

ARena - Education Purpose Augmented Reality Application

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Abstract— The buzz surrounding augmented reality is palpable. As the cutting-edge technology industry transitions into a world of more complicated reality applications and interactive experiences, augmented reality's possibilities are expanding quickly. The augmented reality industry is revolutionizing the user experience through its interactive technology. E-learning has been shown to be the creative and effective method for instructing students and engaging them in this new technological era. There are many online programs and courses available to students, but as we all know, online classes are boring, the principles taught cannot be acquired again, and practical knowledge is essential for subjects like science and others that require actual practice and visualization.

The benefits and potential of augmented reality in the Indian Education System will aid the country's young minds in acquiring vast amounts of knowledge in an engaging manner without being jaded. This research paper describes how ARena an augmented reality application was put into practice. With the help of 3D models, students of all backgrounds can study a variety of concepts on their mobile device, which improves their knowledge more quickly. By visualizing and engaging with the material, students can perform better academics wise. Gives the real-life feel of various models such as Earth, the Solar System, etc.

The application enhances the learning process's impact and appeal. The augmented reality elements of the curriculum produce a unique mixed interactive experience by enhancing learning with the most modern technical breakthroughs. ARena an Education Purpose Augmented Reality Application can help students achieve better results through visualization and full immersion in the subject matter.

Keyword - Augmented Reality, Education, Learning, Technology, Application

I. INTRODUCTION

Augmented reality: what is it? Holographic technology is used to create an enhanced representation of the real world environment and that is known as augmented reality. Augmented Reality (AR) is the combination of the physical and digital worlds, real-time interactions, and accurate 3D object detection and depiction. AR offers novel methods to interact with knowledge, enhanced fact visualization, and reduced cognitive load. The use of augmented reality in education has been the subject of continuing research. The results indicate that the introduction of augmented reality into education has a positive impact on both teaching and learning techniques and has enormous promises.

Even though there has been a lot of research on AR, little has been done in the field of education. There are now more studies on AR as a result of this technology's success in recent years. Specifically, AR provides a useful way to represent a model that has to be seen. In essence, several

websites already provide videos of E-learning concepts and material. Instead of providing the information in the form of a video, what if we included something that may help us visualize that concept better? Here, we introduce our hack, ARena an augmented reality application that lets students and teachers share AR visuals and prominently display learning resources in re-configurable areas.

Students' excitement and interest in learning are severely diminished by the major deficiencies in the Indian Educational System. When we take into account the COVID-19 pandemic, which has affected every country on the planet. One of the areas of the pandemic that had the greatest detrimental effects on society was education, particularly for students in primary and middle schools who had been missing their engaging in-person classes and found it more difficult to relate to their teachers and the subjects they were teaching. Both their academic performance and the mental development of young people are significantly impacted by this. ARena refers to an android application that can be used by students and focuses on education. Students can more easily observe and absorb concepts in an immersive environment with the use of this application. The introduction of specific AR modules is intended to aid with concept comprehension. A learner could, for instance, look at the solar system in three dimensions and observe how the individual planets respond to space. Even planets can be interacted with, and information about them may be retrieved. It also incorporates AR modules for understanding scientific concepts to make their study interesting and pleasant.

II. THE PROBLEM

The Augmented Reality (AR) technology, which improves the real world environment with lifelike virtual information in various kinds of multimedia content, has opened up new potential for the educational sector.

Given the size of the country and the magnitude of this sector, there seems to be a huge need for qualified educators, and research scientists in India. Although if societal advancements are intimately tied to improvements in education and technology, the attitude towards education is not positive.

Several studies have been conducted in an effort to determine how to enhance students' motivation for learning by taking advice from students themselves. Students suggested that a subject matter expert be present in the classroom to provide them with the necessary background knowledge and make the courses more engaging. The preferred method of instruction among students is participatory learning. Students usually think of courses as being abstract and demanding a high level of comprehension and visualization skills. When students find it difficult to fully understand an idea, misunderstandings are the end result. Because they may

prevent students from comprehending scientific concepts and principles, it is necessary to take into account student misunderstandings. So, selecting the appropriate teaching approach is essential to avoiding or minimizing students' misunderstandings.

III. POSSIBLE SOLUTION

One technology that has a lot of potential for use in education is Augmented Reality (AR), particularly for visualizing abstract concepts. Comparing the use of augmented reality to the traditional method, in which teachers use wooden items, is a novel way to enhance the teaching of three-dimensional shapes. There are many advantages to using AR technology in education. Because AR makes it possible for rich visualization and object motion, it can help students who struggle to visualize concepts understand them more clearly. The ability to observe objects or concepts that are undetectable to the human eye at a macro or micro level is another advantage of augmented reality.

The vast majority of the research on augmented reality that has been conducted so far shows that children are eager and interested in learning with this technology. Because its applications are interactive, AR also encourages student involvement in the learning process. By encouraging critical and creative thinking, this improves the learning experiences and comprehension of the pupils.

Technology for visualizing information offer a great deal of potential to increase knowledge and reduce misunderstandings in the educational setting. It is feasible to enhance students' visualizing skills by offering a variety of abstract visual representations and allowing the students to customize and explore them. A wide range of techniques can be used to visualize abstract concepts, and one of them is augmented reality. These visualizing methods can be used to address the issue of misunderstanding and help students comprehend more.

IV. LITERATURE SURVEY

A Review of Research on Augmented Reality in Education: Advantages and Applications Nor Farhah Saidin, Noor Dayana Abd Halim, Noraffandy Yahaya
The research conducted shows that AR technology has the potential to be further developed in education. This is because the advantages and beneficial uses of AR features are able to engage students in learning processes and help improve their visualization skills.

Learning Strategies Using Augmented Reality Technology in Education: Meta- Analysis Mohd Fadzil Abdul Hanid, Mohd Nihra Haruzuan Bin Mohamad S
The paper shows that selection of appropriate learning strategies can influence the success and effectiveness of the technology support used, such as Augmented Reality in education.

Augmented Reality Research and Applications in Education Ezgi Pelin Yildiz
In this research paper, a detailed analysis of the augmented reality environments and applications that are frequently used in the design of learning and teaching environments in the education sector with the digitalization process is included.

Augmented reality (AR) for visualizing solar system motion Surya Gumilar
The research paper concludes that learning media that use Augmented Reality Technology can be used as alternative media in classroom learning, specifically for physics learning in the concept of motion of the solar system.

An Augmented Reality System for Learning the Interior of the Human Body M.Carmen Juan, Francesca Beatrice, Juan Cano
The research paper has presented an AR system for learning the interior of the human body.

Web based Augmented Reality for Human Body Anatomy Learning Rita Layona, BudiYulianto, YovitaTunardi
The application in the research paper provides solutions for student who has difficulty in visualizing the anatomy of a two-dimensional body shape into a three-dimensional practice form.

V. REQUIREMENT ANALYSIS

Scope:

Many uses for augmented reality in education are possible. It makes it simpler for the pupils to learn, understand, and retain the material. Also, AR enhances the fun and engagement of learning itself. Also, it is not restricted to any one age group or educational level and may be applied successfully at all academic levels, including pre-school, college, and even the workplace.

Hardware and Software Requirements :

Hardware Requirements:

Operating system: Android 7.0 (API Level 24) RAM: 4GB
ROM: 265MB
GPU: OpenGL ES Versions: 3.0 or 3.2 Camera: Depth API Support
Sensor: Time-F-Flight (ToF) Hardware Depth Sensor
Display: Multiple GPU Texture Resolutions - 1080p, 720p, 480p

Software Requirements:

OS: Linux, Windows 10, Catalina 10.15.7
Tech Stack : Flutter, Blender, Firebase, Visual Studio Code, Dart, AR Core

Tech Stack:

- Flutter: Google's portable UI toolkit, Flutter, allows developers to create stunning, natively built applications from a single codebase for desktop, mobile, and the web. Flutter is free and open source, integrates with existing code, and is utilized by developers and businesses all over the world.
- Blender: A suite of 3D computer graphics tools called Blender is free and open-source and is used to make animated movies, visual effects, artwork, 3D-printed models, motion graphics, interactive 3D apps, virtual reality, and, previously, video games.
- Firebase: Google's Firebase is a collection of backend cloud computing services and application development frameworks. It supports a number of applications, including Android, iOS, JavaScript, Node.js, Java, Unity, PHP, and C++, and hosts databases, services, authentication, and integration for them.
- Visual Studio Code: Microsoft created the source-code editor Visual Studio Code, generally known as VS Code, for Windows, Linux, and macOS using the Electron Framework. Debugging support, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git are among the features.
- Dart: Dart is a programming language designed by Lars Bak and Kasper Lund and developed by Google. The programming language is designed for client development such as for the web and mobile apps, and it can also be used to build server and desktop applications.
- AR Core: ARCore, also known as Google Play Services for AR, is a software development kit developed by Google that allows for augmented reality applications to be built.

Packages/Libraries used:

- Bloc for state management : Bloc is a state management library for Flutter that implements the Business Logic Component (BLoC) pattern. Bloc state management helps developers build more modular and scalable apps by providing a clean separation of concerns between the user interface and application logic.

- Firebase Firestore: It is a cloud-hosted NoSQL database offered as a part of the Firebase suite of tools by Google. In Flutter, Firebase Firestore can be used as a backend database to store and retrieve data for mobile applications.

- ARCore: It can be used to build AR-enabled applications, by using the 'arcore_flutter_plugin' package, which provides a set of widgets and tools for building ARCore-based experiences. This package allows developers to create AR objects, such as 3D models, animations, and images, and place them in the real world using ARCore's environmental tracking capabilities.

- Vector_math: It is a package in Flutter that provides 2D, 3D, and 4D vector and matrix types, as well as a quaternion type for animating rotations. These mathematical structures are commonly used in computer graphics, game development, and other areas that require advanced mathematical calculations.

- Google APIs: Google APIs is a collection of APIs provided by Google that allow developers to integrate various Google services into their Flutter apps. These APIs include services like Google Maps, Google Analytics, Google Drive, and more.

- json_serializable: json_serializable is a Flutter package that simplifies the process of serializing and deserializing JSON data. It generates code based on annotated classes to automatically convert JSON data to Dart objects, and vice versa.

- freezed: freezed is a package that provides a simple and powerful way to create immutable classes in Flutter. It generates code based on annotated classes to create immutable data structures that can be used throughout the app.

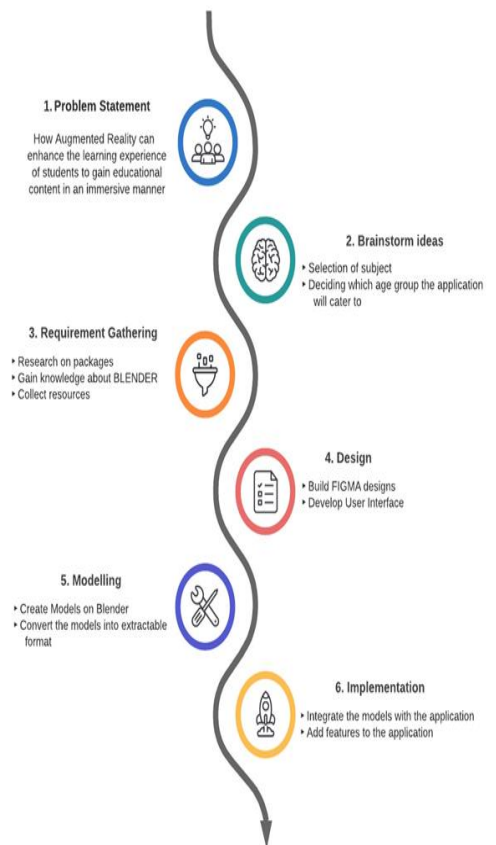
- Injectable: injectable is a dependency injection library for Flutter that makes it easier to manage and organize dependencies in an app. It provides a simple way to declare and manage dependencies, and allows for easy testing and maintenance.

- Hive: Hive is a lightweight and fast key-value database written in pure Dart that can be used to store and retrieve data in a Flutter app. It supports complex data types like lists, maps, and custom objects, and has support for encryption and other advanced features.

Domain-Driven Design (DDD) is a software development approach that focuses on designing software systems around the core business logic and concepts, or "domains", of the application. DDD emphasizes clear communication and collaboration between developers and domain experts to ensure that the software being developed accurately models the problem domain.

In Flutter, DDD can be implemented using a combination of techniques, such as breaking down the app into small, manageable "bounded contexts" that represent specific parts of the app's functionality, and using the BLoC pattern to manage application state and business logic.

VII. PROJECT ARCHITECTURE



1. Research and analysis:

-We did research on Augmented Reality and the compatibility with the language we are using.

-Also studied about how to create 3d models using different available software. Selecting one software. We selected Blender and researched in detailed about this software.

-Research on packages.

-Collection of resources.

2. Planning

-Selection of subject we will focus on.

-Deciding on the topics that we will cover.

-Deciding which age group the app will cater to.

3. Design

-In this phase, the user interface (UI) and user experience (UX) of the app was designed.

-We used Figma to design the UI of the app

-We kept the UI children friendly

4. Modelling

-Studied about the models we wanted to create and then used blender to make the 3d models

-Exported the model in glb/gltf format.

5. Development

-In this phase, the app is developed using the chosen technologies, such as Flutter, ARCore, and Firebase.

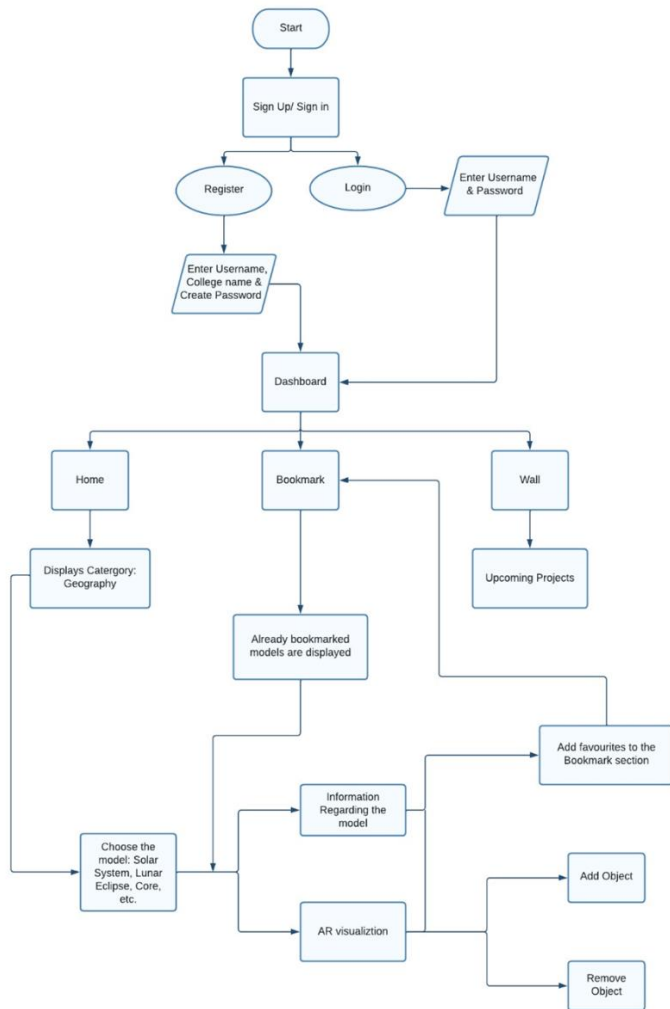
-The features and functionality of the app are implemented, including the ability to display 3D models and animations, as well as the ability to bookmark and navigate through educational content.

6. Testing

-In this phase, the app is tested to ensure that it is free of bugs and errors.

-The app is tested on different devices and platforms to ensure that it performs optimally and is user-friendly.

VIII. PROJECT FLOW DESIGN



IX. METHODOLOGY

In order to ensure effective learning outcomes from the project, careful planning is required before the development process begins.

- Information analysis and collection phase:

In developing learning media for the solar system using Android-based Augmented Reality technology requires preliminary research in the form of performance analysis and needs analysis to find out whether the problems that occur require solutions in the form of learning media development and what is needed in developing the learning media. In analyzing performance and needs, at this stage of research using the method of observation and interviews.

- Planning phase:

The Application as a learning media with an Android-based Augmented Reality feature displays 3D objects. To find out whether this media has fulfilled the criteria, namely validity, practicality, and effectiveness, several evaluations were carried out. The feasibility test is conducted to find out whether this media is feasible to be tested on students through formative evaluation or due diligence conducted by media experts and material experts, if it has not been declared feasible then it must be revised. To find out the practicality of the media can be seen through easy-to-use aspects and instructional flexibility on the feasibility test questionnaire to experts and test the effectiveness of students. After being declared feasible then to find out whether this media is effectively carried out pre-test and post-test to find out whether there is an increase in students' understanding of the material after using the media and student responses questionnaire conducted to determine students' responses to the media.

- Product design phase:

The procedure for developing application as a learning media for planets in the

solar system and human body anatomy follows the stages in the ADDIE development model.

Here is a description of the five ADDIE stages adapted to this study.

- Analysis. At this stage a performance analysis is carried out to find out whether the problem requires a solution in the form of developing learning media and needs analysis to find out what needs are needed in developing learning media.
- Design. At this stage, storyboards, navigation structures, application pageviews and evaluation tools are designed.
- Development. At this stage, we are making and collecting materials for applications, like markers, buttons, models and other materials.
- Implementation. At this stage, the application of the interface design results in the system built. Then the coding stage or the function of some of the commands in the form of program code so that the learning media can running by its functions.
- Evaluation. At this stage the final testing of the application has been done.

For AR:

- Creating models using Blender. Initializing vectors, dimension and grids to position the AR models. Creating session functions to activate the AR model

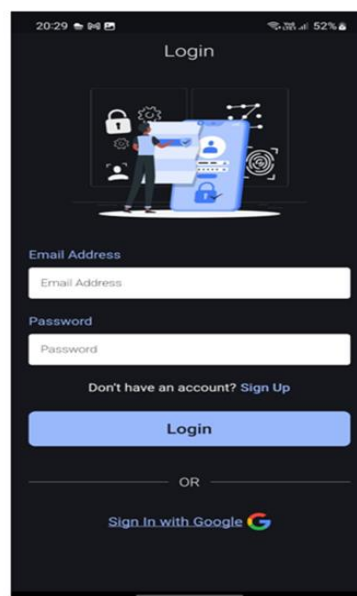
X. PROJECT DESIGN

1. The app has a simple and user-friendly interface. Upon launching the app, users are prompted to login. For first-time users, they will be redirected to the sign-up page. Users can also choose to log in using their Google account.

2. Once the user logs in, they are directed to the home page. The home page displays the user's name and provides access to different categories. The Geography category card contains a collection of 3D models of geological phenomena, Solar eclipses, Lunar eclipses, planets: Saturn, Earth, and Landscapes. Users can select any card from the aforementioned models. Once a card is selected, the user is presented with a description of the model. They can then click on the 'open camera to view AR model' button to view it in augmented reality. This feature enables users to explore the model from different angles, providing a more in-depth understanding of the subject matter.

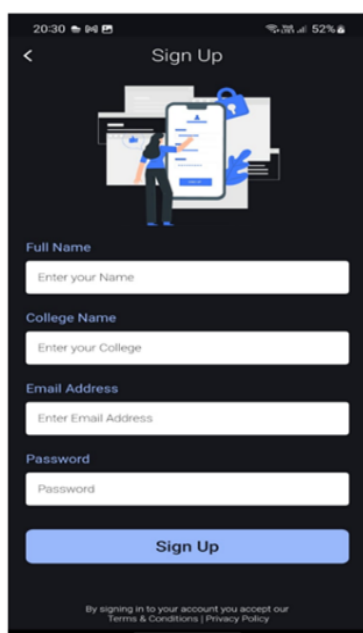
3. Upon opening the camera, the user must click on the 'add object' button to view the model. Once they have viewed the model, they can return to the page where the details of the model are mentioned. Here, the user can add their favorite model to their 'bookmark' list. All bookmarked models can be viewed on the bookmark page.

4. Additionally, the app features a 'wall' page that displays all the upcoming models' cards. This feature allows users to stay updated on the latest models and keep exploring new subjects.

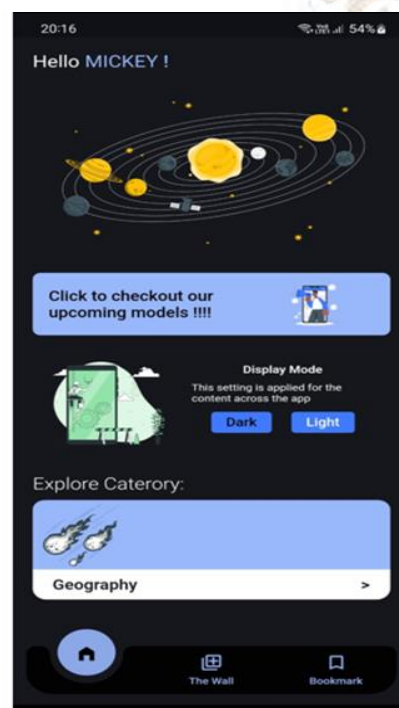


(b) Login page

XI. IMPLEMENTATION



(a) Sign Up page



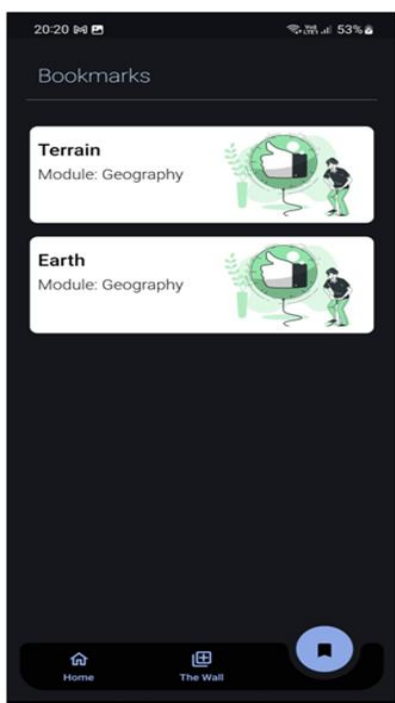
(c) Explore page



(d) Module page



(f) Upcoming Topics page



(e) Bookmarks page



(g) Model Info page



(h) Final AR Model

future with a variety of other functions, such as direct navigation to a certain letter, and it can be created for several platforms in addition to Android. The application is currently reliant on a single target image. To make the application more interesting, interactive, and less dependent on a single or many picture targets, it can be created for multiple image targets or for applications that do not require any image target. It is possible to enhance the camera's picture target identification and rendering. It is possible to integrate gesture and voice control for switching between different sceneries. Moreover, 3D digital books for higher education are conceivable.

- Adding subjects like Biology, Chemistry etc
- Recommending models on the wall based on number of people that have bookmarked a particular model
- More 3D model
- More interactive UI
- More textual material

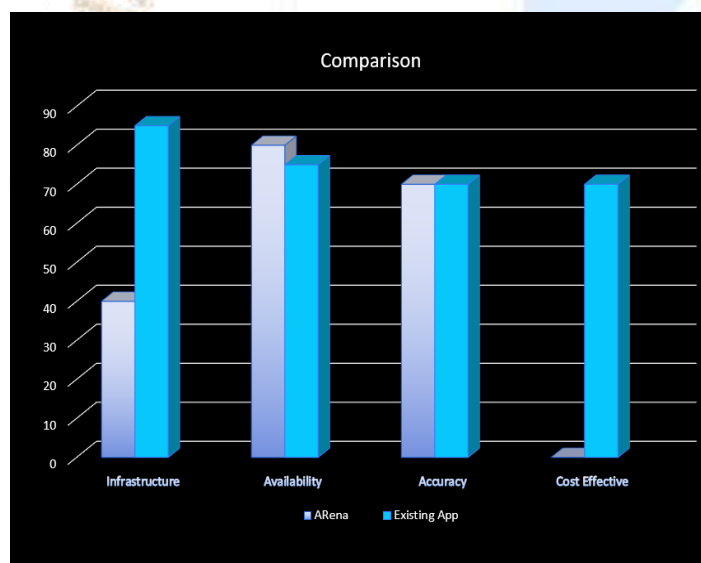
V. CONCLUSION

In 2D arrangement, augmented reality enables the user to build up multiple layers of digital information on top of physical information. The goal of this article is to use augmented reality to improve productivity and learning environments. The findings suggest that AR systems are an effective way to close the knowledge gap for young people. With the help of this AR application prototype, kids can become more comfortable with letter identification, letter pronunciation, and other skills that help with memorizing. The system is compactly created and developed, ready to satisfy user requirements and provide for them in a more efficient and improved way. The actual issue has been carefully observed, described, and assessed in such a way that the consumer is never given an option. More importantly, the old system's constraint had been removed in order to better serve the needs of the user. The data base, input forms, and output reports have all been designed with great accuracy and care since they should be given the proper consideration or else there could be major repercussions that would damage the entire system. The resulting system has been put into use.

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XII. RESULTS AND DISCUSSION



We compared our app to an existing AR application. Here are some of the points at which our app performs better:

- The bookmark feature allows user to bookmark their favourite 3d models which is not found in the existing model.
- For making an app we require high end laptops and software. Here we can say our app is cost efficient as the cost for making our app is negligible in comparison.
- The app provide paid content whereas user can use our app for free. So the cost of usage is zero.
- Existing app is not available for latest version of android whereas our app is available.
- Our UI is more children friendly in comparison.

XIII. FUTURE SCOPE

The potential of augmented reality technology in teaching is still being investigated. As augmented reality interfaces provide seamless communication between the physical and digital worlds, educators and researchers should collaborate to determine how best to apply these features in the educational setting. This programme can be expanded in the

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