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AUGMENTED REALITY APPLICATIONS IN EDUCATION: A COMPREHENSIVE REVIEW

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Abstract: Here we explore the transformative potential of Augmented Reality (AR) applications in the field of education. Through an in-depth analysis of existing literature, case studies, and empirical evidence, the paper investigates the multifaceted impact of AR on teaching and learning processes. Key focus areas include the enhancement of student engagement, the development of interactive and immersive educational content, and the integration of AR into various educational disciplines. Additionally, the paper addresses practical considerations, challenges, and future prospects associated with the widespread adoption of AR in educational contexts. By synthesizing current research findings, this paper aims to contribute valuable insights for educators, researchers, and policymakers seeking to leverage technology for more effective and engaging learning environments.

Keywords: Technology, IT, learning processes, Augmented reality, mixed reality.

1. INTRODUCTION

IT environments for human learning are articulation of work in the complex and technology learning. The incorporation of augmented reality into education has the potential to motivate and inspire students to actively gain knowledge, ultimately resulting in an operational process. Research from the past has identified the issue that if technology is utilized without requiring critical thinking, meaning making, or metacognition, it would result in an unreceptive learning process.

Augmented reality has demonstrated promising potential to enhance the learning process in terms of dynamic, expressive, effective, and meaningful ways. This is due to its cutting-edge technology, which provides users with natural experiences and enables them to interact with virtual and real-time apps. Additionally, research has recently focused on the ways that augmented reality and education might work together. Thus, this concept paper examines the findings that has been carried out with AR. AR should be used in a number of academic subjects, including physics, math, chemistry, biology, medicine, geography, astronomy, and history, according to the review.
This publication attempts to provide an augmented reality application used in the field of safe laboratory practices from this research perspective, so that novices can learn the proper protocol to follow in any laboratory experience that ensures a safe manipulation. The following will be the format of the document: In the related work section, the use of augmented reality in education is discussed along with a comparative analysis of existing realizations in the literature. The proposed application's steps and process are covered in the second part, which is followed by a detailed discussion of the application's benefits and drawbacks in the results and discussion section.

2. RELATED WORKS

Type A) Augmented reality for learning

Technology has permeated every aspect of education; its effects are evident in a significant impact on learning [1] and lead to increasingly creative ways to information and learning. This is due to the fact that employing technology entails addressing real-world problems, using current informational resources, modelling thoughts and ideas, and connecting with subject matter experts. Moreover, it is believed that using technology for education enhances traditional approaches to teaching and learning [2].

The integration of technological resources with academic curricula is increasingly seen as an effective teaching strategy [3]. Utilising the state-of-the-art technologies included into the contemporary educational system requires teachers to be extremely creative and confident in addition to devoting a substantial amount of their own time to utilise technology. As a result, incorporating modern technologies into university mathematics classes offers a way to enhance learning and engagement among students. Therefore, gaining a greater knowledge of learners' perspectives of the applications utilised in lectures—such as multimedia, animations, computer-based simulations, and statistical software—has been the aim of

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current study [4 Geer and Sweeney's research [5] revealed that the use of diverse media applications to elucidate concepts improves the belief held by most academics that science fields are immaterial and abstract, necessitating a high degree of comprehension and inventiveness [6]. It may affect scholars' comprehension of scientific concepts and principles when they encounter complex challenges in grasping the notion or concept [7]. Therefore, the strategy or methods used for education have a significant impact on preventing or minimising pupils' misconceptions. In the scientific community, visualisation technologies, or augmented reality apps, have a lot of potential to clear up mistakes and simplify ideas [8]. Researchers Kozhevnikov and Thornton [9] found that giving pupils a range of options made it possible for them to interact with and explore abstractly visualised pictures. Many modern technologies can be used to visualise concepts and abstract notions. Previous research have looked at two examples of visualisation technologies: virtual worlds and animation. As per [10], students can improve their understanding of abstract concepts by employing augmented reality applications designed for instructional purposes.

Scientific concepts can be explained by theoretical concepts or thoughts. Food chains are one example of an expressive idea found in biology. Theoretical notation mimics visual notation—for example, air pressure (colliding molecules) and photosynthesis—that is not apparent to the human eye. Recent research have shown the advantages of employing technology to depict immaterial notions. With the use of these technologies, it is now possible to profitably observe occurrences that are too vast, too small, too fast, or too slow to be observed with the human eye alone [11]. From the writers' perspective, this technology allows academics to see molecular interactions and comprehend related chemical notions. For example, [12] made an animation to assist students understand the abstract topics in Chemistry. 13] The programme that was utilised to simulate the binding of an enzyme to a substrate for cell biology education. These kinds of augmented reality technologies are being used in education in a way that is more sophisticated.
These days, augmented reality (AR) is one of the technologies that exhibits a wealth of potential, particularly in terms of instructional visualisation. Augmented reality is a new technology that will most likely affect education, according to [14]. According to the Horizon Reports from 2004 and 2010, augmented reality (AR) is a technology that brings the world of computers into the real world [15].

While augmented reality (AR) employs virtual items to improve the actual world, virtual reality immerses users in a totally virtual environment.. To enhance the study of three-dimensional figures, Augmented Reality (AR) is a unique methodology that substitutes the conventional way of teaching using wooden items. Augmented reality technology may be a powerful visualisation tool that allows scholars to learn by using virtual items in a three-dimensional environment [17].

Augmented reality, as opposed to virtual reality, doesn't require any specialised equipment, such head-mounted displays, or HMDs. With smartphones' processing power rising yearly, more and more devices are able to employ augmented reality detection. Take Lenovo's PHAB 2 Pro, which was released in 2016. The first device ever with support for Google's Tango Project and depth tracking [18]. Upon closer inspection, augmented reality applications may be divided into two categories. The first one has applications that can scan real targets, or things. Programmes or systems that have integrated authoring tools to enable users to produce their own augmented reality content fall under the latter group. Platforms such as Aurasma are included in the second category. One of the leading AR platforms in the world, Aurasma was founded in 2011 and provides a feature-rich drag-and-drop web studio that makes it easy for anybody to plan, manage, and keep an eye on augmented reality initiatives [19].

Game-based learning has been found to be an effective way to enhance education by bringing a feeling of pleasure and attraction, according to research. According to Prensky, games that incorporate teaching aids and instructional goals have the power to enhance academic topic learning by making it simpler, more engaging, and ultimately more learner-centered. Rather than using traditional teaching techniques, the 24th Scholars may answer issues independently by digesting the material through activities. Completing gaming activities better satisfies the demands of the modern business, where information processing and analysis are essential. Citation [25].

Type B) Lab based augmented reality

The Real World (RW) is enhanced by computer-generated content connected to particular places and/or activities in an emerging type of experience known as augmented reality. AR apps have grown to be widely accessible and portable on mobile devices over the past few years. Augmented reality (AR) is starting to show up in our audio-visual media (news, entertainment, sports, etc.) and is starting to make a real and exciting appearance in other areas of our lives (e-commerce, travel, SEO, etc.). By enabling instant access to location-specific data gathered and supplied by multiple sources, augmented reality (AR) will support provided by numerous sources of learning (2009). The Horizon Reports from 2010 and 2011 both forecast that augmented reality will soon be widely used on US college campuses.

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The 2009-founded company Layar, based in the Netherlands, offers mobile interactive print tools and augmented reality browsers. Teachers not only use Layar for augment different subject. Students, ages 9 to 10, created handmade posters that explained how the various parts of the human body work. They enhanced physical posters with digital resources using Layar Creator, which helped them better understand the principles of biology. [20].

An all-inclusive solution for setting up, controlling, and viewing 3D content in augmented reality is offered by the French business "Augment." A free license is available for educational use. The students will be able to explore the eternal city by creating a comprehensive historical tour of ancient Rome using "Augment" and modelling tools for 3D creation. During field trips, it enables a more active interaction with the location than merely viewing lecture slides [21].

Latvian Anatomy Next is a very useful resource for medical scholars because it covers incredibly accurate 3D anatomy models that are approved and validated by medical field academics and can be visualised using augmented reality. The models, according to the authors, can help students understanding of the curriculum and enhance their ability to visualise structural relationships in three dimensions. An early stage of training medical students to become more knowledgeable about surgical procedures can be implemented with this application. [22]

The list of augmented reality applications in education provided above is by no means exhaustive, but it does indicate that augmented reality makes learning more engaging and easier than it is now. If teachers want to use completely new models, creating 3D content may be their biggest obstacle because it requires a high level of expertise.

Science is a complex subject with a high degree of abstraction, making it difficult to teach and learn. Hence, it is imperative to verify the efficient utilisation of educational materials and to select supplementary tools with optimal efficiency. Chemistry requires knowledge of and comprehension of a precise, sophisticated vocabulary.
Kids who play Pokémon (not even the augmented reality game) develop enormous vocabularies, as Gee mentioned. They eventually become experts in this language and position themselves for exploitation in the domains where the specialised language is employed because they are so engrossed in the gaming experience. As a traditional justification for constructivist learning theory, children create new knowledge by building on what they already know in order to understand new things. [29]

3. OBJECTIVES

• Improved User Experience: By using augmented reality to create immersive and interactive content, the user experience can be made better.
• Education and Training: To make learning more effective and engaging, create augmented reality applications for educational purposes, such as training simulations.
• Marketing and Branding: Make use of augmented reality (AR) to develop creative marketing campaigns and branding initiatives that engage consumers and advance goods and services.
• Boost Efficiency and Productivity: By incorporating augmented reality (AR) into tasks like data visualisation, remote assistance, and maintenance, industries can achieve greater productivity and efficiency.
• Entertainment and gaming: Develop captivating augmented reality games and experiences to hold users' attention.
• Enable remote collaboration through the use of augmented reality (AR) for shared visualisations, virtual meetings, and other features.

4. METHODOLOGY

The integration of the physical and virtual worlds from a visual perspective is known as mixing, and it is a crucial element of augmented reality systems. The objective is to maintain the registration a virtual object, usually a 3D graphic element in the user's visualization in line with the actual physical objects. The system needs to track objects in the environment and the user's position and orientation in order to achieve this alignment accurately and consistently. Therefore, tracking and registration can be considered one of the core issues with augmented reality. Mobile or handheld devices are the most popular devices for augmented reality applications, followed by desktop or personal computers (PC). AR is associated with mobile technologies by the authors of a few of the articles that were examined. The augmented reality (AR) technologies offered by smartphone-based mobile applications, are portable, affordable, and have enormous educational potential, their study that using augmented reality (AR) in digital educational resources as a didactic tool has several benefits for improving student learning, including increased learner comprehension, increased visibility of the material, and improved theoretical material revelation.

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5. APPLICATION REQUIREMENTS

In order to guarantee that an Augmented Reality (AR) project fulfils user expectations and project objectives, it is imperative to specify the application requirements during project planning. The following typical specifications apply to an AR project:

a) AR Capable device (Mobile Phone): Platform Compatibility: Choose the mobile platforms that your augmented reality app will run on, such as Android and iOS (for Apple products). Certain development tools and considerations might be needed for each platform.

b) OS Version: Specify the minimal and suggested OS versions for your augmented reality application. Think about whether you want to support more recent OS releases or the older ones.
Hardware Requirements: Determine the precise hardware requirements for your augmented reality application, including camera quality, motion sensors (such as accelerometers and gyroscopes), and device performance (CPU and RAM).

c) Sensors (Gyroscope and Camera Motion Tracker): A sensor that gauges rotational velocity around a specific axis is called a gyroscope. It's frequently used to figure out how an object or device is oriented or positioned angularly.

Gyroscopes are frequently found in gadgets that need precise motion tracking and orientation data, such as gaming controllers, smartphones, and drones.

Micro-Electro-Mechanical Systems (MEMS) gyroscopes, mechanical gyroscopes, and fiber optic gyroscopes are among the various varieties of gyroscopes. Because of their affordability and small size, MEMS gyroscopes are widely used.

Gyroscopes are useful tools for managing device movement, image stabilisation, and navigation because they can identify and quantify changes in orientation.A camera motion tracker is a device or software system that tracks the motion of objects or cameras themselves using visual data from a camera. It is also referred to as an optical tracker or camera tracker.In applications related to computer vision, visual effects, virtual reality, and augmented reality, camera motion trackers are frequently utilised.

These systems are able to monitor camera position and movement in three dimensions as well as the relative motion of various objects in a scene. For example, this information can be used to stabilise video footage or create realistic 3D animations.To estimate the motion and position of objects or cameras, camera trackers frequently use computer vision techniques like feature tracking and matching.

d) Unity Gaming Engine: Cross-Platform Development: Unity lets developers make games that work on a variety of operating systems and browsers, including web browsers, Windows, macOS, Linux, Android, and iOS, as well as game consoles like the PlayStation and Xbox and virtual reality/augmented reality gadgets like the Oculus Rift, HTC Vive, and HoloLens.

Visual Development: For both novice and seasoned developers, Unity provides an easy-to-use visual development environment that makes game development simpler. Through the attachment and configuration of components, you can create and modify game objects using its component-based system.
Scripting: C#, a popular programming language for game development, is supported by Unity for scripting. Developers can create gameplay mechanics, manipulate the engine's systems, and control the logic of the game with C#.
Asset Store: Unity offers a marketplace where developers can buy or obtain assets, such as textures, 3D models.

e) Visual Studio (IDE): Versatility: A large number of platforms, frameworks, and programming languages are supported by Visual Studio. Languages used in web development, such as JavaScript, HTML, and CSS, are included in this, along with C++, C#, F#, Visual Basic, and Python.

- Code Editor: With tools like syntax highlighting, code completion, code refactoring, and code navigation, Visual Studio's code editor is a potent tool that helps developers write and manage code.
- Debugging: Developers can set breakpoints, examine variables, step through code, and diagnose problems in their applications with Visual Studio's sophisticated debugging tools.
- Code completion tool IntelliSense: This Visual Studio feature helps developers write code more quickly and error-free by offering context-aware suggestions.
- Version Control: Git and TFS (Team Foundation Server), two popular version control systems, are integrated with Visual Studio.

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f) AR SDK (Arkit / ARcore): Platform: Apple's AR SDK for iOS devices, including iPhones and iPads, is called ARKit.

- Device Compatibility: With processors from A9 or later, it works with a large variety of Apple devices.

g) Testing Device / Emulator: Real-World Performance: The best way to predict how well your app will function in the real world is to use physical devices. On the hardware that it is designed for, you can test the application.

- Sensor Testing: You can test features that rely on sensors, like proximity, gyroscope, GPS, and accelerometer, using physical devices.
- User Experience: You can assess the user experience by taking into account elements such as touch input, screen resolution, and size on a physical device.
- Testing Across Device Variability: To guarantee compatibility and consistency in performance, you can test your app across a range of makes and models..
- Testing for battery life and performance: You can more precisely determine how your app affects device resources, such as CPU usage and battery life.

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