VIRTUAL REALITY BASED ANDROID APPLICATION FOR SPECIAL CHILDREN

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ABSTRACT: Dyscalculia is a hidden neurological disorder in which a child feels difficulty while learning mathematics. Several Virtual reality based applications for cognitive learning for a special group of users have been developed and effectively used to learn complex concepts of various subjects. In our proposed virtual reality android based application we try to combat the issues of dyscalculia children to learn and understand basic of the place value of digits and basic mathematical operations in an effective and immersive interactive environment of Virtual reality based class room. To do so we provide a virtual interactive class room environment based to two rooms through which a child can learn by using head mounted device. In first room a child can moved through class room walls and learn to place value basic concepts by audio sound and interactive effects that have been displayed when a child moved any wall or stay there to learn. In the second room child can learn world problem of addition subtraction and division by just moving through class room walls. The concept of learning through VR based class room walls based on traditional wall charts. We use Virtual class room interactive walls for learning. Moreover, rapid projection of digital technologies showed that interactivity is a key to more significant tools in virtual reality based environment and gaining more attention in learning complex concepts in education.

KEY WORDS: *Virtual reality, camera, real-world, virtual-world*

1. INTRODUCTION

Dyscalculia is one of the hidden disabilities and classified as a child with mathematical learning difficulties (Landerl et al., 2009). A child with dyscalculia faces difficulties in numerous mathematical operations and their severity of disability is dependent on the mental model of the child (Vasconcelos de Castro et al., 2014). Children with dyscalculia lack motivation in counting numbers and performing mathematical equations at early age that affects their academic career because counting numbers and things is an essential part of everyday life (Dehaene, 2011). Children with dyscalculia are not weak and dull but their brain processes in different ways so they feel difficulties with numbers (JP, 2008). Educational methodologies that have been observed for decades for mathematical learning based on manual cognitive activities research revealed that educationalist believes that computer and mobile based serious games provide an immersive change in children's learning (JP, 2008). Interactive games promote participation

and challenges in activities to learn while playing games (Teacher education and special education, n.d.). Computer assistive technologies are great tools of learning for children like virtual reality/augmented reality are great tools for interactive learning in the world full of latest digital age trends (Maqableh & Sidhu, 2010). Virtual reality can overlay real-world with a virtually created environment for its user, for more interactive and interesting as well as challenging environment for learning (Vasconcelos de Castro et al., 2014).

Research revealed that numerous Virtual Reality (VR) based applications are used for cognitive learning for special needs children and sophisticated results encouraged us to pursue that research in the field of VR based mobile application for children with dyscalculia. In this VR application, we try to address an issue that a child face when learning basic concept of place value.

2. LITERATURE REVIEW

Research reveals that in this digital age, traditional learning is looking for new ways to teaching especially for special needs children where they can learn in interactive environment and potentially meet the specified pedagogy of learning such technological tools which involve augmented reality objects and virtual reality environment (Chapter et al., 2019). Assistive technology tools and application are encouraged to be used for neurological disorder pupils for their better understanding of real life system and interaction with latest technology that can encouraged them to be more motivated, act like normal person, and help them to remove the anxiety of their disability (Edyburn, 2000). Research shows that a number of applications were developed to combat the issue of language based learning disorder like dyscalculia (Vasconcelos de Castro et al., 2014; Maria et al., 1997; Yuen, Yaoyuneyong & Johnson, 2011). As children are an important group in software industry cognitive application design and development, it is a challenge for developer to develop a system for a special group of users according to the age and mental model of that group (Holzinger et al., 2005). Numerous mobile applications have been developed as assistive learning tools for language based learning disorder like Dyscalculia, and results and evaluation showed that their effectiveness and improvement in the field of cognitive learning (Vasconcelos de Castro et al., 2014) encouraged us to develop a system that helps a child to learn the concept of place value in mathematics. Few applications that have been developed in the field of virtual reality for the children suffering with dyscalculia are mentioned in Table 1.

Table 1: Literature review

Studies	Area Of Studies
Narrative-based, Immersive, collaborative environment(N.I.C.E) (Maria et al., 1997)	N.I.C.E based on VR learning for children aged 6 to 10 to learn biological concepts with interactive VR medium. A child can learn and explore a garden with head mounted display while a talking signpost can help to interact and explore that virtual space to explore virtual garden to learn different biological concepts.
Dynamic Geometry education (Kaufmann, 2006)	In the research, they summarized their development in the area of 3D geometry design and ability of VR and AR in the pedagogy of

	learning through low cost VR system by creating a 3D easy to learn and explore geometry application.
Physics education book (Dünser et al., 2012)	In this, physics education book was used to overlay the virtual graphics over text book to learn complex electromagnetism concepts using augmented reality.
Guitar Learning with AR (Liarokapis, 2005)	Augmented reality scenarios for guitar learning summed up the design of a prototype for basics of music learning for beginners. In this research, they combined visual and auditory information to learn and explore music with AR so the learner can feel more comfortable and experience a unique learning space with AR.
VR app for Dyscalculia (Vasconcelos de Castro et al., 2014)	This study was based on the comparison of different VR game and their effectiveness for dyscalculia.
VR app for teachers (Passig, 2008)	This research was based on VR environment for teachers to understand how neurological disorder like dyslexia is identified.

3. METHODOLOGY

We design the virtual class room based on two rooms embedded with mathematical learning tasks in a virtual reality environment. We chose to learn basic digits and numbers placement in mathematics for the students having dyscalculia from grade one to grade five. To do so, we chose the concept of traditional class room chart technique “Learn basic concepts through the class room walls”. The interactive simulated class room walls used a physical simulation of placing value concepts for children, as they moved through them they learn the specified concept.

In this proposed prototype of VR based learning for children with dyscalculia, we try to explore the architecture which is based on a layered model of physical simulation, game development software, Google VR, and user. The methodology behind VR based application that encompasses between these layers is shown in Fig. 1 and described below.

3.1. Physical Simulation

Physical simulation represents creation of 3D based environment for immersive user experience that displays an overlay of real-world with virtual 3D environment and can be experienced with virtual reality based camera.

3.2. Game Development Software

Game development software is used to integrate the environment or physical simulation of 3D VR with user controls to enhance interactivity done with the help of software application and Unity is one of them.

3.3. Google Virtual Reality

Google Virtual reality layer represents Goggle API for VR through which the designed physical simulation can be integrated with users control and interactivities through required modalities and Google API used to overlay that environment in realistic visual simulation for user experience.

3.4. User

User represented here with 3D gadgets to experience that VR world of immersive simulation with different devices like head mounted VR or camera etc.

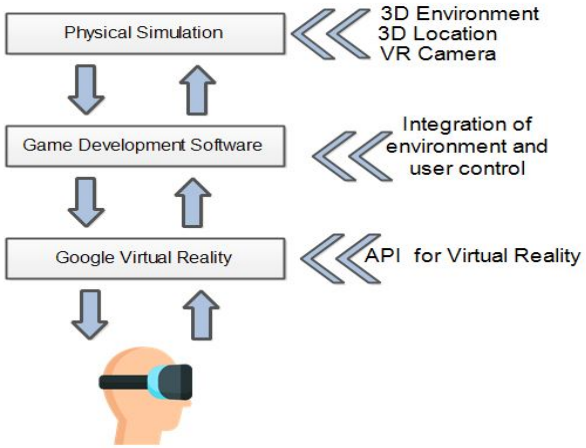

Fig. 1. System architecture for VR based App

In our proposed prototype of place value learning app for children with dyscalculia, 3D environment design and its location of class rooms with walls mounted with place value learning elements were designed as physical simulation. After that, this 3D simulation used as integration with game development software for interactive user controls and immersive view for users was created in Unity gaming software as shown in Fig. 2.

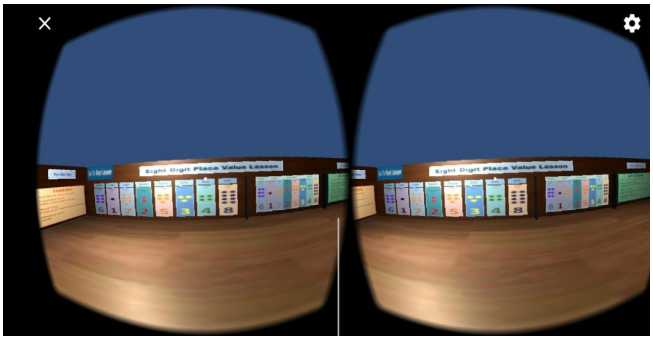

Fig. 2. VR based place value class room

In the end, a virtually created simulation can be seen in a virtual environment with Google API by the user using a head-mounted device.

4. RESULTS AND DISCUSSIONS

Exhaustive research revealed that numerous VR based mobile applications for cognitive learning have been developed previously. It is hard to cover the whole courseware in a mobile application. In this VR based class room, each wall is used to learn basic concept of place value for the children suffering with dyscalculia. When a user interacts with these VR based class room walls, they can learn place value of three digits number up to eight digits number and additionally he/she can hear the audio sound to teach them the concept of place value with different digits. Figures 3,4,5,6 and 7 show that VR based environment clearly.

Interactivity is a key to success for immersive VR based environment where a child can learn by listing sound and physical simulation of numbers while moving towards the class room walls. Changing colors and effects of numbers can increase more interactivity, and appeal children to stay and learn basic concepts.

This research was based on the pilot study; initially we used 10 participants' children to observe the interactivity of the system. To do so, we conducted an initial experiment in which we chose one participant at a time and average time spent by each child is 20 minutes. Experimental evaluation was based on verbal interviews and observations of children feedback regarding VR based applications. Outcomes showed that the factor of interactive learning in VR based class room helped them a lot to learn in immersive environment and improve their skills. Curiosity of learning increased when we use different activities to learn basic skills. It was observed that a child needs no effort to remember complex problems that have been learnt by playing or interacting in the learning environments especially if they have difficulty in learning (Dünser et al., 2012). Therefore, introducing different activities to learn basic concepts through multimedia tools is a sustainable tool for cognitive learning.

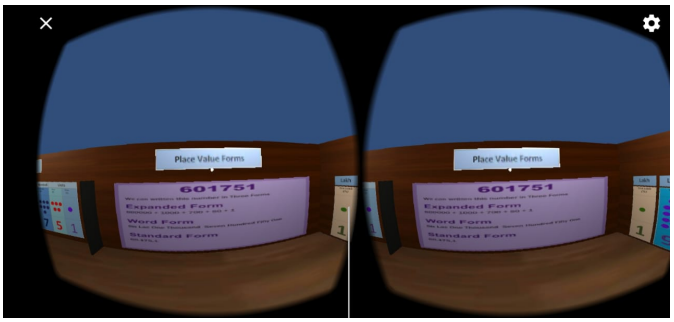

Fig. 3. Three-digit place value

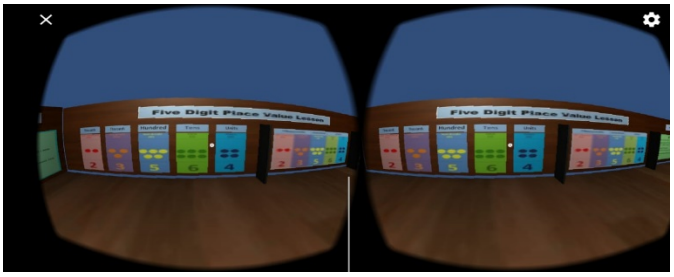

Fig. 4. Five-digit place value

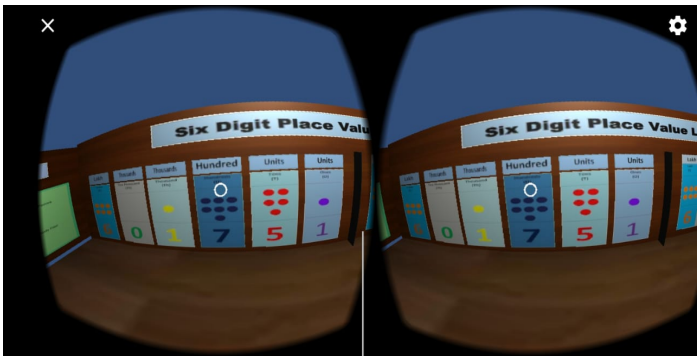

Fig. 5. Six-digit place value

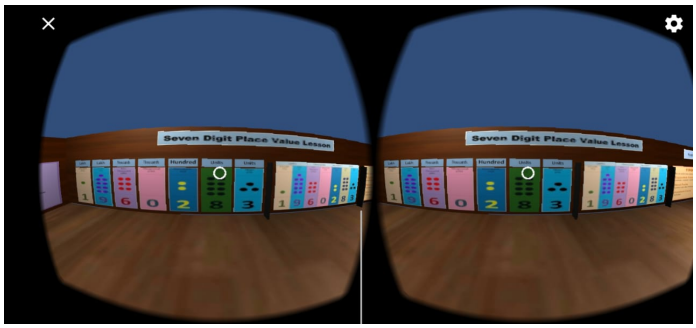

Fig. 6. Seven-digit place value

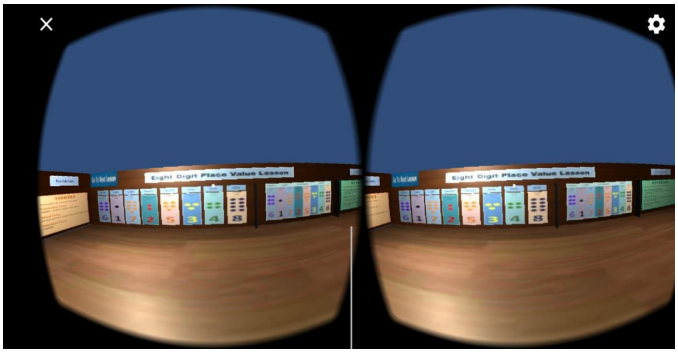

Fig. 7. Eight-digit place value

4.1 World problem

A second VR based room was designed in which a child can learn Word Problems of Addition, Subtraction, Multiplication and Division. Our future work is to add more lessons of Grade 5 countdown book of mathematics as shown in Figures 8 and 9.

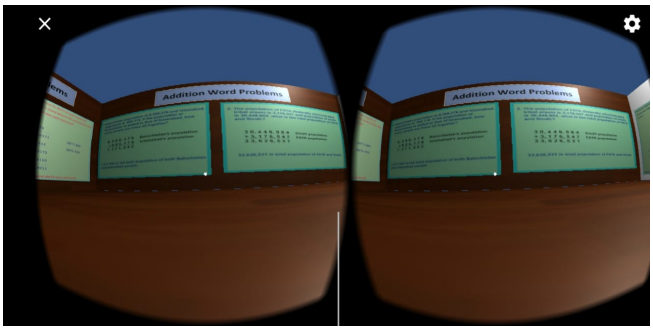

Fig. 8: word problem

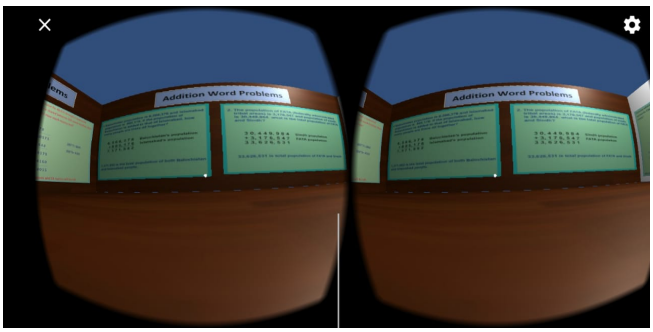

Fig. 9: world problem

5. CONCLUSION

In this research our aim is to develop an Android Application using Virtual Reality Technology for Grade 5 Dyscalculia children. This application helps Dyscalculia children to learn and understand conceptual lessons of mathematics such as place value of big numbers and word problems of addition, subtraction, multiplication and division without frustration and anxiety.

In the era of the digital world, where online interactive applications foster in the market as a learning tool for complex systems. VR based environment enriches with immersive interaction of the real-world for children to learn and understand the mechanism of different concepts. Observation in this pilot experiment clarifies that cognitive learning through different multimedia technologies enhances the capability to memorize basic simple concepts. The curiosity of learning is increased through immersive interaction and a great tool that reflects sustained conceptual understanding.

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