



IJIRCCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 9, Issue 2, February 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.488

 9940 572 462

 6381 907 438

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 www.ijircce.com

Review on Augmented Reality in Education

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ABSTRACT: Technology in education can influence students to learn actively and can motivate them, leading to an effective process of learning. Previous research has identified the problem that technology will create a passive learning process if the technology used does not promote critical thinking, meaning-making or metacognition. Since its introduction, augmented reality (AR) has been shown to have good potential in making the learning process more active, effective and meaningful. This is because its advanced technology enables users to interact with virtual and real-time applications and brings the natural experiences to the user. In addition, the merging of AR with education has recently attracted research attention because of its ability to allow students to be immersed in realistic experiences. The review describes the application of AR in a number of fields of learning including Medicine, Chemistry, Mathematics, Physics, Geography, Biology, Astronomy and History. This paper also discusses the advantages of AR compared to traditional technology (such as e-learning and courseware) and traditional teaching methods (chalk and talk and traditional books). The review of the results of the research shows that, overall, AR technologies have a positive potential and advantages that can be adapted in education. The review also indicates the limitations of AR which could be addressed in future research.

KEYWORDS: Augmented reality, technology, education, education app, education field.

I. INTRODUCTION

Technology has become embedded in education and the results indicate a positive impact on learning and teaching styles. This is because the use of technology involves real-world problems, current informational resources, simulations of concepts, and communication with professionals in the field. In addition, learning using technology is believed to complement the traditional forms of teaching and learning. The integration of technology tools into the curriculum is becoming part of good teaching (Pierson, 2001). Teachers not only have to spend a good deal of personal time working with computers but also should have a high level of innovation and confidence to use the new technologies that are embedded in contemporary education. The integration of technology also provides a means to enhance student learning and engagement in lectures. Therefore, recent studies have aimed to better understand the applications adapted during lectures from the perspective of students, including multimedia, computer-based simulations, animations and statistical showed that the use of a variety of media applications to explain concepts increased the understanding and supported greater collaboration between students. Augmented reality (AR) is a new technology that has emerged with potential for application in education. While a lot of research has been conducted on AR, few studies have been conducted in the education field. The number of studies on AR is growing due to the effectiveness of this technology in recent years. AR has been used in different fields in education.

II. LITERATURE REVIEW

Virtual interactive teaching environment (VITE) was developed in 2001 that uses XML and Augmented Reality to teach top down design with VHDL for Integrated circuit design course [12]. In 2002 as an application for engineering education Multimedia Augmented Reality Interface for E-learning (MARIE) [6] has been developed for topic Moore Machine flow chart, which uses lightweight head mounted display (HMD), a camera and a computer.

Lee had conducted a pilot study using „Skills Arena“, a mathematics video game, used to supplement traditional curriculum and teaching methods in 2004 [9]. The study was conducted on 39 second grade students and it was observed that students were able to solve 3 times more problems in 19 days. The impacts of the study are-

1. Teachers reported improvement in classroom discipline.

2. Students themselves learnt and able to solve difficult problems (by increasing the speed at which questions travel across the screen without direct intervention of teachers.)

3. Increase in involvement of all students and helping other students.

In 2005, to detect chemical properties of caffeine a preliminary experiment was conducted using handheld PC and HMD presentation.[4] The Earth, Sun and Moon relationship was developed by Kerawalla using virtual mirror interfaces in 2006 [2]. The challenges faced while implementing AR in classrooms was –

- 1)teacher’s training for teaching topics with AR
- 2) Time taken was same as traditional system
- 3) Taking care of curricular requirements
- 4)content flexibility.

An Augmented book called AR-Dehaes has been designed in 2010 to provide 3D virtual model that helps students to develop their spatial ability during short remedial classes. A validated study with 24 Mechanical Engineering students concluded that training has a positive impact on students. It is easy to use, attractive for students with cost effective feature as it required only ordinary PC and webcam.

Martin offered a learning process from electrical machines course in electrical engineering degree. It supports an interactive and autonomous study as well as collaborative performances of laboratory practices with other students [18].Block puzzle education system was designed based on augmented reality for infants or children in 2016. They are able to enjoy play and learn at the same time. It visualize 3D model of block puzzle and creates special effects, it also generate words and sound to make children naturally learn words. Using this, children are able to build creativity, fine motor skills, perception of objects and language education.

III. HOW AR IS BEING USED EDUCATION



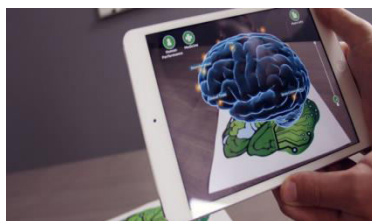
Fig: 1 AR in Education

Interactive AR learning has a significant impact on the student’s progress as it keeps learners engaged by incorporating the components of practical learning in the classroom.

1. Power Of Visualization
2. Enhanced Learning Environment:
3. Interaction Based learning:

Nowadays we may find some excellent examples of augmented reality in education worldwide.

Ability to connect reality and digital content has been steadily improving, opening more options for teachers and students.



- Augmented Reality classroom

Augmented reality animated content in classroom lessons could catch students’ attention in our dynamic day and age, as well as motivate them to study. Adding extra data, e.g. a short bio of a person, fun facts, historical data about sites or events, visual 3D models, would give students a wider understanding of topics

- **Explain abstract and difficult concepts**

AR technology has an ability to render objects that are hard to imagine and turn them into 3D models, thus making it easier to grasp the abstract and difficult content. This is especially good for visual learners and practically anyone to translate theoretical material into a real concept. For example, Polytechnic Institute of Leiria in Portugal integrates AR into math lessons and students report it as helpful, easy and interesting.

- **Engagement and interaction**

By incorporating Augmented Reality into lessons teachers are able to involve students into the process with 3-dimensional models. It may be just a part of the lesson, like a teaser, or the support of the main topic with extra info from a different perspective

- **Discover and learn**

Visitors of museums could access AR via smartphones and discover historical content related to objects. Additional information about what they see, though due to space or budget limitations, not all museums and landmarks can afford this. Once AR becomes more available, there will be new great opportunities for museums. The upside is that Augmented reality is already accessible to visitors through mobile device

- **Objects modeling**

Manual training, hand exercises, quiz solving etc. help earn a better knowledge of any lesson. AR apps for medical students may be one of the ways to learn human anatomy, explore more deeply. Augmented Reality basically means interaction with 3D models. And you can set the rotation, transparency, color scheme, styles etc.

- **Training**

In many cases, theoretical knowledge is not enough to obtain proper skills in professional areas. Students shouldn't be mere listeners and passive observers. Students of technical faculties especially need practice and hands-on experience in their areas.

1.1 AUGMENTED REALITY EDUCATION APPS

Within augmented reality, in education, we can divide it into 3 categories of apps: the ones specialized for students, the ones for kids, and apps

1.1.1 AUGMENTED REALITY APPS FOR STUDENTS

1. **Elements 4D** (Android / iOS) by DAQRI studio, an app for studying chemistry. It allows combining different elements as the simulation, to see how they would react in reality. On their website, you can find lessons plans suitable for high school, secondary and elementary school programs.



Fig: 1.1.1.1 Element 4D

2. **Anatomy 4D** (iOS / Android) is best suitable for medical students. By scanning printed targets the application shows 3D models of a human body and allows to interact with it. Users may change and adjust any part of the human body, learn more about parts, joints, functions etc.



Fig: 1.1.1.2 Anatomy 4D

3. **Corinth Micro Anatomy**, available for [Windows Mobile](#), is another human anatomy application that may be interesting for medical staff. Or **Human Heart 3D** app with less content, but more specific – to explore human heart in details. 3D model of a heart completed with various animations and textual tips about it.

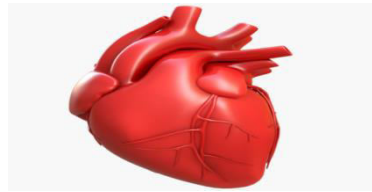


Fig: 1.1.1.3 Human Heart

4. **AugThat** ([Android](#) / [iOS](#)), designed by a former teacher, is the application that brings AR in a classroom. AugThat mainly targets students who lack motivation with help of 360-degree virtual photos and multiple 3D experiences.



Fig: 1.1.1.4 Augthat

1.1.2 AR LEARNING & SELF-EDUCATION APP

1. **Google Translate** ([Android](#) / [iOS](#)) is just great for studying foreign languages without a dictionary. By using Google Translate special “AR mode” you may instantly check up unknown words. Works well both for students and tourists, to navigate in cities abroad



Fig: 1.1.2.1 Google translate

2. **Amazing Space Journey, SkyORB3D, and Star Walk**. All of them have one purpose which is to study the skies with all its secrets. Learn more about stars, constellations, planets of the Solar System, galaxies.



Fig: 1.1.2.2 Space Journey

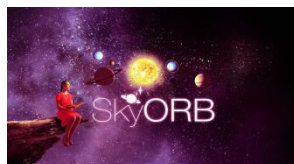


Fig: 1.1.2.3 SkyORB 3D



Fig: 1.1.2.4 Star Walk

1.1.3 AUGMENTED REALITY APPS FOR KIDS

1. **Math alive**, developed for kids in up to 3rd grades, connect a computer, a camera, and specially printed cards. Pupils under a teacher supervision place cards in front of a camera, practicing basic counting skills



Fig: 1.1.3.1 Math alive

2. **Animals Alphabet AR Flashcards** is a similar AR app but for learning letters, the application brings cards “into life” by showing live animals when the answer is correct.



Fig: 1.1.3.2 AR Flashcards

For fun activities, art and drawing there are **Quiver** and **Chromville**. To learn about plants and flora there is **Arloon.Plants** ([Android](#) / [iOS](#)). For the smallest kids check out **Pete the Cat**:

3. **Blipper** ([Android](#) / [iOS](#)) an AR creation tool already used for many educational projects.

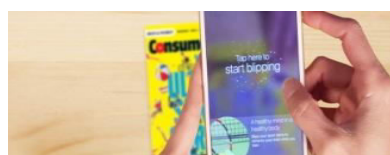


Fig: 1.1.3.3 BlipperIOS

IV. APPLICATIONS

AR used in various fields

This section presents a review of the extant research on the application of AR. This review is organized according to the application of AR technologies in a number of fields of study in education, namely, Medicine, Chemistry, Mathematics, Physics, Biology, Astronomy and History. Research on the application of AR in these fields is reviewed in order to evaluate the potential of AR in education.

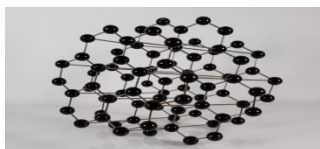
1. Medical education (surgical training)-



Purpose- To provide training and to plan and guide surgical procedures

Feature- AR image-guided therapy

2. Chemistry education-



Purpose- To provide an efficient way to represent and interact with molecules, leading to a better understanding of the spatial relation between molecules

Feature- AR technology for exhibiting the models.

3. Mathematics-



Purpose- To teach geometry through the use of 3D geometrical concepts

Features- Head-mounted display and personal interaction panel

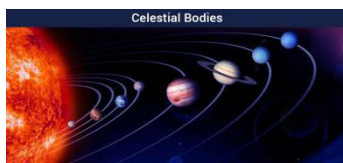
4. Physics-



Purpose- To overlay graphics on top of the physical props to visualize these forces (speed, velocity, acceleration, pressure, friction, energy changes) invisible to the human eye

Feature- Augmented video, videoconferencing, tracked physical props (e.g. toy cars)

5. Astronomy-





Purpose- To show augmented views of the celestial bodies and support learning using spatial visual guides and views from a terrestrial observer

Feature- AR learning environment.

6. History-

Purpose- To gather information and enhance the experience of visitors to cultural organisations (museums and archaeological sites)

Feature- Mobile AR educational games

V. BENEFITS

- Supports seamless interaction between real and virtual environments and allows the use of a tangible interface metaphor for object manipulation
- Provide instructors with a way to strengthen students' understanding in the classroom by augmenting physical props with virtual annotations and illustrations
- Creates a learning experience that is linked to the formal classroom, so that students can learn outside of class hours and outside of school limits
- Enables the visualization of interactions among amino acids and protein building processes as static 2D/3D images and 3D dynamic images (animations).

VI. CONCLUSION

This review of the research conducted in several fields in education shows that AR technology has the potential to be further developed in education. This is because the advantages and beneficial uses of AR features are able to engage students in learning processes and help improve their visualization skills. The features can also help teachers to explain well and make the students easily understand what they are taught. The use of AR technology has also received positive feedback from participants and students who have shown their interest in using AR in their learning processes. These good responses are important because they indicate the willingness of students to actively engage in their studies through AR tools. AR technology is still new in education, thus there are still some limitations. However, the review of the research indicates that most of the limitations are related to technical issues. Such limitations can be overcome over time as research on the integration of AR in education is replicated and improved. When the potential of AR technologies is more fully explored, the beneficial functions of AR can begin to be used widely in all fields of education and the efficiency of the teaching and learning process will be improved.

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