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Enhanced Cognitive Learning with Augmented Reality: An Application for Interactive Learning (ARLearn)

Deepti Patole
Department of Information Technology
K. J. Somaiya College of Engineering
Mumbai, India
deeptipatole@somaiya.edu

Sunayana Jadhav
Department of Information Technology
K. J. Somaiya College of Engineering
Mumbai, India
sunayanavj@somaiya.edu

Kunal Shah
Department of Information Technology
K. J. Somaiya College of Engineering
Mumbai, India
kunal29@somaiya.edu

Pushkar Tambe
Department of Information Technology
K. J. Somaiya College of Engineering
Mumbai, India
pushkar.tambe@somaiya.edu

Manan Doshi
Department of Information Technology
K. J. Somaiya College of Engineering
Mumbai, India
manan.rd@somaiya.edu

Suyash Srivastava
Department of Information Technology
K. J. Somaiya College of Engineering
Mumbai, India
suyash15@somaiya.edu

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***Abstract*— Experiential learning has gained importance lately in academics. Educators are facilitating Learning by Doing in classrooms. But this may not be possible in many circumstances, especially for schools in remote areas with limited resources. This proposed work is about a technology to bridge this gap and help educators. There is a need for making the learning process interactive for kids of primary and pre-primary section in order to build fundamental abilities of reading and understanding their surroundings. ARLearn bridges a paperback book with AR Technology. The AR Technology is designed to make the book content become alive in 3D over any simple smartphone with an interactive storyline. This helps kids to enjoy the learning process. ARLearn (Augmented Reality Learning Book) illustrates the evolution of a new notion of virtual interpretation of classic textbooks and audio-visual information in learners native language. The goal of this application is to help in developing reading habits in kids at an early age by facilitating them to understand the content of books in their own language as well as in English. It is suggested that kids at an early age have a very powerful imagination. Books, where they get accompanying technology to help in understanding, could be the solution that helps the kids to flourish their thinking skills. Using augmented reality technology, which incorporates new technological approaches, allows the user to experience the book content while enjoying and interacting with the information, enhancing the cognitive learning experience.**

Keywords*— *interactive book, instructional learning, mobile technology, augmented reality, enhanced cognitive learning

I. INTRODUCTION

The significance of technology for communication and information and its steady pace of development, in addition to the effects of incorporating such advances into the routine activities of individuals, businesses, and other types of organizations, are all factors that can affect the cognitive resources of a particular society. These alterations call for an increased capacity for learning, as well as invention or creativity, which are essential for gaining access to the actual parameters of knowledge and data.

The virtual representation of the actual world might provide many views and perspectives. Without multimedia, teaching, and learning would be unproductive or, at the least, uninteresting.

This paper shows the results of previous research, as well as the creation and validation of a product called ARLearn. It is based on the idea of augmented reality functionalities, and it proposes a new tool that could improve how well kids learn.

II. LITERATURE REVIEW

Gardner [1] is one of many authors that advocate for more learner-centered models. He purely unveils a different approach to determining and assessing human intelligence, and he proposes that humankind have a broad "intelligence" scope, which is then implemented into a variety of forces or talents. The criteria that are formed to determine the abilities that are typically considered to be intelligence are talents and forces. Gardner analyzed and classified a total of eight distinct "intelligence forces," which are as follows:

1. Verbal and linguistic abilities, including the capacity to read, write, and communicate verbally;
2. Logical and mathematical: capabilities utilized for use in reasoning and calculating;
3. Geographic: having an understanding of spatial relations, form, and color;
4. Sensitivity to sound, tone, as well as rhythm in musical performance;
5. Body and kinesics (the research of body position, stance, movement, and body language in connection to communication): both of these disciplines are related to an adequate understanding of movement and body control;
6. Interpersonal: the capacity to socialize, work together, and comprehend other people;
7. Intrapersonal: the capability of introspective reflection and the management of one's sentiments and actions;
8. An inherent connection with the natural world and its inhabitants, as well as the ability to comprehend how it all works.;

Taking into account how advanced technology has evolved, the fact that most educational systems are still based on

lectures could be a problem. Most schools aren't ready for new educational experiences yet. This is sometimes because they don't have enough money (which is usually unaffordable) or enough teachers, and sometimes because they don't know where to find the right learning materials. After 6 years of investigating information retrieval in collaborative learning and pure e-learning, Henrich and Sieber [2] recently showed that the creation, use, and maintenance of courses are key to the success of technology-enhanced learning approaches.

Augmented reality (AR) is a subfield of computer science that combines elements of computer graphics in three dimensions, computer vision, and human-computer interaction to create a new kind of reality in which computer-generated graphics are superimposed over the live-action video.

Azuma [3] identifies the following as necessary components of AR: blends the physical and digital worlds, allows for real-time interaction, and can track 3D objects in the actual world.

Recent developments in Augmented Reality have been made in the fields of medical visualization, information, sports, entertainment, and business. One area where augmented reality has found use is in medical imaging. During the past few decades, AR has provided doctors with a wealth of anatomical and functional information that is unique to each individual patient. New possibilities for visualization and interaction are explored, and augmented reality (AR) is suggested as a framework to facilitate their realization. A paper by Sielhorst [4] explains how augmented reality technology improves surgical workflow, or how the benefits of 3D user interfaces become clear while completing activities that are difficult to simplify into 2D.

The potential of augmented reality (AR) tools with an educational focus have not been fully realized until recently. According to authors SAMRI, Ferdinandus [5], It is required to have the local wisdom incorporated in material which supports the education of primary students. The electronic material needs to be designed by considering the fact that each learner shall be experiencing the books or material made available in different manner. The animation included in study material helps in engaging the attention of learners. Through using AR technology displays, readers can look at a single book and experience the story with 3D virtual models, as demonstrated in the "MagicBook" (Billinghurst, [6]. Images of "real books" with text and images on each page are used as the basis for MagicBook's user interface. An object recognition head-tracking system makes use of the images' broad black borders as markers.

An innovative method for real-time tracking of scale-, rotation-, and luminance-invariant natural features was presented by Bastos and Dias [7]. The recent development in Education policy [8][9] is focusing more on inclusiveness of all the population irrespective of Lingual variety, It has been proven that the education given in interactive, Learner centric manner helps in building a strong foundation of our education system. In the ASER Report [10] it has been identified that the skill development of rural area or government grade 1 school children is of concern as they lag behind in language skills as well as numeracy skills as compared to private and urban area students. This lag further broadens as the initial years of education are crucial for each child. The use of technology to bridge this gap can be a necessary step to enhance the skills of less privileged students with limited resources available. In the sphere of augmented reality, the authors [11] present fully automated solutions for the problems of camera posture initialization registration and tracking. This means that books can once again have their natural, conventional look with regard to images without the necessity for black borders to serve as tracking marks. The use of Augmented Reality for making the learning experience interesting is proposed by authors in their work [12][13]. This method has been implemented as a core technology in the ARLearn framework, and it may be used in situations when multiple flat objects with different morphologies and natural materials are present at once.

This recent development has opened up new doors for improved teaching materials. Yet, the real difficulty lies in developing the necessary business models for this innovation to be recognized by the market and making it a standard in the field of augmented and mobile learning.

III. EXISTING STSTEMS

The HoloKitab[14] 3D ABC Textbook is an interactive 3D alphabet book created specifically for children. It is both a book and a smartphone application for teaching Nursery toddlers about the alphabet through the use of augmented reality (AR). A single alphabet is shown on each page of the book. When the children scan a page from the book, the object that is located on that page will be recreated in augmented reality (AR), and there will be some voiceover.

First, of its kind, the Genions[15] powered by Augmented Reality (AR) early learning program is designed for children aged 3 and up and those aged 6 and up. This program of immersive and interactive learning was established by child development and pedagogy specialists, and it is based on the curriculum that is followed in India. The Genions Augmented Reality Learning App will be helpful since it will provide a real-life experience in addition to an interactive learning environment, in which students will be able to actively participate in the courses regardless of where they are located physically. Additionally, it will bring to life abstract and challenging curricular topics, which will make the material much simpler to learn and easier to remember. Launch the GENIONS Augmented Reality App, and position the SMART PAD so that it is facing the camera. The optimum augmented reality experience can thus be had by holding the mobile device or tablet in a horizontal position. Also, check to see that there are adequate light sources in the area (this will allow the camera to read the SMART PAD). If there is insufficient illumination, the camera won't be able to scan the SMART PAD and display the augmented reality object.

MicroWorld[16] is an augmented reality teaching tool for Arabic.The purpose of this resource is to provide Arabic-speaking students in junior high school with a better understanding of the chemical elements that are found in the periodic table. The MicroWorld mobile app includes all of the following features as standard:

- Arabic-language user interfaces.

- Photographs depicting each atomic element in its whole, solid state.
- Models consisting of all three dimensions.

In addition, there are three-dimensional models of chemical element atoms and the uses of those atoms in everyday life that can be used to assist students in visualizing the spatial representations of the atoms and remembering their atomic numbers. In addition, MicroWorld makes use of the camera on the user's smartphone in order to identify a marker that is present in the scene. In addition to this, the application shows a three-dimensional (3D) representation of the chemical complex if it is able to identify two of the components that are necessary to construct the molecule.
Students in junior high school and professors of chemistry evaluated the usability of MicroWorld using the Arabic system usability scale. This application underwent unit testing to validate that it delivers the expected results, and the results were positive for all of the situations that were examined. The authors believe that the MicroWorld app has the potential to be a useful tool that may assist in the education of both students and teachers.

The focus of the Kindergarten Digital Storytelling (KiDS) material, which is a sort of multimedia, is on the children's ability to listen to and understand spoken language. The research comes to the conclusion that digital storytelling is an important tool, and that utilizing such content is advised for efficient language learning and the improvement of language skills. Children are more likely to be motivated to learn if they have a suitable storyline.

Multimedia Book is a representation of the development of a novel idea for the virtual interpretation of conventional text books and audio-visual information. Using AR technology allows the final user to experience a range of sensorial sensations while enjoying and interacting with the information, which in turn enhances the learning process. This is made possible by incorporating new technological approaches, which are utilized by AR technology.

IV. Proposed Ststems

Augmented Reality Learning (ARLearn) is a cutting-edge program that facilitates adaptive learning in an interactive setting and adapts to various content formats. It has the potential to be a useful tool for enhancing learning (either individually or in the classroom) and a major advance in the development of digital libraries. Students will be able to take their education to the next level by utilizing a wide variety of interactive instructional materials that can be used in and out of the classroom.

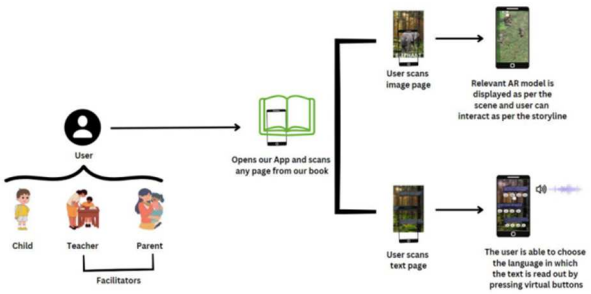

Fig.1. System outline of ARLearn

Fig 1. illustrates the overall system outline of ARlearn. ARLearm is a mobile application and a book targeted towards 5 - 8 year old children. The book will have images and text and the children can use our application to see the AR models of the images of animals, birds, or other things which will help them to understand concepts better. We also plan to add animations, sound and other features to the models. They can even scan the text and listen to the text being read out to them by the app in multiple languages like English or their mother tongue. We also plan to add other activities and games for the kids. This proposed system will make learning and reading more interactive, fun and effective. It will also develop the artistic, spatial, natural and linguistic intelligence of the child. This will be a mobile application which can be installed on any smartphone. The application will be used by small children, their parents and teachers.

System Interface Description :-

- The system will be a mobile application and it can operate well on any smartphone.
- The application will have a seamless front end design so that the users can access the functionalities without any technical problems.
- The user can watch a demonstration video to understand how to use the book and application.
- Using the camera from the application the user can scan different pages of our book.
- The application will detect the page of the book and will display mapped AR models /components accordingly.
- Different animation option buttons and language option buttons for text will also be displayed as per the page of the book.

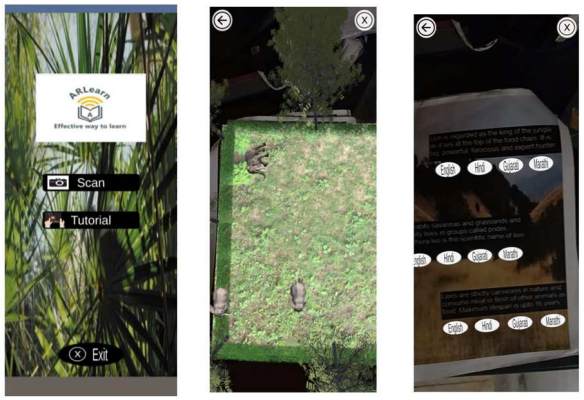

Fig.2. Landing Page, Camera (Images) and Camera (Text)

Above snippets illustrated in Fig 2 are about the Objects and Actions as designed in the application

1. Landing page: It is the landing page from where users can see different options of navigation. The user can go to the demonstration video or open camera for scanning or exit the application.

2. Camera (Images): When a user scans a target page containing an image using the camera, the corresponding AR model and components get displayed along with the virtual buttons for animations.
3. Camera (Text): When a user scans a target page containing text using the camera, the virtual buttons appear giving the option for the user to listen to the text being read out in a specific language.

V. Results and Discussion

We researched and collected factual information and images about 3 animals - elephant, lion and crocodile by referring to children's academic and other educational material, research papers and articles and the web. Using this, we designed a book which contains animal images and informational text using Photopea. These pages of the book were uploaded to Vuforia which added markers on all the images so that they could be used as target images for our AR based mobile application. Then using the facts, we wrote small story scripts for each animal. Relevant 3D models and animations were used from blender and interactive scenes were created using them and the target image database from Vuforia as per the story scripts. C# scripts were used to animate the 3D models and provide interactivity to the scenes. For the text part we translated the text into English, Hindi, Marathi and Gujarati languages and these audios were added to Unity. Using Unity we integrated everything and developed a mobile application called ARLearn directed towards kindergarten and pre-primary level kids to make them learn about animals in a fun and experiential way using AR technology. The kids can even learn in the language that they are comfortable in like their mother tongue for better understanding of the concepts.

In the future, Relevant features and functionalities can be added to the proposed system. Similar applications can be made for the children's textbooks of various subjects. Number of animals and languages can be increased. We can integrate hologram views to this technology for the better understanding of the user. We can add the quizzes in this application after each and every story to understand whether the child understood the concept or not and we can also integrate the scoreboard to the system.

VI. Conclusion

Education is one of the main factors of each child which that fundamentally affect the way he or she perceives the world. Augmented Reality brings innovative approaches to visual learning techniques. Hence, providing the learners with AR experiences with low cost tools in the classroom environment can help in enhancing comprehension skills keeping students' interest alive with its attention and engagement aspect. The National Education Policy (NEP) also makes a point that enjoyable and inspirational books for students which are assisted by technology will be developed including high quality translations into all local and Indian languages. This will develop a reading culture. Research also shows that education in the local languages i.e. mother tongue is a key factor for foundational Learning, and it also improves learning outcomes and academic performance. As mentioned in the National Council of Educational Research and Training (NCERT) learning outcomes for grade 1, the children should be able to identify and read words and simple sentences (NCERT, 2017). As per ASER (Annual Status of Education Report[10]), 21% children in grade 1 of government schools are able to read words where as 46.7% children in private schools are capable of reading the words. By introducing ARLearn which can help and boost the learning experience of children irrespective of their surroundings and opportunities with the help of simple smartphones and books, the learners will be able to connect with books and reading in a much more lucid way, which is the need of today's young generation.

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