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# Applications and Challenges of Augmented Reality in Education Sector: A Report

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**Abstract:** *Augmented Reality (AR) is one of the emerging advanced technologies which bridges the gap between the real and the virtual worlds, that gives students prodigious possibilities to learn the information in a completely unique way. With the rising use of personal smart devices in this modern era, the vast potentials of AR have begun to be explored as the smart devices are capable of producing AR environments. In this paper, we have the purpose of exploring applications and challenges of adopting AR in education. Since augmented reality in education can serve a number of purposes. It helps students easily acquire, process, and remember information. Additionally, AR makes learning itself more engaging and fun. Therefore, this paper is based on the research that has been conducted on AR.*

*It is also not limited to single age group or level of education and can be used equally well in all levels of schooling: from pre-school education up to college, or even at work. The potential of mixing smartphones and augmented reality for education is big, though it still has got to be fully discovered. AR, in various ways, could grant students extra digital information about any subject, and make complex information easier to know. Nowadays we may find some excellent samples of augmented reality in education worldwide. Ability to attach reality and digital content has been steadily improving, opening more options for adopting AR in education sector.*

**Keywords:** *Augmented Reality, Adoption in education, Smart Devices, Application and challenges*

## I. INTRODUCTION

Augmented reality or AR is an upgraded version that extends the actual environment through VR. The main difference between VR and AR is the reality. VR separates a user completely from the real world, whereas AR keeps the user in the real and virtual worlds at the same time through smooth interface, tools and applications such as head set, interactive glasses, tablets and 3D objects. AR consists of three main aspects: (1) integration of real and virtual objects, (2) interaction of these objects at the same time and (3) participation of real and virtual objects for the same task. Although the literature mentions numerous definitions, many scholars agreed that AR technology simultaneously combines virtual reality with actual reality. A few scholars defined AR as computer generated images that provide a composite vision to be seen by a user in the real world. Others stated that AR are devices that allowed virtual objects to be visualised in a real environment. AR is also defined as a direct or indirect presentation of a real environment, complemented by virtual elements created by a computer. Since the advent of this technology, researchers have used it in most fields (medical, military, industry, tourism, entertainment, advertising, psychology, marketing, engineering and the arts). AR has also wielded an effective and strong influence in education. This technology has incited considerable interest among students, stimulating their active participation, high concentration and deep understanding of the subject taught. Education researchers have recognised AR's remarkable potential and substantial impact on cognitive and emotional learning outcomes. This technique helps students connect what they observe in the real world with their previous knowledge and handle goals and tasks because of the following benefits. AR provides effective learning environments and new opportunities to enhance the learning process. For experiments, AR combines the digital environment with the real sensory experience, allowing real and virtual coexistence that in turn leads to engaging user interaction. AR provides not only knowledge but also guidance on how to process acquired information. In addition, this technology is an easy and natural method of teaching because it creates large areas for exploration. AR is a mature area of psycho-physical studies as well for those who suffer from a physical disability. The advantages of introducing AR technology in educational reliability include increased student experience in real-world environments and raised awareness of the environmental context through interface with digital components. Reality is enhanced with additional virtual information. AR also increases the sensory perception of users. Given the learning experience it provides, AR is a good interface for the next generation that enables different means of handling information by designing better educational environments. Designing an educational environment with electronic and scientific training activities can be achieved.

The results showed particularly significant benefits of using AR in primary and secondary schools (pre-university education), where the technology is a highly accessible medium.

Previous research demonstrates that AR can improve education, but this technology has major determinants that must be considered to be acceptable in the field of learning, such as providing low-cost devices and applications based on AR technology. One of the ways to improve the learning process is by enhancing the quality of the educational system with AR, given its ease of use for applications and their benefits, including immersion and enjoyment for learners.

Learning through AR may promote student-teacher interaction and enhance students' satisfaction with the learning experience. It may also develop oral communication skills, social interaction skills and may encourage diversity understanding etc. Therefore, the objective of this paper is to explore the fundamental disputes and possible challenges of AR adoption in education.

## II. DEFINITION

### A. What Is Augmented Reality

Augmented reality (AR) is an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli delivered via technology. It is a growing trend among companies involved in mobile computing and business applications in particular. Amid the rise of data collection and analysis, one of augmented reality's primary goals is to highlight specific features of the physical world, increase understanding of those features, and derive smart and accessible insight that can be applied to real-world applications. Such big data can help inform companies' decision-making and gain insight into consumer spending habits, among others.

### B. Why Augmented Reality is Important in Education

Even though many teachers globally prefer to stick to traditional teaching methods, AR technology is making inroads in educational establishments and enterprises.

So, what is augmented reality in education, and how does it affect students' performance?

As they learn, many students find it difficult to perceive theoretical information without any visuals or relatable examples. As a result, many concepts remain incomprehensible and out of reach for students.

This is where augmented reality applications come to the rescue, visually transforming information and creating order from the chaos.

Talking about the future of augmented reality in education, the TOJET study was also in this vein. It demonstrated the positive impact of AR technology on knowledge retention compared to traditional teaching methods.

### C. Benefits of Augmented Reality in Education

There are many advantages of using augmented reality applications in education that have already been discovered by practicing educators. Here are the main ones below:

#### 1) Advantages of augmented reality in education

- a. Access to learning materials. Educational institutions often lack up-to-date teaching materials; many students have to study outdated information or search for information on their own at home. In an AR application, you can download the latest data and display it in an interactive format.
- b. Access to virtual equipment. In cases where it is necessary to explore specific equipment and learn how to use it, an augmented reality application can present the required 3D model and helpful explanations. This adds practical value to the traditional learning materials.
- c. Higher student engagement. Students study the material more deeply through immersion, which makes it feel more real and relevant. This is a substantial change of pace and an exciting experience for many.
- d. Faster learning. A new way of presenting information helps reduce the overall learning time. Subsequently, there is more time for practice and in-depth examination of niche topics.
- e. Safer practice. In such cases as anatomy lessons, students no longer need to dissect real animals; this can be accurately simulated through software. Students get the same level of practice without harming anything or working with dangerous tools.

### D. Augmented Reality Uses in Education

Thinking about how to use augmented reality in education? There are many fields where AR applications can become a great solution to many problems.

So, let's have a look at how augmented reality can be used in education.

#### 1) Augmented Reality In Schools

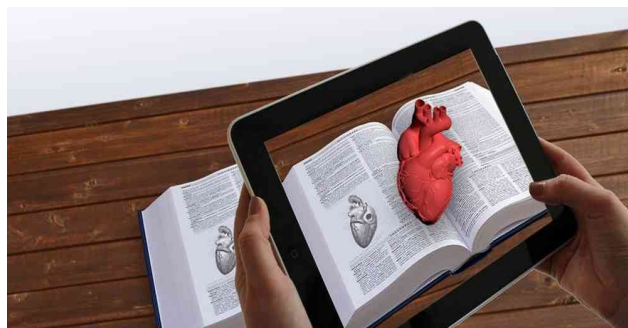




What is AR in school? It's an application that can be used during lessons for better representation of the material being studied. For example, school students can explore such complex sciences as biology, anatomy, physics, and even math more interactively and engagingly. In addition, an augmented reality app in the elementary classroom can simulate different cases that are hard to explain and even help develop children's creativity.

But do you know how to use augmented reality in the classroom? Most modern mobile devices such as smartphones and tablets are suitable for AR application use, and many of the young generation already have personal gadgets. Still, it's only a benefit as kids can do their homework with more excitement and learn whenever they want.

## 2) Augmented Reality In College



Whether students want to study humanitarian sciences or technical science, augmented reality solutions for a university can be very helpful. For example, medical students can learn anatomy and practice examining the body with an AR app representing the human body inside and out. In addition, many universities use augmented reality for teaching students engineering, math, design, astronomy, and much more.

Augmented reality for students makes the educational process more engaging and safer. The technology allows conducting experiments like trying different chemical combinations and seeing what can happen with no harm to students and university property. Moreover, AR applications can help students with creative activities in college and with organizing university events.

## E. AR for distance learning



Over the past couple of years, the method of distance learning has become very popular due to the pandemic. For this reason and others, online education will likely continue to be used worldwide long after the situation stabilizes. Augmented reality applications

can serve as a convenient platform for online learning, where the student can receive the necessary materials and collaborate with other students and teachers in real time.

We should also mention that distance-learning students do not always need a teacher to explain the material. A good app can contain an entire presentation on each topic with a short or detailed explanation of the theory and interactive practice. Thus, students can study independently at a high level in the location most comfortable to them.

#### *F. AR in Education Use Cases*

There are several prominent examples of augmented reality in education that show the actual capabilities of such learning methods.

- 1) **Children's safety education.** More than 80 kindergartens in China made use of AR technology in an elementary education program to teach children from an early age all the basic safety rules and develop self-awareness in this area. The organizers suggest that this interactive education method has a better chance of making children remember such vital information and apply it in life.
- 2) **Augmented reality in Western University.** The Unity Charitable Fund was granted for an AR project for Western University that will allow students to swim with sharks! This is considered to be a great experience for making decisions under pressure and for students-biologists to explore the sharks' view and behavior up close.
- 3) **Google Arts & Cultures in the classroom.** In the conditions of quarantine and a pandemic, it has become much more challenging to organize excursions to museums, exhibitions, theatres, etc., for students. This application from Google allows you to conduct a virtual 3D tour of the most famous museums globally, spend a day at ballet, and even visit different countries without leaving a class or home.

#### *G. Challenges of augmented reality in education*

This section describes the common challenges found in AR used in education studies across different domains. The challenges discussed in this section are elaborated because they come from different domains. They are only shared based on their general importance in figure,

- 1) **Challenges related to individuals:** This challenge is meant to discuss some of the common issues associated with individuals in the literature. Three challenges are reported in individuals, namely, teachers, students, and developers.
  - a) **Related To Teachers:** The first is for teachers; many challenges have been associated or faced by teachers, such as the inability to teach in a sensory manner, followed by limited class time, limited knowledge of AR, fear of failure in using technology, lack of equipment and high cost and insufficient training for dealing with technology. Moreover, teachers may have misconceptions of using AR tools and cannot improve student performance due to a lack of reliance on AR. Teachers are insufficiently familiar with the AR technology. Teachers cannot afford these ad-hoc developments. Teachers are unaware of how to increase students' learning motivation with AR. Studies that attempted to engage the teacher to assess educational gains using different measures are lacking; furthermore, most studies did not include the teacher as an instructional designer.
  - b) **Related To Students:** This section aims to review the challenges faced by students during and after the use of AR in education as collected through literature. Among the most important challenges facing students while using AR technology are students' difficulties related to their abilities, being the pioneers in AR-enabled subject's difficulties in connecting and observing while also using AR technology. Other issues include imaginative abilities, the inability of students to keep up with the lessons, and a lack of student sensory perception for AR-related experiments. Additional issues are limited background knowledge, student difficulties in developing learning awareness, lacking spatial concepts, lacking cognitive load and learning motivations and the inability of participate and interact.
- 2) **Challenges Related To Equipment and Tools:** In this section, we explain the most important challenges related to the equipment and tools that are used in AR technology in terms of factors such as cost of equipment, difficulty in use, and inappropriate operation. The main challenge for users of the AR technology is expensive equipment, expensive educational systems financial restraints AR technology. Insufficient equipment. All of the above challenges led to limited access to labs. In addition, technical challenges arise in the equipment, such as complex instruments; difficulties arise in preparing devices and specialised instruments are needed. Other challenges are lack of relevant teaching facilities and creative design equipment, like tools. Using equipment is also difficult. Insufficient learning outcomes of tools and a lack of effective learning strategy tools are other challenges.

- 3) *Challenges related to teaching using AR* : This section reviews the challenges of teaching with the use of AR technology in terms of factors such as technical, scientific, and educational efficiency.  
These challenges include lack of teaching experience, lack of experience in using AR in education, lack of teaching assistance, lack of teaching facilities and lack of various appropriate instructional AR applications.  
Further challenges are lack of effective teaching materials, unknown learning effectiveness, the inability to provide interactive learning in outdoor learning environments, the inability to provide observational learning and its mechanisms and difficulties connecting to actual instances of the observed phenomenon. Time is an important challenge, that is, time is insufficient for teaching. Studies are lacking that compare the effectiveness of AR technology and other technologies on student learning. In terms of teaching languages, AR contributes less for students who need verbal assistance by removing the necessity for spoken language.
- 4) *Challenges Related To AR System and Development*: This section reviews the challenges of the system used in AR technology, such as limited capability, financial restrictions and system instability. Other challenges are the need to develop applications to help motivate students, especially in STEM applications, inadequate system design, lack of practical system content and excessive work needed to create content. Incorporating AR in courses is difficult, and the cost of development of AR-related content is not always affordable for educational institutions. Creating AR system experiments is challenging as is lack of virtual ongoing professional development. The development of an educational AR system is time consuming.
- 5) *Challenges Related To Usages of AR* : This section illustrates the challenges related to the use of AR technology collected from the literature. For example, no proper guidelines exist for applying AR for education, unfamiliarity with the environment, long-term involvement, occasional instability and cognitive overload.  
Furthermore, users are sometimes not accustomed to using AR. In terms of training, challenges include no content available for practice, a lack of opportunities for practical observation, limited knowledge to use AR, few experiences of using AR in education, limited and unnatural experience and lack of AR use in education. Some of the challenges are in technological knowledge such as difficulties in use, and a lack of using AR and game-based learning in educational settings. Furthermore, computer skills are required, and academic staff must be involved actively when designing virtual learning scenarios to obtain maximum learning benefits.  
Simulations for real scientific data are lacking. Developmental difficulties arise. Sufficient information about the educational usefulness of AR is lacking.
- 6) *Challenges related to environment*: In this section, the challenges are related to AR environments found in the literature are provided.  
These challenges include the difficulties of learning in an outdoor environment is challenging and learning overload. Real environments are different from virtual environments. The objects in the real and virtual worlds must be properly aligned with respect to each other, or the illusion that the two worlds coexist will be compromised. Situational contexts for the environment are lacking.
- 7) *Challenges related to studies on AR*: This section illustrates the challenges collected from the literature on the quality and quantity of studies conducted on AR. These challenges include the few studies that have been conducted in educational observation and academic collection. AR scaffold environments must be provided to support deep learning. Furthermore, few studies have been conducted on AR cognitive learning and on using AR in language. Comparative studies between the effectiveness of AR technology and other technologies on student learning are lacking. Comparative studies between AR teaching and traditional teaching method are lacking. Literature on using AR technologies in science teaching is lacking. Disadvantages of tools and content in analysis and discovery of data exist.  
Studies are lacking in acceptance of AR as a learning tool and the perception of users in education. Studies in elementary or secondary school context are lacking. Effects of AR technology in learning have not been comprehensively investigated. Studies on AR in education are lacking.  
Few studies have explored how to use AR technology effectively for science education. No studies have been conducted on AR technology that involve taste and smell.



Figure 1: Challenges Overview

### III. KEY TAKEAWAYS

- 1) Augmented reality (AR) involves overlaying visual, auditory, or other sensory information onto the world in order to enhance one's experience.
- 2) Retailers and other companies can use augmented reality to promote products or services, launch novel marketing campaigns, and collect unique user data.
- 3) Unlike virtual reality, which creates its own cyber environment, augmented reality adds to the existing world as it is.

### IV. CONCLUSION

Researchers have attempted to use this technology in several areas, including education. However, the number of studies using AR in education has been relatively low. This technology is supposed to be used in the future because it is useful in education, as previous studies have shown, and it is likely to spread considerably in the near future. Many researchers have focused on AR in education with different ideas, different samples and different cultures. We conclude from this literature review that AR strongly supports the educational process. However, after comparing the research studies, we note that the effect of AR in education is not different from that of traditional methods.

We believe that the information that has been raised in literature is absolutely correct and unquestionable, but the greatest challenge is in the way to choose the applications of AR for each purpose and method of use. Lack of experience, technical problems, application user interface, fear of failure by teachers, and the time (lecture time is limited or insufficient). Additional factors are other costs (prices of smartphones and tablets), the Internet and technical problems. We believe that if these challenges are addressed, AR will be an extremely appropriate tool in education.



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