Gamifying Education: Investigating the Efficacy of a Game-Based Educational App with Augmented Reality

IRIN SEBASTIAN[1], AISWARYA RAJU[2], AKASH MANUEL[3], JOEL JOBY[4] & PROF. SMITHAJACOB[5]

Abstract / Due to the recent pandemic situation, the usage of digital platforms to reach educational requirements has been expanded vastly. But recent studies show that this virtual method is not as effective as the traditional education system since students are not able to fully understand the idea or concept. Hence both the teachers and students are struggling a lot, especially when it comes to explaining the structure of different objects which these students might not have seen before (for example, the structure of molecules, cells, 3D figures, etc.) This study focuses on the effectiveness of providing a platform for students and parents in which students can learn the concepts through games and see the 3D models of various figures. This will provide an in-depth idea of its shape, structure, and nature. Thus, by getting a live 3D image, the students will be able to capture the idea more clearly. If the platform shows the competing students' leaderboards, it will enhance their learning spirit. Thus, the platform will act as an aid in understanding the educational concepts along with their regular education.

I. Introduction

The Indian education system has multitudinous excrescences which drain the interest and enthusiasm of a pupil to explore and learn. The normal academy classes are monotonous due to which a pupil fails to fantasize different concepts, especially wisdom, and ultimately loses interest in learning. At the point when we take a gander at the Coronavirus plague that has not passed on to influence any single country on the planet, Education was one of the most negatively affected corridor by this epidemic, especially for the scholars of primary and middle seminaries as they had been missing their in-person interactive classes and set up it much more difficult to connect to their preceptors and the generalities tutored by them. This not only affected their academics but was also a big trouble to arising minds. Indeed though e- literacy has come a new normal for us, faculties and scholars are still facing loads of difficulties. Different online platforms are just trying to connect preceptors and scholars but they aren't suitable to make the learning of scholars more effective and interactive.

II. Background

Two cutting-edge technologies, gamification and augmented reality (AR), are being employed more frequently in educational settings to improve the learning process. While AR is a technology that superimposes digital items on the real world, gamification is the use of game design ideas and features in non-game contexts. Gamification and augmented reality have both been found to improve learner engagement, motivation, and learning results. On the effectiveness of merging these two technologies in educational contexts, however, little research has been done.

A. Gamification

Gamification is a technique used to engage and motivate learners in educational settings. It involves the use of game design elements and principles in non-game contexts. The use of gamification in education has become increasingly popular in recent years, with educators and researchers recognizing its potential to enhance learning outcomes. It can be used in various forms of learning, including face-to-face, online, blended, and mobile learning. It can be used to motivate learners, increase engagement, and enhance learning outcomes. Gamification can be used to teach specific skills or concepts, or it can be used to create a more immersive and engaging learning experience.

B. Game-based learning

Game-based learning is the use of games to teach specific skills or concepts. It involves the use of game design elements and principles to create engaging and interactive learning experiences. Game-based learning has become increasingly popular in education due to its ability to engage learners and enhance their learning experience. It can be used to teach a wide range of subjects, from language and literacy to science and mathematics. Game-based learning can be used to create a more immersive and engaging learning experience, which can help learners to understand complex concepts and ideas.

C. Augmented Reality

Augmented reality (AR) is a technology that superimposes digital objects onto the physical world. AR is becoming increasingly popular in education due to its ability to create immersive and engaging learning expe-

riences. AR can be used to enhance learning by creating interactive and engaging experiences that can help lear- ners to understand complex concepts and ideas. AR can be used to create simulations, visualizations, and de- monstrations that can enhance the learning experience. AR can also be used to provide learners with real-world context, which can help them to see the practical appli- cation of the concepts they are learning.

Recent systematic literature reviews, scientific mapping, meta-analyses, and bibliometric studies that looked at the effect of gamification on education presented both the advantages of using gamification in educational set- tings as well as the problems and restrictions that must be resolved in order to fully benefit from gamification. Gamification is recognised as a legitimate didactic stra- tegy that has the potential to be utilised in conjun- ction with a variety of technologies and other learning methods and approaches due to the success of its inte- gration into teaching and learning activities within pe- dagogical contexts.

III. Problem Statement

The majority of people have attended traditional schools, which have been operating for a while. The- re are public institutions run by the school district that are separated into grades and offer both primary and secondary education. It covers information communi- cation between a teacher and students in a classroom setting. Notwithstanding the difficulties, several colleges and universities still use traditional teaching approaches to promote learning. This includes the following,

- The Indian education system has numerous flaws which drain out the interest and enthusiasm of a student to explore and learn.
- The normal school classes are monotonous due to which students struggle to envision many concepts, particularly those in science, and eventually lose in- terest in studying.
- Education was one of the most adversely affected part by the pandemic, especially for the students of primary and middle schools.
- Students have been missing their in-person interacti- ve classes and found it much more difficult to connect to their teachers and the concepts taught by them.
- Various online platforms merely attempt to connect teachers and students, but they are unable to impro- ve the effectiveness and interaction of student lear- ning.

These issues are solved by introducing safe experiential learning that's engaging for learners which can create a dynamic that can inspire learners to develop skills and competencies as they focus on the activities of the ga- me. They can function as individual learning activities and as a powerful content delivery mechanism over se- veral sessions that last for the duration of the course. In order to deliver content the syllabus is divided into levels through which the students must progress, with students getting feedback rather than grades.

IV. Literature Review

Author [1] proposed an educational application that uses augmented reality (AR) technology to enhance the learning experience. The application is designed to be used in classrooms to supplement traditional teaching methods and provide a more interactive and engaging learning environment for students. The application of- fers a range of features, including 3D models of objects and concepts, interactive animations, and multimedia content such as videos and audio recordings. It also in- cludes a feature that allows students to interact with virtual simulations, providing a hands-on learning ex- perience. The application is designed to be easily custo- mizable by teachers, allowing them to create their own AR content and integrate it into their lesson plans. The author suggested that this flexibility can help to cater to different learning styles and engage students who may struggle with traditional teaching methods. The poten- tial benefits of using AR technology in education, in- cluding increased student engagement, improved reten- tion of information, and the ability to provide a more personalized learning experience are discussed. It also highlights the challenges associated with implementing AR technology in classrooms, such as the need for spe- cialized hardware and training for teachers. Overall, the application proposed in the paper offers an innovative approach to education by leveraging AR technology to provide a more interactive and engaging learning expe- rience for students.

Author [2] proposed an augmented reality (AR) ba- sed interactive game designed for children. The game combines physical and virtual elements to create an immersive and engaging experience for children. The author outlined the development process of ChildAR and its potential benefits for children's education and entertainment. The game is designed to be played on mobile devices, and it requires players to move around and interact with real-world objects to complete tasks within the game. The game uses AR technology to over- lay virtual objects onto the real world, allowing players to interact with both. For example, players might use their device's camera to see and interact with virtual animals or objects overlaid in the real world. The ga- me could also incorporate educational elements, such as teaching children about different types of animals or natural phenomena. They also discussed the technical aspects of developing the game, including the software and hardware requirements, and provide a detailed des- cription of the game mechanics and user interface. The authors also discussed potential future directions for the game, including incorporating machine learning algo- rithms to enhance the game's educational content and incorporating social networking features to allow chil- dren to interact and collaborate with each other. Ove- rall, ChildAR is an innovative and promising application of AR technology for children's education and entertain- ment. However, further research and development are necessary to fully explore the potential of this techno- logy in the field of education and to ensure that any AR-based games for children are safe, age-appropriate, and encourage healthy behaviors.

Author [3] proposed an AR-based tool for educa- tional purposes. The tool, called TeachAR, is designed to enhance traditional teaching methods by providing an interactive and engaging learning experience for stu- dents. TeachAR uses AR technology to overlay digital content onto real-world objects or environments, allo- wing students to interact with both. For example, Tea- chAR might allow students to use their smartphones or tablets to scan a textbook page and then see 3D models or animations overlaid onto the page, providing a more immersive and visual learning experience. The authors outlined the development process of TeachAR, including the software and hardware requirements and the design of the user interface. The authors also dis- cussed the potential benefits of using TeachAR in edu- cation, such as improving student engagement, moti- vation, and learning outcomes. TeachAR has potential applications in various educational settings, such as in K-12 schools, universities, and vocational training pro- grams. The authors suggest that TeachAR could be used to enhance traditional teaching methods in a variety of subjects, including science, technology, engineering, and mathematics (STEM) fields. They also discussed some of the challenges and limitations of using AR techno- logy in education, such as the need for adequate tech- nical infrastructure and the potential for distractions or disorientation caused by the overlay of virtual con- tent onto the real world. Overall, TeachAR is an inno- vative and promising tool for enhancing traditional tea- ching methods using AR technology. However, further research and development are necessary to fully explore its potential in education and to ensure that it is used in a safe, effective, and age-appropriate manner.

Author [4] investigated the effects of using augmen- ted reality (AR) technology in early childhood educa- tion. The paper focused on a specific AR-based edu- cational program called AR-Child, which is designed to teach young children about different animals. The author first provides an overview of AR technology and its potential applications in education. It then describes the development and implementation of the AR-Child program, which involves using AR technology to over- lay virtual 3D models of animals onto real-world cards. The program is designed to encourage children to explo- re and learn about different animals through interactive and engaging experiences. They presented the results of a study that evaluates the effectiveness of the AR-Child program in promoting children's learning outcomes. The study involved a group of preschool children who par- ticipated in the program and a control group who did not. The children's knowledge of animals was assessed before and after the program using a standardized test. The results showed that the children who participated in the AR-Child program had significantly higher sco- res on the animal knowledge test than the control group. The authors suggested that this indicates that AR tech- nology has the potential to be an effective educational tool for young children. They also discussed some of the challenges and limitations of using AR technology in education, such as the need for appropriate hardware and software, the potential for distractions or disorien- tation caused by the overlay of virtual content in the real world, and the need for age-appropriate and safe content. Overall, the study suggests that AR techno- logy has the potential to be an effective and engaging educational tool for young children. However, further re- search is necessary to fully explore its potential and to address some of the challenges and limitations of using AR technology in education.

Author [5] proposed an educational application de- signed for young children using augmented reality (AR) technology. The application, called Cubo Kids, is de- signed to encourage children's learning and exploration of different topics through interactive and engaging ex- periences. The author first provides an overview of AR technology and its potential applications in education, particularly in early childhood education. It then descri- bes the development and features of Cubo Kids, which includes interactive games, stories, and activities focu- sed on different educational topics, such as math, scien- ce, and language development. They also discussed the potential benefits of using Cubo Kids in early childhood education, such as promoting children's cognitive, so- cial, and emotional development. The authors sugges- ted that AR technology can provide a more immersi- ve and engaging learning experience than traditional methods, which can help children to retain information better and develop a positive attitude toward learning. They also addressed some of the challenges and limi- tations of using AR technology in early childhood edu- cation, such as the need for appropriate hardware and software, the potential for distractions or disorientation caused by the overlay of virtual content onto the real world, and the need for age- appropriate and safe con- tent. Overall, Cubo Kids is an innovative and promising educational application that uses AR technology to pro- vide an engaging and interactive learning experience for young children. However, further research is necessary to fully explore its potential and to ensure that it is used in a safe, effective, and age- appropriate manner.

Author [6] discussed the benefits of AR and gamifi- cation in education and how these technologies can be used to enhance the learning experience. The framework consists of four phases: the analysis phase, the design phase, the development phase, and the evaluation phase. In the analysis phase, the authors recommended iden- tifying the learning objectives and selecting the appro- priate AR and gamification elements to support these objectives. In the design phase, the authors suggested creating a storyboard and designing the user interfa- ce for the AR application. In the development phase, the authors recommended developing the AR applica- tion and integrating the gamification elements. Finally, in the evaluation phase, the authors suggested testing the application with a target audience and gathering feedback for further improvements. The authors provi- ded examples of how this framework can be applied in different educational contexts, such as language learning and medical education. They also discussed the challen- ges and limitations of using AR and gamification in edu- cation, such as the cost of developing and implementing these technologies and the need for effective instructio- nal design. Overall, the paper provides a comprehensive framework for developing a supplementary learning tool

using AR and gamification and highlights the potential benefits and challenges of using these technologies in education.

Author [7] explains how traditional methods of teaching English pronunciation, such as repetition and rote memorization, can be less effective than more engaging and interactive approaches, such as AR games. The authors described their development of an AR game called "Talking Tom and Friends AR Pronunciation Game" which uses AR technology to create a more immersive and engaging learning experience. The game includes a variety of pronunciation exercises, such as tongue twisters and word associations, which are presented in a fun and interactive way. The authors conducted a study to evaluate the effectiveness of the AR game compared to traditional methods of teaching English pronunciation. The results showed that the AR game was more effective in improving students' pronunciation accuracy and confidence. The authors attribute this to the game's ability to provide immediate feedback and engage students in a more interactive and enjoyable way. Overall, the paper demonstrates the potential of AR games to assist children in improving their English pronunciation and provides a practical example of how AR technology can be applied in an educational context. The study's findings also suggest that more engaging and interactive approaches to learning can be more effective than traditional methods in certain contexts.

Author [8] presented a study that investigates how a gamified augmented reality (AR) mobile app can influence interest formation in English learning. The authors note that interest is a key factor in successful language learning and that technology can be used to enhance interest formation. The study involves the use of a mobile app which incorporates AR technology and gamification elements into English language learning. The app includes a variety of activities, such as language puzzles and quizzes, which are designed to be engaging and fun. The authors recruited a group of Chinese university students to participate in the study and evaluated their interest formation in English learning over a period of eight weeks. The results of the study indicate that the use of the app was effective in promoting interest formation in English learning. The authors found that the app's gamification elements, such as the use of points and rewards, helped to motivate the students and sustain their interest over time. The AR technology was also found to enhance the immersive and interactive nature of the learning experience. Overall, they demonstrated the potential of gamified AR mobile apps in promoting interest formation in English language learning. The authors suggest that future research could explore the use of similar technology in other educational contexts and investigate how different types of gamification elements and AR features can influence interest formation.

Author [9] defined gamification as the use of game design elements in non-game contexts to motivate and engage learners. The author provided a comprehensive review of the existing literature on gamification in education and identifies several practical implications for designing and implementing gamified learning experiences. These include the importance of incorporating elements of challenge, feedback, and social interaction into gamified learning activities. They also discussed the potential outcomes of gamified learning experiences, such as improved learner motivation, engagement, and learning outcomes. They highlight the need for careful consideration of the specific learning objectives and the design of appropriate gamification elements to achieve these outcomes. They presented several examples of successful gamified learning experiences in different educational contexts, such as language learning and science education. These examples demonstrate the potential of gamification to enhance learner motivation and engagement, as well as to support the development of specific skills and knowledge. Overall, the paper highlights the practical implications and outcomes of gamifying learning experiences and provides guidance for designing and implementing effective gamified learning activities. The authors emphasized the importance of considering the specific learning objectives and the needs of the learners in designing gamified learning experiences that canachieve meaningful learning outcomes.

Augmented reality (AR) and gamification are two innovative technologies that have garnered significant attention in the field of education. AR combines the physical world with digital information, while gamification applies game design principles to non-game contexts. Both technologies have been used to enhance the learning experience and motivate students to engage with educational content. Author [10] found that certain technologies have been implemented in various educational settings, including K-12 schools, higher education, and vocational training. This revealed that AR and gamification have the potential to improve student engagement, motivation, and learning outcomes. AR has been used to enhance learning in subjects such as science, geography, and history by providing interactive 3D models, simulations, and virtual tours. Gamification has been used to make learning more fun and engaging, with elements such as points, badges, leaderboards, and challenges. Both technologies have been used to promote collaborative learning and improve student performance. The literature review also found that the effectiveness of AR and gamification in education depends on various factors, such as the content's quality, the technology's design, and the pedagogical approach. It is important for educators to carefully consider these factors when implementing these technologies in their classrooms. In conclusion, AR and gamification are promising technologies that can enhance the learning experience and motivate students to engage with educational content. However, their effectiveness depends on various factors, and further research is needed to determine the most effective pedagogical approaches and design strategies.

Quiver is a note-taking app designed specifically for programmers, engineers, and scientists. It allows users to create and organize notes using a combination of text, code snippets, and math equations, as well as drawings and diagrams. One of the key features of Quiver is its ability to handle multiple languages and file types, including Markdown, LaTeX, Python, and Ruby. This makes it easy to create and store code snippets and technical

notes in a variety of formats. Quiver also offers a range of customization options, allowing users to choose from various themes and fonts and customize keyboard short- cuts and other settings. In addition to its note-taking features, Quiver also includes a built-in Markdown edi- tor, a preview mode for LaTeX equations, and support for version control with Git. Overall, Quiver is a power- ful and flexible note-taking app that offers a range of features tailored specifically for technical professionals. Animal 4D is an augmented reality (AR) app that allows users to interact with 3D models of animals th- rough their smartphone or tablet. The app uses AR tech- nology to bring the animals to life on the device's screen, making them appear as if they are right in front of the user. To use the app, users need to print out special image markers, which are used to trigger the AR expe- rience. Once the markers are placed on a flat surface, such as a table or floor, the user can scan them with the app to reveal a 3D model of an animal. The app currently includes a range of animals, including lions, tigers, elephants, and sharks. Users can interact with the animals by moving their device around the marker, which causes the 3D model to move and respond in real- time. The app also includes an information mode, which provides users with facts and details about each animal. Overall, Animal 4D is a fun and engaging app that of- fers an immersive AR experience for children and adults alike. It combines technology and education to provide a unique learning experience that is both entertaining and informative.

Curiscope is an educational app that offers immersi- ve VR experiences and augmented reality (AR) content to help users learn about anatomy and biology. The app uses advanced technology to create interactive experien- ces that allow users to explore the human body and other biological systems in a way that is engaging and informative. One of the key features of Curiscope is its VR experiences, which allow users to enter a virtual en- vironment and interact with anatomical structures and processes in 3D. These experiences include "The Great White Shark,"which allows users to swim with a virtual shark and learn about its anatomy and behavior, and "Virtuali-Tee,"which uses AR technology to create an interactive t-shirt that shows users the inside of the hu- man body. The app also includes a range of educational content, including videos, quizzes, and interactive ani- mations, that help users learn about topics such as the circulatory system, the digestive system, and the respi- ratory system. The content is designed to be accessible to users of all ages and skill levels, making it a valua- ble resource for students and educators alike. Overall, Curiscope is a powerful educational tool that leverages VR and AR technology to create engaging and informa- tive experiences that help users learn about anatomy and biology. Its user-friendly interface and range of con- tent make it a valuable resource for anyone interested in learning about the human body and other biological systems.

Counting with Paula is an educational app designed for children to learn math and other early childhood skills. The app features a popular cartoon character na- med Paula, who guides children through various acti- vities that teach them about counting, addition, sub- traction, shapes, colors, and more. The app includes a range of educational games and activities that are de- signed to be engaging and interactive, including jigsaw puzzles, memory games, and matching games. It also features animated videos and songs that help reinfor- ce the concepts being taught, and encourage children to practice their math skills. One of the key features of Counting with Paula is its focus on making learning fun and entertaining. The app uses colorful graphics and engaging animations to capture children's attention and keep them engaged, while also providing feedback and encouragement to help them build confidence and im- prove their skills. The app is designed to be easy to use and navigate, with intuitive controls and clear instruc- tions that allow children to work independently or with a parent or caregiver. It is available in multiple langua- ges, making it accessible to children around the world. Overall, Counting with Paula is a valuable tool for pa- rents and educators looking to teach early childhood math and other skills in a fun and engaging way. Its mix of games, activities, and videos makes it a versa- tile resource that can be used in a variety of learning environments.

Kutuki is an educational app designed for children to learn through interactive games and activities. The app offers a range of content, including stories, songs, games, and activities, that are designed to help children develop early childhood skills such as reading, writing, math, and social-emotional learning. One of the key fea- tures of Kutuki is its focus on creating content that is culturally relevant and reflects the diversity of Indian so- ciety. The app features stories and songs that draw from Indian mythology and folklore, as well as games and ac- tivities that incorporate elements of Indian culture and tradition. The app also includes a range of interactive features, such as quizzes, puzzles, and drawing tools, that encourage children to engage with the content and develop their skills in a fun and engaging way. It offers a personalized learning experience, with content that is tailored to each child's age and skill level, and progress tracking tools that allow parents and educators to mo- nitor their child's learning and provide targeted support where needed. Overall, Kutuki is a valuable tool for pa- rents and educators looking to supplement their child's learning with interactive and culturally relevant content. Its focus on early childhood development and personali- zed learning make it a valuable resource for children in India and around the world.

The Toffee Ride kids app is an educational and enter- tainment platform designed for children aged 5-12 years old. The app offers a range of educational games, videos, and interactive activities to help children learn while ha- ving fun. The content is designed to cover a variety of topics, including math, science, and language arts, and is aligned with educational standards. Toffee Ride al- so includes a social element, allowing children to con- nect with their friends and family and share their achie- vements and progress. Parents can also monitor their child's activity and progress through the app. The Tof- fee Ride kids app aims to provide a safe and engaging learning environment for children, with features such as

parental controls, ad-free content, and no in-app purchases. Overall, Toffee Ride offers a comprehensive educational and entertainment platform for children, helping them learn and grow in a fun and interactive way. MentalUP Educational Games App is a mobile application designed to improve cognitive skills such as attention, memory, problem-solving, and logical thinking in chil- dren. The app offers a variety of games and exercises that are specifically designed to be fun and engaging while also providing educational benefits. The app's fea- tures include personalized training programs based on the child's age and skill level, progress tracking, and ga- mified rewards to encourage continued use. MentalUP is suitable for children aged between 4-13 and has been de- veloped in collaboration with academic researchers and education professionals. It is available for download on both iOS and Android devices.

Science AR is an augmented reality (AR) applica- tion that provides interactive learning experiences for students in the field of science. The app uses AR tech- nology to create 3D models of scientific concepts that can be explored and manipulated in real-time. Users can point their device's camera at a designated image or ob- ject, and the app will overlay a 3D model or animation on top of it. Science AR covers a range of topics such as human anatomy, space exploration, and chemical reac- tions. The app also includes quizzes and challenges to reinforce learning and test understanding. Science AR is available for download on iOS and Android devices.

Adventure Academy is an online educational plat- form developed by the creators of ABCmouse. It is de- signed for children aged between 8-13 and provides a range of interactive activities and games that cover va- rious subjects such as math, science, social studies, and language arts. The platform offers a virtual world where children can create their own avatars and explore diffe- rent environments while completing quests and challen- ges. Adventure Academy also includes features such as personalized learning paths, progress tracking, and re- wards to encourage engagement and motivation. It is available on desktop and mobile devices and requires a subscription to access the full range of content.

TutAR is an augmented reality (AR) platform that offers a next-level classroom experience by creating an immersive and interactive learning environment. It allows educators to incorporate AR content into their lesson plans, making the learning process more enga- ging and memorable for students. With TutAR, students can view 3D models of objects and concepts, watch vi- deos, and interact with virtual simulations in real-time. The platform also offers a collaborative learning featu- re, allowing students to work together on projects and share their ideas and insights. In addition to its edu- cational benefits, TutAR offers a cost-effective solution to traditional classroom methods. Schools and educa- tors can save money by using digital content instead of physical materials and textbooks. Overall, TutAR of- fers an innovative approach to education by leveraging AR technology to provide a more engaging and effective learning experience.

V. Conclusion

Augmented Reality gamified learning apps can effecti- vely engage learners and make learning more interacti- ve and enjoyable. By overlaying digital content onto the physical world, AR can create immersive and interactive learning experiences that are not possible with traditio- nal methods. Typically, AR in education encompasses the capacity to both engage and excite. Gamification can further enhance the learning experience by adding elements of competition and reward, motivating learners and making the learning process more engaging. Howe- ver, this system will provide gamified education to the children of LKG, UKG, and classes 1 and 2. The system will also allow parents to view their children's perfor- mance for each subject, their score, and the time taken to complete each game associated with the subject. It will also provide a leaderboard where it will display the score of each student who plays the game of that parti- cular subject and it can be viewed by their parents. The system will also enable an option of 3D models for the students where they will view the 3D models of various objects respective to their course. Compared to the tra- ditional learning method this system will act as an aid for easy learning and understanding of concepts.

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