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# POTENTIAL OF AUGMENTED REALITY IN EDUCATION: A REVIEW

**Mr. Sachin Kumar[1] & Mrs. Manisha Mohanty[2], Ph. D.**

*[1]Research Scholar, Department of Education, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh*

*Email: sachinkumar230001@gmail.com*

*[2]Associate professor, D. N. Government College, Itanagar, Arunachal Pradesh*

*Email: manishamohanty2009@gmail.com*

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***Abstract***

*Teaching-learning is an approach that focuses on various ways in which learning activities can interact with learners. Nowadays, this form of learning thrives on digital technology that has evolved enormously. One of the approaches widely employed nowadays is "Augmented Reality". Augmented Reality in teaching-learning has made significant progress across the world in recent years. This paper provides an overall presentation of its prevalence and usage. In this paper, a literature review has been conducted based on the research in the field of ICT in general and AR technology in particular. Major issues have been classified and discussed according to their similarities and differences. This paper focuses on how those issues are studied, how they have evolved, and what results have been carried out from the research.*

***Keywords:*** *Augmented Reality, Educational Applications, Education, Inclusive learning, Information, and communication technology*



## Introduction

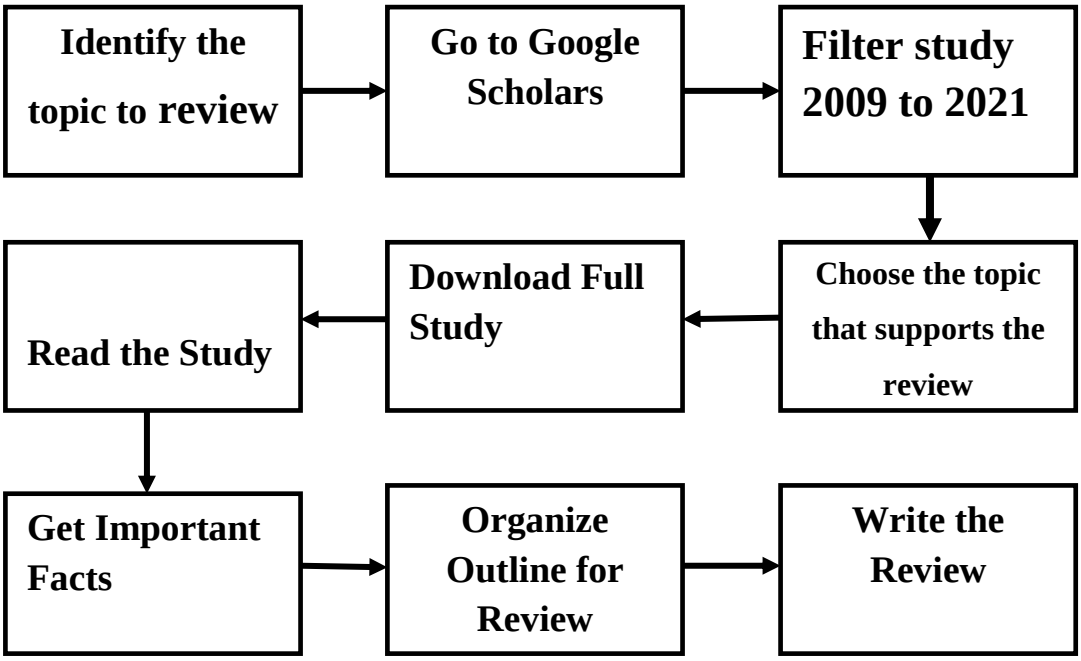
Interactive teaching-learning is an approach to teaching and learning that focuses on various ways in which learning activities can "interact" with learners. One of the key components of interactive learning is "information" and the design of teaching materials to attract learners, creating a greater desire to learn. Students can prepare for class by interacting with provided resources to reduce lecture time and allow more engagement in class. Through interactive learning, learners engage with various media such as computers, smartphones, tablets, and social networks. Such engagement helps create a comfortable level of interaction

between learners and teachers. Nowadays, this form of learning thrives on digital technology that has evolved enormously. One of the approaches widely employed nowadays is "Augmented reality mobile learning".

Augmented Reality is becoming more commonly available within educational environments. AR is used in many fields, especially in education. It is a notable technology for pedagogical use. It has been used in the development of teaching and learning materials from kindergarten to university levels; specific insight for exploring immersive learning approaches utilizing virtual and augmented reality tools. AR is a new technology that combines the real world with the virtual world through a hardware device combined with the use of different software. This makes it possible to see images that look like objects and that are displayed on the screen, where they are transformed into a 3D object floating above the real surface. This creates a visual effect that shows the object moving and creates a sense of excitement. Both AR and VR as elements of the mixed reality continuum rely on human-computer interaction. AR has a working principle that can be categorized into 2 types of image analysis: using a marker as the main work (marker-based AR) and using different characteristics in the image for analysis (marker-less-based AR). The elements of virtual reality technology include a Marker (also known as a markup), video camera, webcam, cell phone camera, or other sensors. Display components include a display device and processor software for a 3D object.

**Method**

The literature source for this review was the Social Sciences Citation Index (SSCI) database, one of the highly recognized databases indexing core journals in the social sciences. The period was set from 2009 to 2021, and the document type was limited to journal articles in an attempt to review studies of potentially more consistent quality. We used the keyword "Augmented Reality" for searches, and 27 papers were identified as the research sample pool of this review. Content analysis was done to extract the information from each paper.The research methods broadly involved qualitative, quantitative, and mixed designs.




**Relevant Literature**

- **Abdinejad, Talaie, Qorbani & Dalili, (2021) studied the student perceptions using augmented reality and 3D visualization technologies in chemistry education**. A comprehensive survey was conducted to gather student feedback on the effectiveness of these tools and their perception of the subject matter using these technologies. Result reveals that The AR app has the potential to create a significant impact in the field of chemistry education
- **Bridges, Robinson, Stewart, Kwon, & Mutua, (2020) studied the augmented reality: teaching daily living skills to adults with intellectual disabilities.** In this study, a multiple-baseline across behaviors design was used to examine the efficacy of an augmented reality intervention for teaching daily living skills to three young adults with disabilities in a residential post-secondary education program. Results indicate the intervention was effective in increasing independence among all participants. Furthermore, the intervention was found to be a socially acceptable and non-stigmatizing method for supporting young adults in a residential post-secondary education program.
- **AlNajdi , Alrashidi & Almohamadi, (2020) conducted a research on the effectiveness of using augmented reality (AR) on assembling and exploring educational mobile robot in pedagogical virtual machine (PVM).** Augmented

reality (AR) has shown potential for aiding users in their assembly tasks. This study used a Pedagogical Virtual Machine (PVM) to evaluate the learning effectiveness of AR. A total of 36 students participated in the study; 18 students participated in both experimental and control groups. Findings demonstrated that the PVM with AR approach was more effective in learning achievement, learning activity enjoyment, and usefulness than the paper-based approach.

- **Bhagat, Liou, Spector & Chang, (2019) investigated on the use of augmented reality in the formative assessment**. This study aimed to examine the effectiveness of using AR-based formative assessment for improving elementary students' learning achievement and motivation in a unit of instruction involving butterflies. A total of 70 students in Grade 4 were selected from an elementary school in Taiwan. The experimental group (35) underwent an AR-based intervention that involved formative assessment using iPads whereas the control group (35) followed the traditional teaching method and formative assessment. One-way Analysis of Covariance (ANCOVA) and multivariate analysis of variance (MANOVA) was employed to analyze the data obtained. The results indicated that using the AR-based formative assessment improved not only students' learning performance but also learning motivation effectively compared with a traditional formative assessment approach.
- **Cakir & Korkmaz , (2019) conducted a study on the effectiveness of augmented reality environments on individuals with special education needs.** The purpose of this study is to determine the design, development, and effectiveness of the Augmented Reality (AR) environments aimed at providing individuals with special education needs. The developed AR teaching materials are thought to be useful in terms of allowing children with special education needs to meet their basic needs with their efforts without being dependent on others. The design-based research design was used to conduct this study. Four teachers and 6 students constituted the group of the study. Design Observation Forms, Student Attention Observation Form, and Criterion-Referenced Assessment Tools were used to collect data. According to the results, AR teaching material is appropriate and helpful in terms of contributing to the development of children with special education needs by bringing them real-life experiences. Moreover, it was observed that students were more eager and enthusiastic about the lesson during application. Indeed, their level of readiness for

the lesson increased, their interest in the subjects increased, and they were relatively more active and more likely to respond correctly to questions.

- **Huang, Ball, Francis, Ratan, Boumis & Fordham, (2019) conducted a study on augmented versus virtual reality in education: an exploratory study examining science knowledge retention when using augmented reality/virtual reality mobile applications.** The purpose of the study was to address this gap in the literature by comparing AR and VR technologies about their impact on learning outcomes, such as retention of scientific information. Specifically, the research used two-condition (AR vs. VR) between subjects' design to test college students' science-knowledge retention in response to both auditory and visual information presented on a Samsung S4 smartphone app. Our Results (N = 109) suggested that VR is more immersive and engaging through the mechanism of spatial presence. However, AR seems to be a more effective medium for conveying auditory information through the pathway of spatial presence, possibly because of increased cognitive demands associated with immersive experiences.
- **Ibili , Çat, Resnyansky, Şahin & Billinghurst, (2019) investigated the effects of assessment of geometry teaching supported with augmented reality teaching materials to enhance students' 3D geometry thinking skills.** This research aimed to examine the effect of Augmented Reality (AR) supported geometry teaching on students' 3D thinking skills. This research consisted of 3 steps: (1) developing a 3D thinking ability scale, (ii) designing and development an AR Geometry Tutorial System (ARGTS), and (iii) implementation and assessment of geometry teaching supported with ARGTS. A 3D thinking ability scale was developed and tested with experimental and control groups as a pre-and post-test evaluation. An AR Geometry Tutorial System (ARGTS) and AR teaching materials and environments were developed to enhance 3D thinking skills. A user study with these materials found that geometry teaching supported by ARGTS significantly increased the students' 3D thinking skills. The increase in average scores for Structuring 3D arrays of cubes and Calculation of the volume and the area of solids thinking skills was not statistically significant. In terms of other 3D geometric thinking skills sub-factors of the scale, a statistically significant difference was found in favor of the experimental group in pre-test and post-test scores. The biggest difference was found in the ability to recognize

and create 3D shapes. The results of this research are particularly important for identifying individual differences in the 3D thinking skills of secondary school students and creating personalized dynamic intelligent learning environments.

- **Khan, Johnston, & Ophoff, (2019) conducted a research on the impact of an augmented reality application on learning motivation of students.** The purpose of this research was to measure and understand the impact of an augmented reality mobile application on the learning motivation of undergraduate health science students at the University of Cape Town. The research examined the differences in student learning motivation before and after using the augmented reality mobile application. A total of 78 participants used the augmented reality mobile application and completed the preusage and post-usage questionnaires. The results showed that using an augmented reality mobile application increased the learning motivation of students. The attention, satisfaction, and confidence factors of motivation were increased, and these results were found to be significant.
- **Papanastasiou, Drigas, Skianis, Lytras & Papanastasiou, (2019) investigated the effect of virtual and augmented reality effects on K-12, higher and tertiary education students' twenty-first-century skills.** The purpose of this review article was to present state-of-the-art approaches and examples of virtual reality/augmented reality (VR/AR) systems, applications, and experiences that improve student learning and the generalization of skills to the real world. Thus, we provide a brief, representative, and non-exhaustive review of the current research studies, to examine the effects, as well as the impact of VR/AR technologies on K-12, higher and tertiary education students' twenty-first-century skills and their overall learning. According to the literature, promising results are indicating that VR/AR environments improve learning outcomes and present numerous advantages of investing time and financial resources in K-12, higher, and tertiary educational settings. Technological tools such as VR/AR improve digital-age literacy, creative thinking, communication, collaboration, and problem-solving ability, which constitute the so-called twenty-first-century skills, necessary to transform information rather than just receive it. VR/AR enhances traditional curricula to enable the diverse learning needs of students. Research and development relative to VR/AR technology are focused on a whole ecosystem around smartphones, including applications and educational content,

games, and social networks, creating immersive three-dimensional spatial experiences addressing new ways of human-computer interaction. Raising the level of engagement, promoting self-learning, enabling multi-sensory learning, enhancing spatial ability, confidence and enjoyment, promoting student-centered technology, a combination of virtual and real objects in a real setting, and decreasing cognitive load are some of the pedagogical advantages discussed. Additionally, implications of a growing VR/AR industry investment in the educational sector are provided. It can be concluded that even though there are various barriers and challenges in front of the adoption of virtual reality in educational practices, VR/AR applications provide an effective tool to enhance learning and memory, as they provide immersed multimodal environments enriched by multiple sensory features.

- **Bistaman, Idrus, Rashid, (2018) conducted research on the use of augmented reality technology for primary school education in Perlis, Malaysia.** This research gave a brief insight into the potential and challenges of Augmented Reality in education to enhance the method of teaching and learning from conventional to technological by using AR technology.
- **Turan, Meral & Sahin, (2018) conducted a research on the impact of mobile augmented reality in geography education: achievements, cognitive loads, and views of university students.** Augmented Reality (AR) technology is commonly used in education. AR offers a combination of the virtual and real world; thus, it can help students in learning abstract and complex subjects. The purpose of the current study was to determine the impact of mobile AR technology on achievement, cognitive load levels, and views of 95 first-year university students (40 in the experimental group and 55 in the control group) enrolled in a geography course in the social sciences education department of the education faculty of a university in Turkey. A sequential explanatory design, a mixed method type of research, was used. The data were collected using an achievement test, a cognitive load scale, and a semi-structured interview form. The results of the study showed that AR increases students' achievement and decreases their cognitive load levels, and the students' views about AR technology were positive.

- **Alasheeri, ( 2017) studied the effectiveness of using augmented reality strategy in enhancing learning English for cycle one students in the elementary stage in the kingdom of Bahrain.** The study aimed at measuring the effectiveness of a designed software computer program based on augmented reality in teaching English to cycle one student in the elementary stage in the Kingdom of Bahrain and investigated the competencies that are fulfilled through utilizing the designed program. The study implemented the quasi-experimental methodology by applying the program to two groups, controlled and experimental. The data analysis revealed an improvement in students' performance in learning English in the experimental group than their peers in the controlled group, which indicates the effectiveness of the designed program.
- **Teng, Chen, & Chen, (2017) studied the impact of augmented reality on programming language learning: efficiency and perception.** Although the learning of programming language is critical in science and technology education, it might be difficult for some students, especially novices. One possible reason might be the fact that programming language, especially for three-dimensional (3D) applications, is too complex and abstract for these students to understand. Programming for 3D applications requires understanding the spatial relationship of 3D objects and hence needs a visualization technique. Given this, this article presents an augmented reality (AR)-enhanced learning system that offers visual representation and interactivity to help students learn to program for 3D applications. To examine the influences of such an AR-enhanced system on student learning, a within-group experiment with 34 college students was conducted. All students used both an AR-enhanced version and an ordinary version. The findings revealed that the AR-enhanced version made students have better learning efficiency than the ordinary system. In addition, the AR-enhanced system also made students have enhanced perceptions in terms of system usability, flow experience, and user perception.
- **Akcayır, Akcayır, Pektas & Ocak, (2016) studied the augmented reality in science laboratories: The effects of augmented reality on university students' laboratory skills and attitudes toward science laboratories.** This study investigated the effects of the use of augmented reality (AR) technologies in science laboratories on university students' laboratory skills and attitudes towards laboratories. A quasi-experimental pre-test/post-test control group design was employed. The participants

were 76 first-year university students, aged 18e20 years old. They were assigned to either an experimental or a control group. Qualitative and quantitative data collection tools were used. The experimental results obtained following the 5-week application revealed that the AR technology significantly enhanced the development of the university students' laboratory skills. AR technology both improved the students' laboratory skills and helped them to build positive attitudes towards physics laboratories.

- **Chen, Chou & Huang, (2016) investigated the effect of an augmented-reality-based concept map to support mobile learning for science.** Computer hardware and mobile devices have developed rapidly in recent years and augmented reality (AR) technology has been increasingly applied in mobile learning. Although instructional AR applications have yielded satisfactory results and prompted students' curiosity and interest, several problems remain. The crucial topic for AR applications is the lack of appropriate instructional scaffolds to help students organize the content to be learned. Moreover, a lack of appropriate instructional activities and scaffolds often results in student confusion and frustration. Therefore, we integrated AR with concept maps to form a concept-mapped AR (CMAR) scaffold. Subsequently, whether CMAR improves learning outcomes, motivation, and attitude in mobile learning activities was determined. An empirical study was conducted on 71 fifth-grade elementary students in Southern Taiwan. The students were divided into CMAR and AR system groups. The results showed that students in the CMAR group performed significantly better than those in the AR group. The student interview results also showed that the CMAR system helped students organize what they wanted to learn.
- **Harley, Poitras, Jarrell, Duffy & Lajoie, ( 2016) studied the comparing virtual and location-based augmented reality mobile learning: emotions and learning outcomes.** Research on the effectiveness of augmented reality (AR) on learning exists, but there is a paucity of empirical work that explores the role that positive emotions play in supporting learning in such settings. To address this gap, this study compared undergraduate students' emotions and learning outcomes during a guided historical tour using mobile AR applications. Data were collected in a laboratory (Study 1; N = 13) and outdoors (Study 2; N = 18) from thirty-one undergraduate

students at a large North American university. Findings demonstrated that learners were able to effectively and enjoyably learn about historical differences between past and present historical locations by contextualizing their visual representations and that the two mobile AR apps were effective both in and outside of the laboratory. Learners were virtually situated in the historical location in Study 1 and physically visited the location in Study 2. In comparing results.

- **Hsu, (2016) investigated the effects of learning English with augmented reality: do learning styles matter?** This study attempted to develop and compare two Augmented Reality (AR) educational game systems for third graders to learn English vocabulary in free and situated surroundings. One system was developed based on a self-directed learning approach that did not restrict the learning sequence, while the other was based on a task-based learning approach that limited the learning sequence. The flow experience, cognitive load, foreign language learning anxiety, and learning effectiveness of the students with different learning styles (i.e., serial or global) were assessed. The results showed that the students using the self-directed or task-based AR educational game system had similar and high learning effectiveness, although those using the self-directed system revealed higher flow experience. However, the students with a serial learning style had lower mental effort and foreign language learning anxiety regardless of using the self-directed or the task-based AR educational game system. It was found that the challenge and control of the system conformed to the student's proficiency. The learning objects (e.g., pen, pencil, book, chair, desk, eraser, ruler, etc.) did not have a restrictive learning sequence. Providing free learning steps was preferable, and restricting which step to begin with was not necessary. This study confirms that the mental efforts of students are greater when they experience more learning anxiety at the same time; however, it is not the case that lower learning anxiety and mental effort is better for learning. On the contrary, a little learning anxiety and mental effort, but not too much, is helpful for learning.
- **Riva , Baños , Botella ,Mantovani & Gaggioli, (2016) conducted a research on transforming experience: The potential of augmented reality and virtual reality for enhancing personal and clinical change .** First, the paper focuses on the two leading virtual technologies – augmented reality (AR) and virtual reality (VR) – exploring their current uses in behavioral health and the outcomes of the 28 available

systematic reviews and meta-analyses. Then the paper discusses the added value provided by VR and AR in transforming our external experience by focusing on the high level of personal efficacy and self-reflectiveness generated by their sense of presence and emotional engagement. Finally, it outlines the potential future use of virtuality for transforming our inner experience by structuring, altering, and/ or replacing our bodily self-consciousness. The outcome may be a new generation of transformative experiences that provide knowledge that is epistemically inaccessible to the individual until he or she has that experience, while at the same time transforming the individual's worldview.

- **Le, Pedro, Lim, Park, Park & Kim, (2015) investigated the effect of a framework for using mobile-based virtual reality and augmented reality for experiential construction safety education.** This study proposes a framework for using mobile-based Virtual Reality (VR) and Augmented Reality (AR) for experiential construction safety education. The framework consists of the following three modules: Safety Knowledge Dissemination (SKD), Safety Knowledge Reflection (SKR), and Safety Knowledge Assessment (SKA). The system prototype was developed and evaluated with case studies to identify the system's benefits and limitations. The results concluded that using mobile-based VR+AR would improve construction safety & health effectively.
- **Wei, Weng, Liu & Wang, (2015) studied the teaching based on augmented reality for a technical creative design course.** Student creativity is currently attracting considerable attention. An increasing number of high schools in China are trying to improve the learning motivation and creativity of students, as well as the teaching efficiency of creative design, by introducing augmented reality (AR) technology into creative design courses. However, many teachers have only limited knowledge of AR, and software developers are not familiar with general creative design education, which makes it difficult to incorporate AR in such courses. In many high schools in China, the lack of relevant teaching facilities and creative design equipment means that the environment in which the technology curriculum is applied still has a long way to go to meet the real requirement of the curriculum. To address these problems, we present a general technical creative design teaching scheme that includes AR. The approach is based on the ARCS model of motivational design, social psychology, and

a computational model of creativity. Two teaching aids are introduced to support this teaching scheme: "AR Creative-Classroom," which explains the domain relevant knowledge of creative design, and "AR Creative-Builder," which helps students to build actual AR scenes. The results of a pilot study show that the proposed teaching scheme significantly improves learning motivation, student creativity, and the teaching of creative design.

- **Bower, Howe, Credie, Robinson & Grover, (2014) studied the augmented reality in education – cases, places, and potentials.** Augmented Reality is poised to profoundly transform Education as we know it. The capacity to overlay rich media onto the real world for viewing through web-enabled devices such as phones and tablet devices means that information can be made available to students at the exact time and place of need. This has the potential to reduce cognitive overload by providing students with "perfectly situated scaffolding", as well as enable learning in a range of other ways. This paper will review the uses of Augmented Reality both in mainstream society and in education, and discuss the pedagogical potentials afforded by the technology. Based on the prevalence of information delivery uses of Augmented Reality in Education, we argue the merit of having students design Augmented Reality experiences to develop their higher-order thinking capabilities. A case study of "learning by design" using Augmented Reality in high school Visual Art is presented, with samples of student work and their feedback indicating that the approach resulted in high levels of independent thinking, creativity, and critical analysis. The paper concludes by establishing a future outlook for Augmented Reality and setting a research agenda going forward.
- **Cai, Wang & Chiang, (2014) conducted research on a case study of Augmented Reality simulation system application in a chemistry course.** The comprehension of micro-worlds has always been the focus and the challenge of chemistry learning. Junior high school students' imaginative abilities are not yet mature. As a result, they are not able to visualize microstructures correctly during the beginning stage of chemistry learning. This study targeted the ''the composition of substances'' segment of junior high school chemistry classes and involved the design and development of a set of inquiry-based Augmented Reality learning tools. Students could control, combine and interact with a 3D model of micro-particles using markers and conduct a

series of inquiry-based experiments. The AR tool was tested in practice at a junior high school in Shenzhen, China. Through data analysis and discussion, we conclude that (a) the AR tool has a significant supplemental learning effect as a computer-assisted learning tool; (b) the AR tool is more effective for low-achieving students than high-achieving ones; (c) students generally have positive attitudes toward this software, and (d) students' learning attitudes are positively correlated with their evaluation of the software.

- **Ibanez, Serio, Villaran & Kloos (2014) studied the experimenting with electromagnetism using augmented reality: Impact on flow student experience and educational effectiveness**. The purpose of this study was to assess to which extent an AR learning application affects learners' level of enjoyment and learning effectiveness. The study followed an experimental/control group design using the type of the application (AR-based, web-based) as the independent variable. 64 high school students were randomly assigned to the experimental or control group to learn the basic principles of electromagnetism. The participants' knowledge acquisition was evaluated by comparing pre-and post-tests. The participants' level overall-state perception of flow was measured with the Flow State Scale and their flow states were monitored throughout the learning activity. Finally, participants' perceptions of the benefits and difficulties of using the augmented reality application in this study were qualitatively identified. The results showed that the augmented reality approach was more effective in promoting students' knowledge of electromagnetic concepts and phenomena. The analysis also indicated that the augmented reality application led participants to reach higher flow experience levels than those achieved by users of the web-based application. However, not all the factors seem to influence learners' flow state, this study found that they were limited to concentration, distorted sense of time, sense of control, clearer direct feedback, and autotelic experience. A deeper analysis of the flow process showed that neither of the groups reported being in flow in those tasks that were very easy or too difficult. However, for those tasks that were not perceived as difficult and included visualization clues, the experimental group showed higher levels of flow that the control group.

- **Lu & Liu, (2014) studied the integrating of augmented reality technology to enhance children's learning in marine education.** This study adopts concepts from digital game-based learning to design an innovative marine learning program integrating augmented reality (AR) technology for lower-grade primary school students. The proposed activity integrates physical and virtual learning materials, encouraging students to engage in an interactive learning environment that makes learning fun and interesting. The program introduces Taiwan's marine ecology and water resources. To assess learners' engagement, a quasi-experimental research design was used, where the participant pool consisted of 51 primary school students in Taiwan. Results indicate that (1) students were highly confident in the learning activities and viewed them satisfactorily, (2) students acquired the target knowledge, and (3) the innovative learning program specifically helps low academic achievers improve learning performance.
- **Lin, Chen & Chang, (2013) conducted study on assessing the effectiveness of learning solid geometry by using an augmented reality-assisted learning system.** This study integrates augmented reality (AR) technology into teaching activities to design a learning system that assists junior high-school students in learning solid geometry. The following issues were addressed: (1) the relationship between achievements in mathematics and performance in spatial perception; (2) whether system-assisted learning can improve the spatial perceptions of students; (3) whether students with high, average, and low academic achievement learn effectively after taught with system assistance; (4) system usability; (5) system task load; and (6) the relationship among various factors. The study participants were 76 students from Tainan City, Taiwan. Qualitative and quantitative data are obtained using pre- and post-system-assisted learning paper-pencil tests, a system usability scale, a National Aeronautics & Space Administration Task Load index, and observations and focus group interviews. Analysis results indicate that students' math scores and spatial perception during the test closely correspond to each other. Additionally, system assistance can improve the spatial perceptions of the student. Regarding group differences related to the significance of impact, students with average and low academic achievements exhibit small and medium levels of effectiveness but are insignificant in high academic achievement students. As for system usability, students

with low academic achievements demonstrate a positive attitude towards the intensive programs provided by the system. However, the correlation between students' learning effectiveness and system usability/task load was low.

- **Wu, Lee, Chang & Liang, (2012) studied the current status, opportunities and challenges of augmented reality in education.** Although Augmented Reality (AR) has gained much research attention in recent years, the term AR was given different meanings by varying researchers. In this article, researchers first provide an overview of the definitions, taxonomies, and technologies of AR. Researchers argue that viewing AR as a concept rather than a type of technology would be more productive for educators, researchers, and designers. Then researchers identify certain features and affordances of AR systems and applications. Yet, these compelling features may not be unique to AR applications and can be found in other technological systems or learning environments (e.g., ubiquitous and mobile learning environments). The instructional approach adopted by an AR system and the alignment among technology design, instructional approach, and learning experiences may be more important. Thus, researchers classified three categories of instructional approaches that emphasize the "roles," "tasks," and "locations," and discuss what and how different categories of AR approaches may help students learn. While AR offers new learning opportunities, it also creates new challenges for educators. Researchers outline technological, pedagogical, and learning issues related to the implementation of AR in education.
- **Wang & Chen, (2009) studied the experimental study on collaborative effectiveness of augmented reality potentials in urban design.** This paper presents a framework for an intelligent agent-based AR system, called Augmented Reality-based Urban Designer (ARUDesigner), which could allow designers to assess virtual urban designs in a real, natural, and familiar workspace. To demonstrate and validate the strengths and weaknesses of this emerging innovative application, two realistic urban design scenarios were used in one preliminary experiment to compare the performance and effectiveness of the traditional wood block (TWB) method and the Augmented Reality technology (ART) which is ARUDesigner. The results from this preliminary experiment showed that although some technical difficulties in the AR system (ARUDesigner) introduced negative performance factors to the overall

outcome, all the subjects believed that the AR system holds significant potential for urban design.

**Conclusion**

After reviewing the literature in the context of AR in education found that the number of AR studies in education has significantly increased over the years. during 2009 to 2021. In addition, it was found that more and more empirical studies were carried out on Science, as well as few studies were conducted on social science, mathematics and linguistics. Further, more often quantitative research method was used than other methods. AR technology is useful for preschool learners to higher education students and an effective tool for all subjects and especially for science laboratories, teaching geography, especially geomorphology topics. Few studies suggested that augmented reality can be exploited as an effective learning environment for learning the basic principles of electromagnetism in high school provided that learning designers should strike a careful balance between AR support and task difficulty. It is also equally applicable to children with special education needs. On the whole, one can infer that AR is a technology of the coming future. It can bring significant changes in education, though there is still a lot of room for improvement that needs to be addressed in future research. In this paper, several approaches to implementing AR technology in education are discussed. Much advancement is yet to be made to make AR a perfect platform for educational purposes. The researchers have significantly contributed to making it easier for students. Finally, it is expected that the findings in this study could reveal the importance of the adoption of effective AR in education, and provide potential directions for future research.

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