Augmented Reality Education Tool for Children with Learning Disabilities

Darsheeka Bipin Singh, Karan Shah, Sally Annice Peter, Snigdha Sahu, Mudit Kapoor

Abstract- **In this paper, we have discussed the basics of augmented reality, its functionality, its working and its application in the field of education for children with learning disabilities or special needs. Augmented reality provides a very interactive, vibrant and insightful aspect to traditional learning. It allows combining a myriad multimedia objects; such as, images, videos, audio files and three dimensional object models. To further understand its objective, we have also explained the multiple learning disabilities and how this education tool serves as a better education tool. Depending on the type of learning disability, different kids have different educational requirements. Some disabilities cause them to have a range of emotional responses based on application components like colors and the interaction interface, etc. Therefore, special consideration has to be given to the design and interface of educational tools targeted at these children. Special focus is laid on its performance ability and current status of technology oriented education tool in India. We have verified this by creating a prototype education tool as per the needs of two educational organizations in Mumbai and testing the tool in an experimental class to analyze the impact and limitations. Our education tool comprehensively addresses the diverse range of factors that need to be kept in mind while designing educational applications for children with the specific learning disabilities. In this paper, we explain the specific components of our application using which we have achieved the totality required for an education tool that deals with an especially sensitive class of students.**

***Index Terms*- Augmented reality, android mobile application, children, education in India, image processing, learning disabilities, mobile education, multimedia teaching tools, object recognition**

I. INTRODUCTION TO AUGMENTED REALITY

Augmented reality (AR) is live immediate or roundabout perspectives of a physical, genuine environment whose components are increased (or supplemented) by PC produced tangible enter, for example, sound, feature, representation or GPS information. It is identified with a more general idea called intervened reality, in which a perspective of the truth is adjusted (perhaps even decreased as opposed to expanded), by a PC. Therefore, the innovation capacities by upgrading one's present view of reality.

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By differentiation, virtual reality replaces this present reality with a reenacted one. Enlargement is ordinarily continuously and in semantic connection with natural components, for example, games scores on TV amid a match. With the assistance of cutting edge augmented reality innovation (e.g. including PC vision and item distinguishing) the data about the encompassing true of the client gets to be intuitive and digitally manipulative. Simulated data about nature and its protests can be overlaid on this present reality.

II. INTRODUCTION TO LEARNING DISABILITY AND CHILD DEVELOPMENT

An issue in one or a greater amount of the fundamental mental procedures included in understanding or in utilizing dialect, talked or composed, that may show itself in the blemished capacity to tune in, think, talk, read, compose, spell, or to do numerical estimations.

In India 1.67% of the 0-19 population has a disability. 35.29% of all people living with disabilities are children. Other estimates say that India has 12 million children living with disabilities. Only 1% of children with disabilities have access to school [3].

Training for the individuals with incapacities/uncommon needs has not been profoundly offered thought in developing nations like India and is likewise joined by monetary issues and asset supports to advance instruction and giving a possibility of work to them. In spite of the fact that US has discovered innovation propelled instruction help to help add to an educational module, Indian schools do not have this preference and advancement.

Turning into a capable independent citizen is crucial for conforming to grown-up life, yet numerous grown-ups with learning inabilities (LD) rank taking care of cash and keeping money as the most troublesome among the issues they experience. Issues here are regularly fixed to particular attributes of LD or attention deficit/hyperactivity disorder (AD/HD) and other extraordinary needs like Speech or Language Impairment (SLI) correspondence issue, for example, faltering, impeded explanation, a dialect impedance, or a voice debilitation that unfavorably influences a tyke's instructive execution and Specific Learning Disability (SLD).

The accompanying are so a percentage of the numerous ailment and incapacities confronted by youngsters that can be bolstered with legitimate training frameworks.

The following are so some of the many illness and disabilities faced by children that can be supported with proper education systems, as studied at our associated schools mentioned later in the paper [4] –

A. *Autism (AU*) - A formative incapacity altogether influencing verbal and nonverbal correspondence and social connection, for the most part present before age three that unfavorably influences a kid's instructive execution. Different qualities regularly connected with extreme introvert characteristics are taking part in tedious exercises and stereotyped developments, imperviousness to ecological change or change in day by day schedules, and abnormal reactions to tangible encounters.

B. *Developmental Delay (DD)* - As characterized by every State, implies a deferral in one or a greater amount of the accompanying ranges: Physical advancement, cognitive (discernment) improvement, correspondence, social or enthusiastic advancement, or versatile (day by day living abilities) improvement.

C. *Emotional Disturbance (ED)* - A condition showing one or a greater amount of the accompanying qualities more than a drawn out stretch of time and to a checked degree that unfavorably influences a kid's instructive execution:
A powerlessness to discover that can't be clarified by educated, tangible, or wellbeing components.
A powerlessness to manufacture or keep up agreeable interpersonal associations with associates (different understudies) and educators.

D. *Multiple Disabilities (MD)* - Simultaneous (happening in the meantime) weaknesses, (for example, scholarly inability lack of sight, intelligent handicap orthopedic hindrance, and so forth.), the mix of which causes such extreme instructive needs that they can't be served in a custom curriculum program exclusively for one of the debilitations. The term does exclude hard of hearing sightlessness.

E. *Specific Learning Disability (SLD)* - An issue in one or a greater amount of the essential mental courses of action included in understanding or in utilizing dialect, talked or composed, that may show itself in the flawed capacity to tune in, think, talk, read, compose, spell, or to do numerical computations. The term incorporates such conditions as perceptual inabilities, mind damage, insignificant cerebrum brokenness, dyslexia, and formative aphasia. The term does exclude learning issues that are principally the aftereffect of visual, hearing, or engine incapacities; of learned handicap; of passionate unsettling influence; or of ecological, social, or monetary burden.

F. *Speech or Language Impairment (SLI)* - A correspondence issue, for example, faltering, disabled explanation, dialect impedance, or voice weakness that unfavorably influences a tyke's instructive execution

Research demonstrates that low instructive accomplishment, job desires and mistaking legislative projects for clashing qualification criteria have brought about numerous youngsters with incapacities not making effective moves from school to postsecondary instruction, vocation and independent living. While numerous might want to figure out how to spare cash and manufacture resources, they apprehension landing a position and sparing a share of their salary may make them lose their incapacity advantages and different backings, for example, medicinal services. One noteworthy hindrance that adds to this issue is the absence of useful math (ideas of time, cash, weights and measures, and so on.) abilities among this gathering. To add to this officially existing issue, there is the issue of English being the internationally acknowledged medium of composed and verbal correspondence in all available study material.

III. APPLICATION OF AUGMENTED REALITY IN EDUCATION

Augmented reality applications can complement a standard curriculum. Text, graphics, video and audio can be superimposed into a student's real time environment. Textbooks, flashcards and other educational reading material can contain embedded "markers" that, when scanned by an augmented reality device, produce supplementary information to the student rendered in a multimedia format. Students can participate interactively with computer generated simulations of historical events, exploring and learning details of each significant area of the event site. On higher education, there are some applications that can be used. For instance, Construct3D, a Studiers tube system, allows students to learn mechanical engineering concepts, math or geometry. This is an active learning process in which students learn to learn with technology. Augmented reality can aid students in understanding chemistry by allowing them to visualize the spatial structure of a molecule and interact with a virtual model of it that appears, in a camera image, positioned at a marker held in their hand. It can also enable students of physiology to visualize different systems of the human body in three dimensions. Augmented reality technology also permits learning via remote collaboration, in which students and instructors not at the same physical location can share a common virtual learning environment populated by virtual objects and learning materials and interact with another within that setting.

This resource could also take of advantage in Primary School. Students learn through experiences, besides when children are so young, they need see to learn. For instance, they can learn new knowledge about Astronomy, which is usually difficult to acquire to them, with this device children can understand better The Solar System because they would see it in 3D; even children under 6 years old could understand it following that method. In addition, learners could change the pictures of their Science Book for using this resource. On the other hand to teach bones or organs, they could also stick one paper on their body and that paper contains an embedded "markers" about a bones or an organ that existed under the paper, and the teacher would only need to press a button when children would change the place of the paper, in this way, we would use the

same embedded "markers" in order to teach another part of the body.

Develop the value of the practical module implementation in schools and organizations. To provide the support required to develop a need based curriculum using technology to close the gap between societal problems for people with disabilities. Since learning seems to be the main cause of concern, technology can be used to develop innovative teaching programs that help in faster rate of learning, better memory and grasping power.

Augmented Reality proves its results for children with learning disabilities as it directly works on the different difficulties they face, from being shy to talk to humans, lack of attention span, need for multimedia visuals and environment for better grasping ability and easy memorizing ability. We have conducted and tested the results for the same further in this paper.

IV. CURRENT STATE OF AUGMENTED REALITY APPLICATION IN EDUCATION IN INDIA

Trimensions is a software development firm providing services on augmented reality [5]. Trimensions is into developing educational and learning systems using Augmented Reality, on the 3D Web as well as on popular virtual worlds like Second Life and platforms like OpenSim and Unity. However, their official website does not list any augmented reality application to provide education to either normal kids in pre-school and primary school or kids with learning disabilities. Same is the case with other software firms that have just begun their venture into augmented reality. Some Indian augmented reality applications which are built with a far-sighted educational perspective are not based on the Android platform. They are for desktops or laptops, etc. The rare educational applications using augmented reality which are based on the Android platform are expensive and do not have a comprehensive focus including considerations for kids with special needs; e.g., those suffering from learning disabilities.

In India, the fresh concept of augmented reality has just begun penetrating not only various old and new software companies but also educational institutions providing technical courses on computer technologies. Its main attraction for the developers is games, entertainment, language, geophysical mapping, etc. It will take time for it to reach the level of circularity it needs to address comprehensively the issues involved in providing education to all categories of kids. In our application, we have tried to inculcate this same comprehensiveness we speak of.

V. CURRENT TEACHING METHODS IN INDIA FOR CHILDREN WITH LEARNING DISABIILITIES

Augmented Reality has been used by a technology services enterprise in the US (Alive Studio Co) to create storybooks for kindergarten children, teaching basic number skills to preschoolers etc [1]. But so far, there is no recognized augmented reality tool used for education for children with learning disabilities. Certain technology tools such as EduComp Smart class has been used in certain schools it is a teacher-led educational content based solution that has dramatically improved learning outcomes in Private Schools [2]. It comprises of projector screens with digital curriculum content. Most schools for special children still stick to paper aid for teaching.

Currently Education is provided at a very basic schooling level in certain schools for people with disabilities. Finance education is ignored by most schools in India as an unnecessary subject, but its need grows with the development and empowerment of the country and its people. Augmented Reality technology to develop an android application on money management (Financial Literacy) specially designed for people with special needs (Learning Disabilities) would be a significant solution to an emerging fundamental learning disability subject. Augmented Reality helps address various learning disabilities helping the students learn. The concept of using augmented reality – 3D Modeling- Audio Video and Images, helps generate a greater engaging time span with the students using a highly cost-effective project.

VI. WORKING OF ARET

Our project comprises of a simple Smartphone holder, a table to rest the books/flashcards and board games, a cable connecting the phone to the projected screen and speakers for audio output. Through the project, the teacher is able to read 3D books, play interactive games and flashcard pop-up quiz with the class. The ability to impact the sense of sight and hearing triggers a vital enhancement in the education level for the children as proved by research. This mobile kit can be used anywhere without large resource or material requirements. Our application has 3 major modules – alphabets, numbers and shapes each witth audio, video and 3D models.

We created a prototype, called Augmented Reality Education Tool (ARET) to test the concept of augmented reality and analyze its impact, outcome and limitations. It makes the use of Vuforia SDK developed by Qualcomm Connected Experiences, Inc. [7] Using the SDK along with Unity 3D [8], we created Augmented Reality applications.

Using Vuforia SDK, we created flash cards with tracking points. These tracking points help the application to identify the correct alphabet or the number and augment the corresponding objects. These tracking points are unique to each flash card. The more the tracking points, the better the application can track it. These tracking points are calculated based on the difference between the neighboring pixels. If the

selected pixel has a higher intensity than a predefined threshold after comparing it to the neighboring pixels, that

Fig. 1 Alphabet Flashcards used in ARET

pixel is selected as a tracking point. The points are also calculated along the edges of any point by again calculating the pixel intensities along the edge.

After calculating unique points for each flash card, the files are imported to Unity 3D for further processing. Along with the files from Vuforia, we also import 3D models that were modeled in different modelling softwares, the audio files and the video files that are needed in the application. We provide the behaviors of each element like the virtual buttons, audio, video and the 3D models by writing code for each event. After adding the behaviors for each event, we build the application using the Android SDK and get the apk file. This apk file is used to run the application on the mobile device.

The ARET application consists of 3 modules:

- Alphabets
- Numbers
- Shapes

Each of which uses different functionalities of augmented reality. The multimedia data in each comprises of:

- Text
- Audio
- Video
- Image
- 3D Models

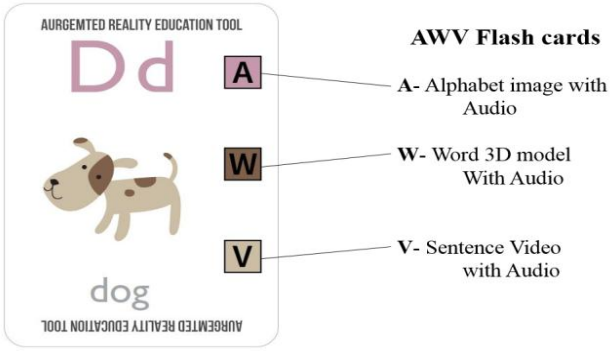

Fig. 2 (a) Virtual Buttons in alphabet flashcard

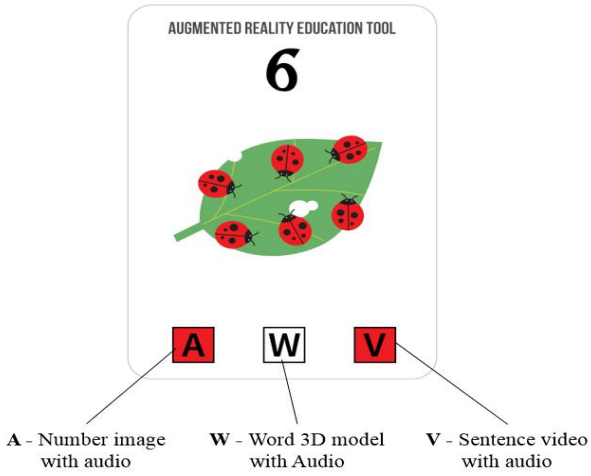

Fig. 2 (b) Virtual Buttons in number flashcard

All modules are interactive, as the AWV buttons can be touched to display the data stores, the card can be rotated to view different angles of the object; in the case of shape cards, the output answer text is shown on the card space below.

Fig. 3 (a) Demo run of Shape Circle with text displayed in box

Fig. 3 (b) Demo run of number 1

Fig. 3 (c) Demo run of alphabet C

VII. SURVEY AND ANALYSIS

We have associated with CHILDReach school, Mother Foundation and community centres of Aastha Parivaar for our project [6].

CHILDReach is an NGO school for students with learning difficulties that range from dyslexia, behavioral problems and ADHD. CHILDReach set up a program for children with learning difficulties in Santacruz (West), Mumbai in 1999. It advocates appropriate education for the students with learning difficulties and slow learners. CHILDReach caters to children in the age group of 6 to18 years. It has an ideal student-teacher ratio of 8:1 that ensures a lot of personal support. Currently, over 60 students from a cross section of society study at CHILDReach.

Mother foundation is a boys' orphanage currently Located in Malad (West). It houses approximately 50 boys of different age groups ranging from 3 to 16 years of age and the boys attend a local Hindi medium school.

Below are the details of the survey we conducted in our associated centres –

Current Education level: Kindergarten
Current education Language: Hindi and English (secondary)
Medium of education (tools/teaching aid used): Speaking, writing, boards, stories
Current English language level: Extremely basic (few words and numbers only)

Words taught using ARET: 10 words – Apple, Cat, Dog, Goose, Hat, Kite, Lion, Mouse, Orange and Queen

Total time of teaching words with and without ARET each: 30 minutes and 20 minutes respectively

Quantitative results:

Table. I Education Efficiency

% of words learnt	Education Efficiency	
	Age <= 3	3 < Age < 6
Verbal Teaching	60	60
Using ARET	80	90

Table. II Level of Development

% of Children who learnt the words	Level of Development	
	Age <= 3	3 < Age < 6
Verbal Teaching	63.64	54.55
Using ARET	100	90.91

Qualitative results:

Table. III Level of Interest

Rating (%)	Level of Interest	
	Age <= 3	3 < Age < 6
Verbal Teaching	90	60
Using ARET	100	80

Table. IV Pronunciation

Rating (%)	Pronunciation/ Diction	
	Age < 3	3 < Age < 6
Verbal Teaching	60	60
Using ARET	80	80

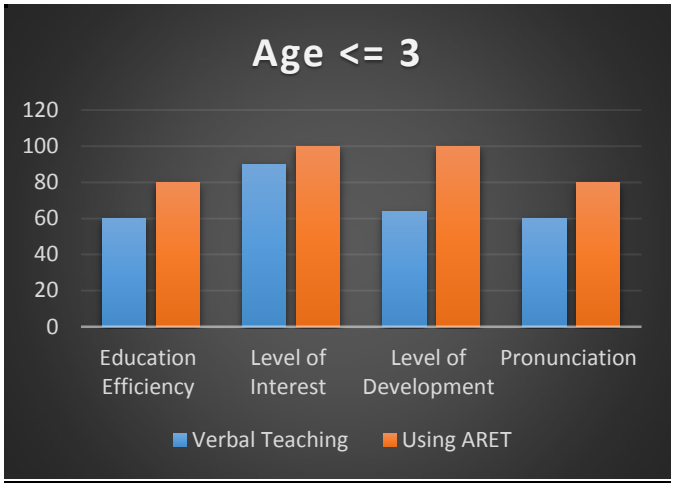

Fig. 4 Performance of children aged less than 3

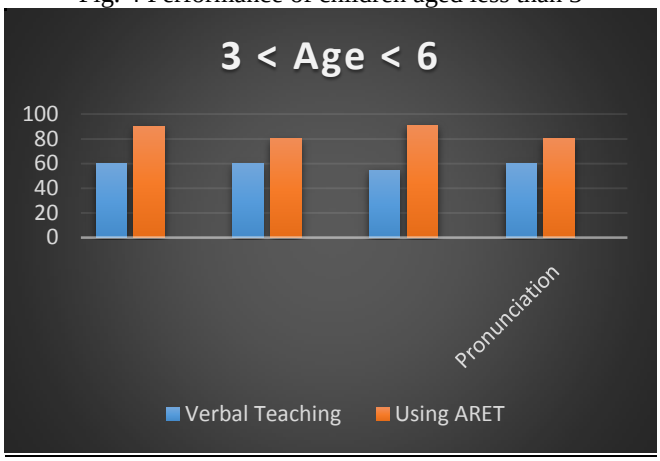

Fig. 5 Performance of children aged above 3

Survey Conclusion:

- Age group with most interest in using ARET: Age<=3
- Age group that learnt most no. of words: 3<Age<6
- Age group that most benefited from it: Age<=3
- Overall improvement in pronunciation (Rating UA/VT): 33%
- Overall improvement in learning efficiency (Rating UA/VT): 41.7%
- Overall improvement in interest in education (Rating UA/VT): 16.7%

VIII. LIMITATIONS AND FUTURE SCOPE

Although, we have come a long way through our endeavor at providing a comprehensive approach to educating kids using augmented reality in India, the idea is novel. Hence, there is a long road ahead of us to try and polish our application into one that is at a universally accepted quality standard. ARET, for now, is a basic toolkit limited to letters, numbers and shapes. There are myriad components, both software and hardware, that can be added to our application in the future. We can extend the letters to a proper language module, the numbers to a mathematics module, and so on.

Project ARET, in the future, also aims to overcome the limitation of being inflexible. We hope to make the application increasingly customizable and interactive. We can add games and quizzes, 3D videos, stories, evaluation tools, augmented reality spaces within the application, etc.

A key factor for the creation of Project ARET was affordability; therefore, arising compromises because of that also need to be addressed. We have to aim to provide a high quality application at a low price so that every person in every nook and cranny can use it. In comparison to the augmented reality product for children in USA, ARET costs $1/60^{th}$ the price.

We also have a lot of concerns regarding optimization of the application's performance parameters, i.e. processor usage, memory space required, response time, camera sensitivity, effect of light, and heat generation.

In the future, we hope to make ARET one of the best choices for teaching kids using augmented reality, especially those with learning disabilities. For this purpose, we will collect more sample data and conduct a pilot study on other social, mental and behavioral patterns we need to incorporate in our algorithms so ARET is closer to classroom standards for all categories of kids.

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