topic may appear to be abstract and difficult for the students. Students have reported that AR does make the lesson a little more interesting than just reading from texts and solving problems. Students also reported that they can realize how "real" atoms and molecules are, allowing them to have a mental image of what is going on when atoms and molecules inside and outside their bodies interact with each other.

c) AR as a supplementary visualization

Students reported that they were allowed to wrap their minds on the phenomenon of atomic bonding. The images used in the AR app were three-dimensional simulations that were superimposed on real images as seen live in the camera of tablet devices. This idea suggests that AR apps can serve as a substitute for actual objectives when the lesson demands that the students be given a chance to develop or gain a mental map or image of physical surfaces, paying attention to details of shape or texture. This work also suggests the use of AR apps as visual aids for other sciences such as Biology, Physics, and Earth Science. These other disciplines demand different sets of competencies to which augmented reality can be utilized as well. Although the AR app used in this work was deemed "basic" by the students,

they mentioned that there is an opportunity for the teacher to seek other AR apps that are more complex and more realistic. After, augmentations to reality can be made as close to reality as possible.

d) Attention to inaccuracies

As mentioned previously, teachers should be familiar with the inaccuracies that a chosen AR app can show to the students. Inaccuracies may prove detrimental to concept development, hence, teachers should explain the limitations of each visualization. The teacher should always pay attention to all the physical details of the visualizations and have foresight as to how the students may end up getting confused or may develop misconceptions. These details include physical limitations, oversimplification, deletion of important physical aspects, or even other visual details such as texture and color of simulations.

Augmented Reality in the Classroom

Note cards have long been a staple for memorizing new concepts in chemistry. With AR, those notecards can now come to life and provide richer content for learning. For this task, HP Reveal can be used to quickly create AR notecards with augmented images or video (step-by-step directions in Supporting Information). The physical AR notecards contain a QR code, reactants, chemical substrate, and a reaction arrow that points to an unrevealed product. Upon interaction with HP Reveal, a video is projected onto the AR notecard space, and the product's chemical structure is immediately shown. Following a short delay, a hand-drawn mechanism shows the electron movement via the curved-arrow formalism. The HP Reveal application allows audio recording and playback for the augmented projection; however, this simple demonstration limited the content to chemical drawings without a formal discussion. For future notecards, one could envision including discussions about key concepts while drawing the mechanism as found in numerous Youtube videos based on organic chemistry mechanisms. An example of an AR notecard can be found in Figure 1 with the remaining Organic Chemistry I AR he Supporting Information. The overall opinion of the AR Notecards was informally gathered during a spring semester of Organic Chemistry I at Southern Illinois University. The class was provided a printout of the AR Notecards (found in the Supporting Information) and a short video of HP Reveal's capabilities at a time of the semester when mechanism drawing was introduced (e.g., the addition of HBr to alkenes). Through interactions with the students through the remainder of the semester, several general dialogues emerged. First, the students liked that all the mechanistic information for a series of reactions was in a single location. Second, students expressed that the technology was "cool"

and liked the step-by-step process given in the videos. On the negative side, several students expressed frustration that the video could not be paused or rewound. This is understandable as the students were interested in taking notes or analyzing the written structures in more detail. While this feature is currently unavailable in HP Reveal, it does provide a desirable design feature for those interested in creating future applications or platforms for AR content. The preparation of the physical AR notecards was initially straightforward. Chemdraw was used to generate molecular structures and import them into Microsoft Powerpoint with a square border. Those notecards could be printed and then used as a physical image source with HP Reveal software to create an "Aura" that associates that trigger image (physical object) with an AR projection. However, while preparing the "Auras", the HP Reveal software requires/requests that the trigger image contain unique characteristics to allow differentiation among other images. Owing to the scope of this project, a simple reaction arrow with substrate and reactants does not provide enough differentiation among the presumed notecards for Organic Chemistry I. Therefore, QR codes were incorporated into each AR notecard as a mechanism to provide differentiation between reactions. The QR codes for each AR notecard were produced by entering text that described each reaction into the free, online QR code generator.20 The QR code generator method is powerful because even a single letter (or capitalization of a letter) leads to a significantly different pattern in the QR code. This differentiation in the QR code helps guide the accurate recognition of the AR notecards. Unfortunately, the QR code incorporation is not completely perfect within HP Reveal. It was found that if the QR code is located at the same location for ∼20 cards (e.g., lower right corner), the HP Reveal becomes confused and may provide incorrect AR projections. Therefore, the provided Organic Chemistry I reaction notecard set (Supporting Information, n = 30 cards) uses a systematic variation in the location of the QR code around the inside borders of the cards. This placement system allowed the HP Reveal application to successfully register the AR projections for all examples. It is this author's opinion that proper variation of QR code placement could provide access to 50−60 different AR notecards and perhaps even more if new shapes, colors, or defining features were added to the different notecards. Alternatively, if even more notecards were needed in a given situation, another methodology could use multiple HP Reveal accounts that hold different sets of cards (e.g., 30−40 cards per account) that a content retriever could then follow/unfollow as needed. The AR projection content was created with a simple recording setup (Supporting Information) using a smartphone that overlooked an enlarged notecard. The video was recorded at a

resolution of 640 × 480 pixels, which was the lowest reasonable resolution available on the smartphone. Upon recording the curved-arrow reaction mechanism, the video was associated with the trigger image inside the HP Reveal software (Supporting Information). The application allows for the imported video to be a maximum of 100 MB in size and therefore limited the video lengths to around 4 min at the recording resolution. Longer videos could be created (e.g., larger than 100 MB) and then reduced in size using video editing software on a computer. However, in this demonstration, recordings were limited to less than 4 min to demonstrate that all content could be generated and implemented within the smartphone environment. The 30 AR notecards were created over 2 days, and the most significant limitation was the mistakes made during the drawing of the organic mechanisms, which required a complete restart of the video recording for a given reaction.

Conclusion

Augmented Reality in education strengthens the opportunity for teacher and student interactions. Findings of this work show that AR apps are useful in initiating an interactive classroom, hence, we label them as a useful tool for interactive student engagement. The use of AR technology poses benefits to teaching implementation in terms of providing innovation as a visual aid for teaching and learning and it is also a technology that is relatively easy to understand. It provides a three-dimensional visualization, a simulation of a phenomenon that is superimposed in real environments, providing a crossover between virtual reality and reality. It does however poses actual challenges to pedagogy in terms of designing appropriate lessons that do not cause misconceptions due to oversimplification of visualizations, one that also provides a more in-depth approach to understanding lessons (e.g chemical bonding).

There is also a need for more free resources to make it more available to many, and app developers for education with constant updating. Students reported generally positive learning attitudes about science after experiencing augmented reality. They discussed how Chemistry can be made much friendlier and how lessons can much better be taught and learned in the classroom through effective visualization of ideas. Students reported as well that augmented reality in general does not offer anything new or novel. Generally, the researchers see a bright future for the use of augmented reality applications in teaching. It is a young technology that has great potential to serve as an alternative to bulky and expensive teaching visual aids. Currently, it simply suffers due to the lack of attention that it is receiving but the researchers are hopeful that over time its merits will be known more in the

educational profession and its issues will be addressed and improved upon. Our outlook on the future of AR in education is bright as we hope that other members of the concerned society such as co-teachers, parents, and especially the students will cooperate to embrace this technology as well.

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