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Customizable Virtual Reality Gamification for Enhanced Teaching and Learning for Students with Dyslexia

Fasee Ullah[1], Thievalson a/l Johnsan[2]

[1]Institute of Emerging Digital Technologies (EDiT) and Center for Cyber Physical Systems (C2PS),Department of Computer and Information Sciences, Universiti Teknologi PETRONAS, 32610 Seri Iskandar, Perak Darul Ridzuan, Malaysia
fasee.ullah@utp.edu.my
[2]Institute of Emerging Digital Technologies (EDiT)and Center for Cyber Physical Systems (C2PS), Department of Computer and Information Sciences, Universiti Teknologi PETRONAS, 32610 Seri Iskandar, Perak Darul Ridzuan, Malaysia
thievj07@gmail.com

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Abstract— *Virtual Reality (VR) technology has garneredconsiderable attention for its potential applications in education and therapy, particularly for children with neurodevelopmental disorders. Moreover, this study focuses on the exploration and effectiveness of VR-based interventions in improving object identification skills in children who have been diagnosed with dyslexia, autism spectrum disorder (ASD),Developmental Coordination Disorder (DCD), attention deficithyperactivity disorder (ADHD), and brain injuries. The existing literature needs to improve with traditional interventions tomeet the specific needs of children with these conditions. Thus,this paper proposes a novel VR-based intervention systembased on a theoretical framework to improve object identification skills in children aged 6-12. The intervention seeks to create interactive and multisensory learning environments where children can practice identifying and categorizing objects in a secure and supportive atmosphere. By harnessing the capabilities of VR technology, including immersive visuals, auditory feedback, and interactive simulations, the intervention aspires to boost engagement, motivation, and learning outcomes for children with dyslexia, ASD, DCD, ADHD, and brain injuries.Anticipated results include improvements in participant object identification, measured by standardized assessments and task performance metrics. Qualitative observations and user feedback will offer insights into the subjective experiences, preferences, and challenges encountered during the intervention. The study aims to contribute valuable insights to the burgeoning field of VR-based interventions for children with neurodevelopmental disorders and inform future educational and therapeutic advancements.*

Keywords— ***Virtual Reality (VR) interventions, neurodevelopmental disorders, object identification skills, multisensory learning, educational advancements.***

I. INTRODUCTION

Virtual Reality (VR) technology has become a tool with far reaching consequences, especially in the social sectors suchas education and health. Virtual reality can provide learners with experiences and approaches that cannot be solved byimplementing conventional learning methods, which means unique opportunities to address the problems that children with neurodevelopmental disorders face. For example, dyslexia, Autism Spectrum Disorder (ASD), Developmental Coordination Disorder (DCD), Attention-Deficit/Hyperactivity Disorder(ADHD), as well as head injuries cause problems determining spatial relations, objects' size and shape, and coordination when interacting with the environment, which substantially impacts their learning and development process.

Dyslexia is a disability affecting an individual's ability to read,write, and spell, whereby the affected person has issues with visual phonological processing, such as identifying objects by name. Children with dyslexia may be unable to distinguish different assemblages of similar features in letters or objects relevant to the task and may be unable to identify objects correctly. Likewise, learning disorder in ASD, which is characterized by a deficit in social communication and interaction, may affect the child's ability to identify and group objects based on specific features that pertain to the shape, colour,and use of the object [1].

In the case of DCD, which affects motor coordination and planning, children may face challenges manipulating objects and coordinating their movements to interact with their environment effectively [2]. Children with ADHD, characterizedby difficulties in attention, impulse control, and hyperactivity, may struggle to maintain focus and sustain attention during object identification tasks, leading to errors and inconsistencies in performance [3]. Moreover, children with brain injuries resulting from trauma or neurological conditions mayexperience impairments in cognitive functioning, including memory, attention, and executive functions, which can affect their ability to process and recognize objects accurately [4]. Traditional interventions for children with neurodevelopmental disorders, such as worksheets, flashcards, and verbal instructions, often fail to address the specific challenges faced bythese children in object identification tasks. These interventions may need more engagement, cater to individual learning styles, and overlook the complex cognitive processes involvedin object recognition and categorization [5]. Additionally,assistive technologies, while beneficial in specific contexts,may not provide the multisensory experiences and personalized support needed to facilitate object identification skills

effectively [6].

Given the shortcomings that are characteristic of conventional interventions and assistive technologies, it is apparent that there is a dire call to search for effective and new strategies by which object identification abilities can be effectively enhanced in children with neurodevelopmental disorders. The growing technologies that have the potential to solve these challenges include virtual reality (VR). VR technology offers extensive possibilities for appealing to children and incorporating them into learning activities in which they can acquire skills in a virtual but safe environment [7], [8].

Eventually, it is essential to notice the lack of research on the efficacy of VR-based interventions to enhance object identification skills in children with NDDs. Several studies reveal that they enhance patients' cognitive and sensory-motor abilities through VR. However, only a few have segmented object identification as an outcome to be achieved by its use [9], [10]. This gap strengthens the need for researching the other learning aspects of students with dyslexia, ASD, DCD, ADHD, and brain injuries in the identification of objects with the help of VR technology.

A. Contributions

The following are the contributions listed below:

1) Develop a Customizable VR Learning Environment: Create an interactive VR application designed to teach basic geometric shapes (cubes, cylinders, pyramids) in alignment with elementary school curricula. The environment will be tailored to the cognitive abilities and sensory preferences of children diagnosed with dyslexia,ASD, DCD, ADHD, and brain injuries.
2) Explore Customization and Inclusivity Features: Investi- gate the role of customization features within VR appli- cations to adapt content delivery and interaction methods based on individual learning profiles. This exploration aims to enhance inclusivity and accessibility, ensuring that VR technologies effectively support diverse learning needs in educational settings.

The rest of the paper is constructed as follows: The literatureis available in Section II. The detailed work of the proposed framework is discussed in Section III. The results discussions, conclusion, and future work are available in Sections IV and V, respectively.

II. RELATED WORK

In recent years, Virtual Reality (VR) technology has emerged as a significant tool in the medical industry, especially in addressing learning disabilities like dyslexia. Dyslexia is a common learning disability affecting an individual's writing and spelling abilities. It often comes with difficulties in object identification and spatial awareness. Customizable VR systems offer a promising approach to mitigating these challenges and enhancing learning outcomes for dyslexic children. Virtual Reality (VR) is a digitally generated representation of a three-dimensional space that allows users to interact with it as if it were real or tangible [11]. This contact is enabled by specialized electronic devices such as headphones with screensor

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sensor-equipped gloves.

The primary goal of virtual reality is to immerse peoplein sensory-rich experiences that mimic real-life situations or imaginary realms. In recent years, research findings indicate the viability and innovation of virtual reality as a human-computer interface technique. VR has gradually progressed from the theoretical research stage of the laboratory to the stage of mass and industry application, and as a bridge between the digital and the real world, providing people with a new way to recognize and experience the things aroundthem. Furthermore, the American Times Weekly have named it one of the top ten most promising technologies for the future. [12], [13] investigated the field of AR, in which 3D virtual elements are blended in real-time into a 3D actual environment. It outlines the applications investigated in the medical, manufacturing, visualization, path planning, entertainment, and military fields. The author covers AR system characteristics, thoroughly examining the tradeoffs between optical and video mixing techniques. Two of the most severe issues in developing a successful AR system are registration and sensing failures. [14] also, add that introducing the VR systems has brought a new twist to surgical planning and training. The environmental models allow the surgeons to manoeuvre through the sequences and enhance their movement prowess through the virtual environment. These aid in simulation and minimize mistakes during actual operations, which increases accuracy and shifts risks faced by patients since nurses are familiar with the various appearances of the anatomy of different patients and the complex possibilities of every surgery. These tools utilize VR technology to establish a fully immersive and interactive learning environment to support dyslexic children with the course material. In the words of [15] "VR tools can be developed to offer playful adaptive learning experiencesfor children with dyslexia according to their special cognitive profile". Moreover, VR can be incredibly effective in thisanalogy, presenting dyslexic learners with lifesize scenarios and involving multiple senses to help them identify objects and develop a sense of space without fear or anxiety.

A. *Adaptive Learning Environments*

The customizable nature of VR environments means that educational content can be adapted to each child's learning pace and style. [16] emphasize that adaptive VR systems can adjust the difficulty level and the type of stimuli presented to the learner based on their performance and progress. This adaptability ensures that children with dyslexia receive personalized instruction that caters to their strengths and addresses their weaknesses, thereby enhancing their learning efficiency and motivation.

B. *Enhanced Spatial Awareness*

The ability to have a cognitive sense of where things areis impaired in dyslexic children, affecting the capacity not only for moving through space and understanding geometric relationships and visual information. In an article by [17], they discuss how VR can be implemented to tackle spatial skills environments offer possibilities for learning about spacerelations such as different surrounding contexts and the resultsof moving from one place to another based on provides visuospatial cues which assist dyslexic students in acquiring better understanding about relations between points to path further improving their navigation abilities. They can engage with 3D objects and virtual spaces where children can safely practice and perfect their spatial abilities.

C. *Interactive and Engaging Learning*

One of the critical advantages of VR is its ability to create highly engaging and interactive learning experiences. The [16]notes that the immersive nature of VR captures learners' attention and makes educational activities more enjoyable. Forchildren with dyslexia, who often face frustration and low self- esteem due to their learning difficulties, the engaging natureof VR can make learning more appealing and reduce anxiety associated with traditional educational methods.

D. *Multisensory Learning*

VR tech legislates multisensory Learning, an attribute ex- ceedingly advantageous for dyslexic children. By amalgamating visual, auditory, and kinesthetic components, VR delivers a comprehensive sensory experience that fortifies Learning. Evidence from [18] posits that "Multisensory VR realms can bolster memory retention and comprehension through simultaneous sensory engagement". For instance, dyslexic children can observe, listen to, and manoeuvre virtual entities, assistingthem in grasping concepts more profoundly and cementing information more efficaciously.

E. *Real-Time Feedback and Assessment*

Another essential thing that VR has going for educationis the capability to develop real-time feedback, according to [19]. These VR systems can track user actions to provide real-time feedback, which is very important for practising and reinforcing correct responses and correcting mistakes. This instant feedback loop enables dyslexic children to learn from their mistakes and strengthen good learning habits, leading to better grades in school and stronger self-esteem.

In contexts extending beyond educational spheres, VR technology additionally exhibits potential in therapeutic and rehabilitative applications for children with dyslexia. [20] elaborates on how VR-centered therapeutic ventures may be orchestrated to cater to cognitive and motor impairments linked with dyslexia. Such initiatives can encompass drillsthat enhance eye-hand coordination, memory retention, and sequencing prowess, frequently representing areas of challengefor individuals grappling with dyslexia. A study published in provides significant insights into the application of VR in neurorehabilitation. The research highlights the distributionof scientific contributions (SCs) in VR-based rehabilitation across different periods, revealing crucial trends and shifts in focus over time. Notably, the SC ”Rehabilitation” consistentlyaccounted for over one-third of all publications. The study found that the SC ”Neurosciences and Neurology” increased from 10% of publications in the early period to 20-25% in later periods, reflecting the growing interest in VR applications in neurological contexts. Similarly, SCs ”Engineering” saw an increase from 8.4% to about 12%, while ”Computer Science” experienced a decline from 12% to less than 6% [21]. The study identified key research topics and their distribution over time through text analytics. Initially, topics like Simulation, Tele-rehabilitation, and Cognitive Issues were prominent, but these declined in subsequent periods. There was a significant shift towards topics such as Neural Impact in the middle period and an increased interest in Intervention in the latest. This trend suggests a broader and more balanced distribution of research interests in VR-based neurorehabilitation in recent years.

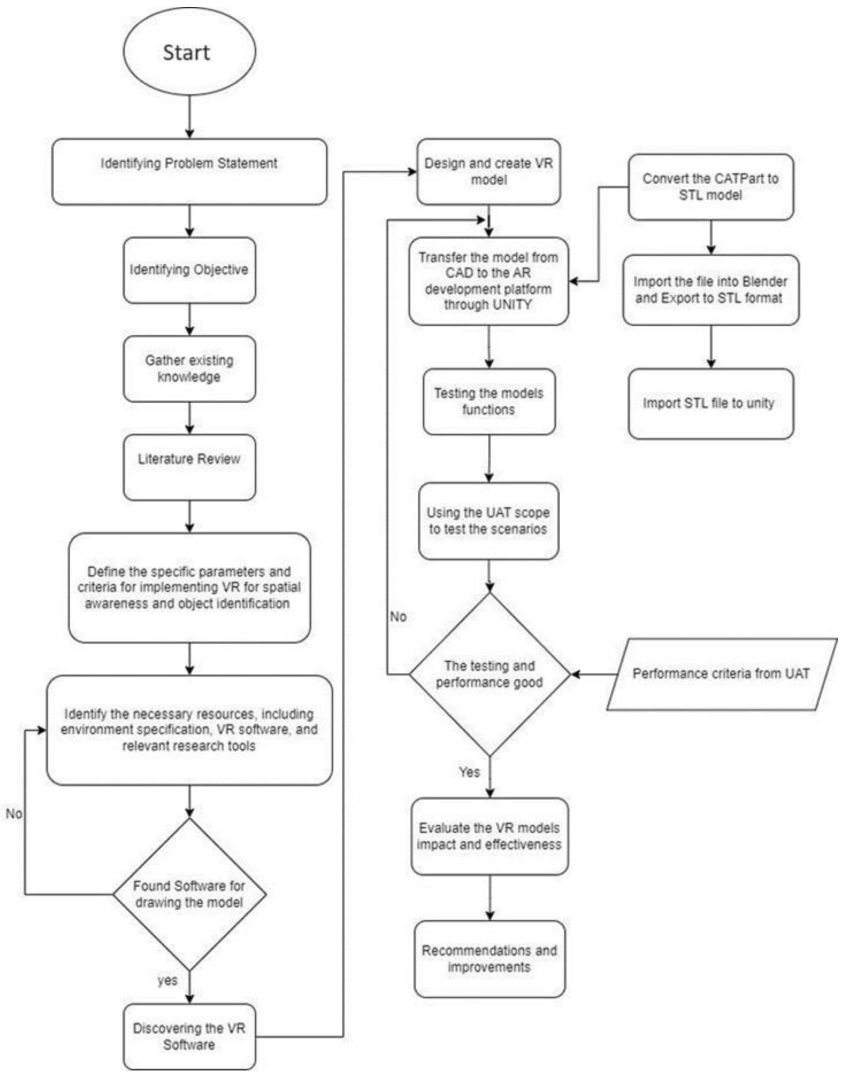

Fig. 1. The proposed Framework for Enhanced Teaching and Learning for Kids with Dyslexia

III. THE PROPOSED FRAMEWORK FOR ENHANCED TEACHING AND LEARNING ACTIVITIES FOR KIDS WITH DYSLEXIA

The basic idea behind this research is to provide an alternative method of learning and training about the inner workings of pipeline isolation plug technology by adopting the Agile framework—the proposed framework for enhanced teaching and learning activities for kids with Dyslexia, depicted in Fig. 1.

Moreover, the proposed framework functionalities are explained below.

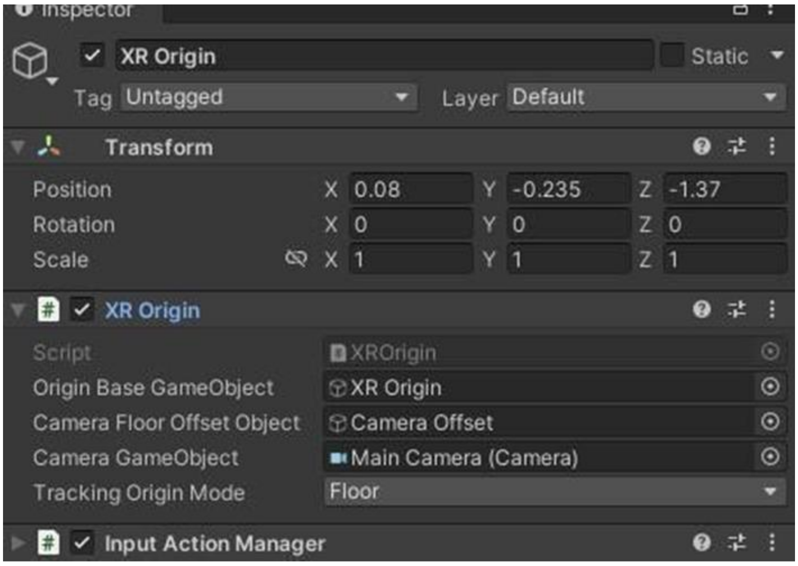

Fig. 2. Unity XR origin

A. User Acceptance Testing (UAT) and User Interface/User Experience (UI/UX)

We have conducted a detailed examination of the target audience and their requirements. We determined that the target audience consists of pipeline engineers and technicians, professors, and students who require a user-friendly interface to acquire information on the PIP intuitively. Based on this study, we created a basic yet effective user interface allowing users to obtain crucial information quickly. Thus, we employed the Unity XR toolkit and Unity UI creation tools to craft an immersive and interactive user interface (UI) for our VR model. Fig. 2 illustrates how the Unity XR toolkit played a pivotal role in ensuring the smooth compatibility of our model with the XR-origin VR equipment we acquired. This effective synergy enabled us to effortlessly incorporate 3D elements, animations, and user interactions, thereby elevating the overall user experience within the virtual environment.

B. Creating a VR Environment with Unity

The Unity XR toolkit and Unity UI building tools have created a Virtual Reality (VR) model for the learning envi- ronment. The objective is to create an interactive, immersive virtual reality environment that would enable an in-depth understanding of the functioning and design. The first job is to configure the VR environment parameters; this included making a plane to serve as the base for the entire VR model shown in Fig. 3. The camera and user model have been imported from Unity's local library to provide a flawless connection with the VR equipment with the XR Origin and Meta Quest.

C. Importing Assets from Unity

The 3D models, textures, audio files, scripts, and other items that can significantly improve the creation process are available in the Unity Asset Store. Our goal in utilizing these resources was to expedite the development of a superior, immersive virtual reality setting. The main processes taken to acquire and incorporate assets from the Unity Asset Store into this research are outlined in the following phases. The first step in acquiring assets involves exploring the Unity Asset Store to identify suitable resources for our VR learning environment. This process included navigating the Asset Store via the Unity Editor or web browser, using search keywords and filters to find specific assets such as 3D models of educational tools, environmental textures, sound effects, and scripts for VR interactions. We also reviewed asset descriptions, screenshots, ratings, and user reviews to evaluate the quality and suitabilityof each asset for this research, ensuring that the selected assetswere compatible with the version of Unity we were using and with the Unity XR toolkit for VR development. Dependingon whether the assets

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were free or paid, we purchased ordownloaded the selected assets from the Unity Asset Store. We also reviewed and adhered to the licensing terms of the assets, including any requirements for attribution or usage limitations.Using the Unity Editor, we imported the downloaded assets into this research, accessing the Unity Package Manager to manage and import the asset packages. We selected the down-loaded asset packages and imported them into this research, ensuring all necessary files and dependencies were included. Then, we organized the imported assets within the research hierarchy to maintain a clean and manageable structure.

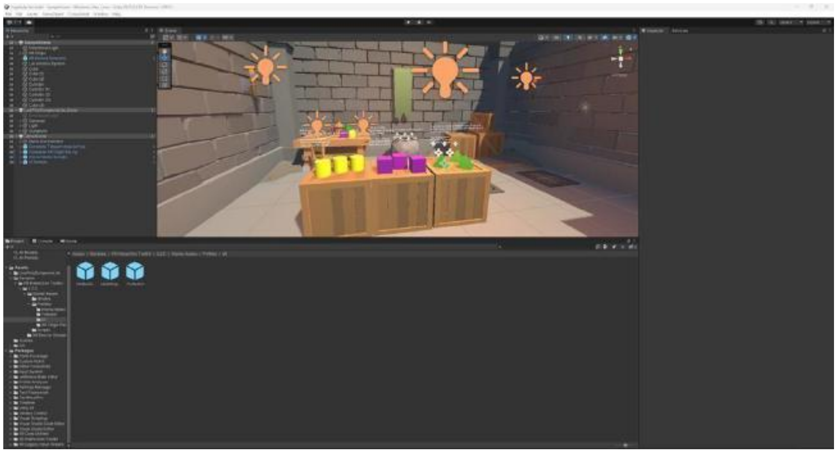

Fig. 3. Unity Interface

D. *Setting Up the Scene*

After acquiring and importing the assets, the next step is integrating them into the VR learning environment. This involved creating and setting up the VR scenes where the assets would be used, designing the virtual environment, including the layout, lighting, and ambience to create an immersive experience, and placing the 3D models and other assets within the scene. We positioned, scaled, and rotatedthe assets to fit the intended design and functionality of theVR environment and added interactivity to the assets usingthe Unity XR toolkit, configuring objects to respond to user inputs such as grabbing, moving, and manipulating virtual objects, as shown in Figure. Customization and enhancement of the assets were done to align with the specific needs of this research, which included modifying materials and textures of the assets to match the visual style and educational purpose of the VR environment, writing and integrating custom scripts to control the behaviour of the assets and add educational featuressuch as feedback mechanisms and instructional prompts, and implementing animations and visual effects to enhance theinteractivity and engagement of the VR environment.

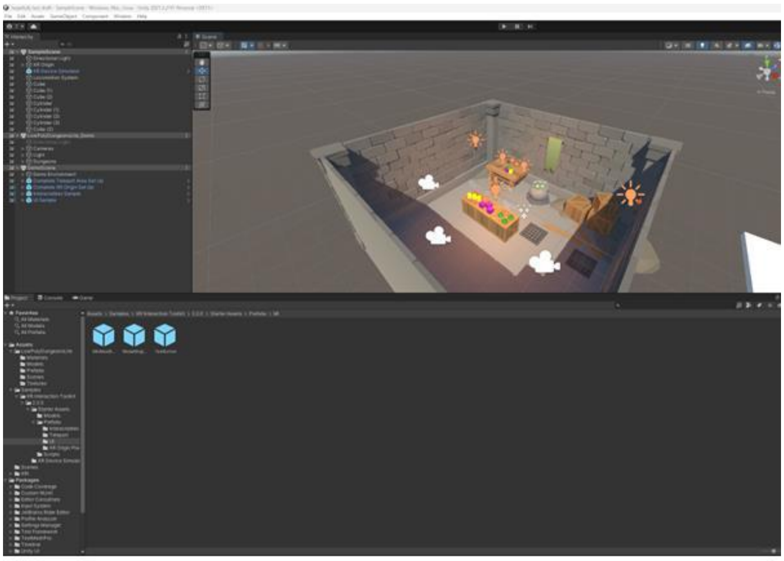

Fig. 4. Importing Assets from the Package Manager and Setting up the scene

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E. Integrating XR Origin VR into this Research

During the development of the VR learning environment, integrating XR Origin VR proved to be a game-changer, especially given the constraint of not having a VR headset for testing and visualization. XR Origin VR, a versatile framework within the Unity XR toolkit, allowed us to create and simulate VR experiences without the immediate need for physical VR hardware. This was crucial for this research, enabling us to accurately simulate the VR environment and interactions, ensuring that the virtual scenes and user experiences wereprecisely designed and functional. By leveraging XR Origin VR, we could visualize and interact with the VR scenes directly within the Unity Editor. This involved setting up the XR Origin component, which lays the foundation for VR interactions such as head tracking, hand tracking, andobject manipulation. Configuring the XR Origin allowed usto simulate the movement and viewpoint of a user wearing a VR headset, facilitating the testing and refinement of the immersive aspects of the environment without needing the hardware. This approach ensured that the VR environment wasdesigned to provide an engaging and intuitive user experience, particularly benefiting children with dyslexia by offering a well-crafted and interactive learning space. Moreover, inte- grating XR Origin VR into the research opened the potential for cross-platform deployment. The XR Origin framework is compatible with multiple VR platforms, including Oculus, HTC Vive, and Windows Mixed Reality. This meant that once the VR environment was fully developed and tested within theUnity Editor, it could be deployed across various VR hardwaresetups, ensuring accessibility and usability for a broader audi- ence. The cross-platform capability also allowed us to future-proof the research, providing opportunities for scalability and adaptation as new VR technologies and platforms emerge.

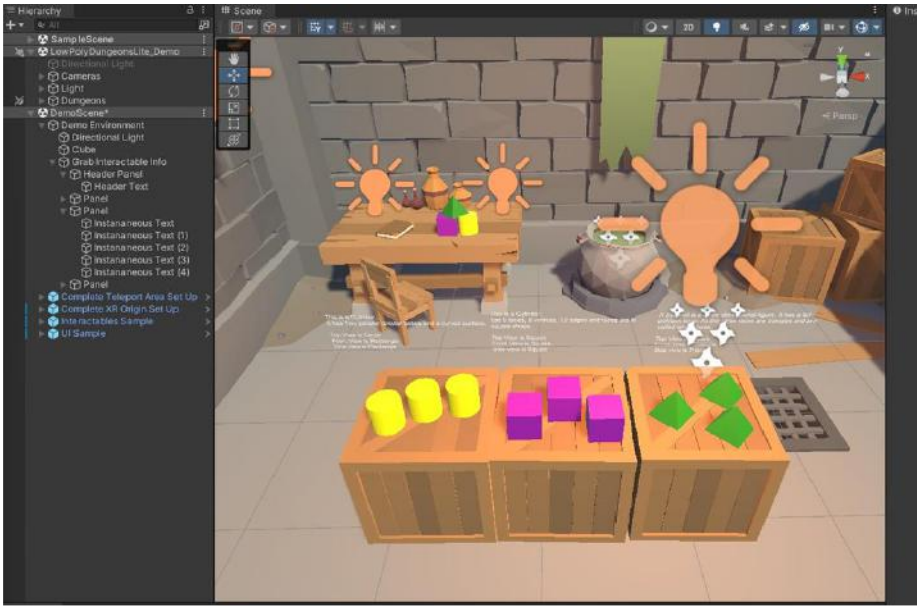

Fig. 5. Shapes and Texts incorporation

F. Adding Interactable Objects

This research mission focuses on incorporating interactable objects within the VR environment, specifically designed to aid children with dyslexia in learning object identification and spatial awareness. This was achieved by populating the virtual space with various geometric shapes- cubes, cylinders, and pyramids—integral to the educational content typically covered in a 10-year-old's curriculum. The primary goal was to create a hands-on, engaging experience that allows children to learn by doing, reinforcing their understanding of shapes and spatial relationships. We programmed these objects to be fullyinteractable using Unity's XR Interaction Toolkit. Children can pick up, move, rotate, and stack these shapes, enabling themto engage in meaningful and enjoyable interactions, as shown in Fig. 5. This interactive element is crucial, transformingpassive learning into an active, tactile experience. Children can better understand their properties and relationships by manipulating the objects, which is especially beneficial for those with dyslexia who may struggle with traditional learning methods. Additionally, we integrated floating descriptions andlabels that provide immediate feedback and information about each shape, enhancing the educational value of the VR envi- ronment. This multimodal approach caters to various learning styles, ensuring that all children, regardless of their preferred learning method, can benefit from the VR experience. By making the objects interactable, we not only aimed to createan engaging educational tool but also sought to provide a supportive and inclusive learning environment that addresses the unique challenges faced by children with dyslexia.

IV. RESULTS AND DISCUSSION

This section will present the findings from developing and implementing the VR learning environment, focusing on its effectiveness, user feedback, and potential impact on impairedchildren. The results will be discussed about this research objectives by providing insights into the success and areas for improvement of the VR model.

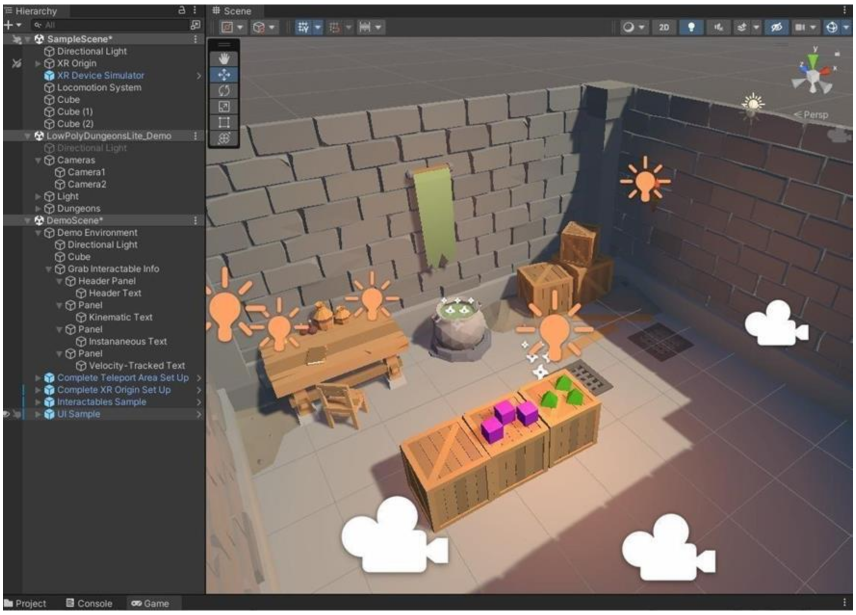

Fig. 6. Setup of the Environment to promote constant stimulation

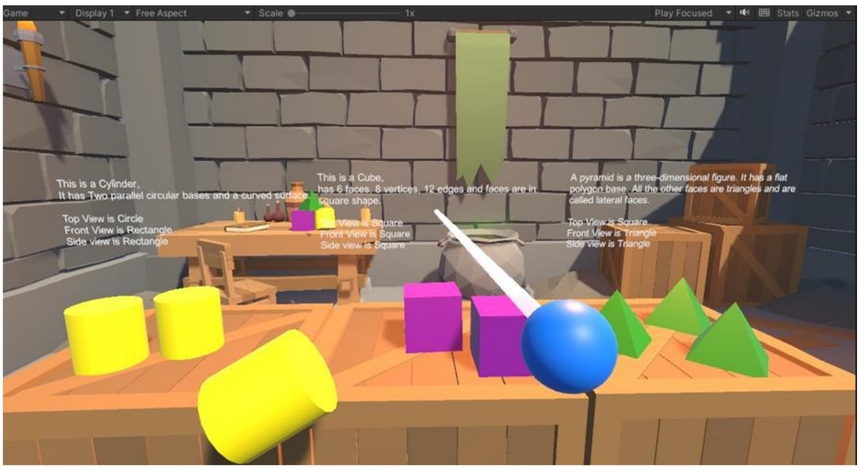

Fig. 7. Final view of the finished prototype

A. *Environment Setup and Design*

The VR environment was successfully set up using Unity and the XR Interaction Toolkit. The development process involved creating a virtual classroom with various geometric shapes, including cubes, cylinders, and pyramids, which were fully interactable, as shown in Figs 6 and 7. These shapes were positioned strategically within the environment to encourage exploration and interaction. Floating descriptions were added to each shape, providing real-time information to the users. One of the primary goals of this research is to create anengaging and interactive learning experience. User feedback indicated that the VR environment was immersive and intuitiveto navigate. Children could pick up, move, and manipulate ge- ometric shapes easily, enhancing their understanding of these objects' properties and spatial relationships. The interactive nature of the VR environment kept the children engaged, stimulated and motivated to learn, which is a significant advantage over traditional learning methods.

B. Integration of XR Origin VR

The integration of XR Origin VR was a crucial aspect ofthe research, particularly given the lack of access to a VR headset. This feature allowed for accurate simulation of the VRenvironment on different platforms, including desktops and mobile devices, ensuring that the learning experience could be accessed widely, as shown in Fig 8. The cross-platform capability of the XR Origin VR proved to be effective, with minimal discrepancies in the user experience across different devices. This flexibility is particularly beneficial for educa- tional institutions with limited resources, allowing them to provide VR learning experiences without requiring extensive hardware investments.

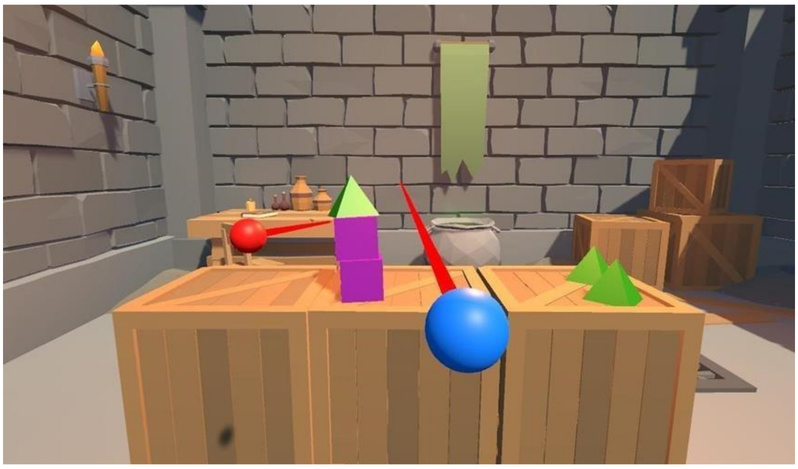

Fig. 8. Features of interacting and stacking using Origin VR

C. Learning Impact

One of the research's key objectives is to enhance object identification and spatial awareness in children, particularly those with dyslexia and dyspraxia. The VR environment proved to be effective in achieving this goal. Through hands- on interaction with the geometric shapes—cubes, cylinders, and pyramids, which were directly taken from a 10-year- old's textbook for educational reference—children developed a better understanding of the properties and relationships of these shapes, as shown in Fig. 9. This was evidenced by improved performance in post-interaction assessments, where children were asked to identify and describe the shapes, they had interacted with in the VR environment. The research also extended its benefits to children with dyspraxia and autismby explicitly labelling the left and right hands with red and blue colours, respectively. This visual aid helped these childrendistinguish between their left and right sides, significantlyimproving their spatial awareness and coordination skills. The consistent use of colour-coding reinforced the left-right distinction, which can stimulate neural pathways associated with motor coordination and spatial orientation. This method facilitated immediate learning within the VR environment andhas potential long-term neurological benefits. Furthermore,the interactive and immersive nature of the VR environment offered significant medical benefits, including applications in rehabilitation. For instance, children with motor coordination issues could use the VR environment to practice precise move- ments in a controlled setting, improving their motor skills overtime. The hands-on interaction and the ability to manipulate and stack shapes helped children with nuanced motor skill challenges to practice and refine these skills in an engag- ing and non-threatening manner. The VR environment also allows educators and therapists to monitor real-time progress and adjust the learning experience. This adaptability ensured that the educational content was always aligned with each child's individual needs, enhancing the intervention's overall effectiveness. Additionally, the VR environment allowed for cross-platform capabilities, enabling children to access thelearning modules from various

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devices, ensuring accessibility and convenience.

Fig. 9. Simulation of the learning process and ability to interact and stack with objects

V. CONCLUSION

Integrating Virtual Reality (VR) technology in educational and therapeutic settings has shown significant potential in im- proving learning outcomes and addressing specific challenges faced by children with dyslexia, dyspraxia, and autism. This research aimed to create an immersive and interactive VR environment using Unity and the XR toolkit, which focused on enhancing object identification and spatial awareness. By incorporating geometric shapes from a 10-year-old's textbook and using colour-coded hands for left-right distinction, the research offered a comprehensive and engaging learning expe- rience tailored to the target audience's needs. Children could interact with shapes hands-on in the VR environment, which led to a better understanding of their properties and spatial relationships. This interactive approach was particularly ben- eficial for children with motor coordination issues, enabling them to practice precise movements and develop better spatial awareness. The research's adaptability and cross-platform ca- pabilities ensured accessibility, making it a valuable tool for educators and therapists working with children with special needs.

In future work, this research will include mathematics, science, and language arts could be integrated to provide a more comprehensive learning experience for children. Additionally, this research will address multiple areas of their curriculum and enhance overall educational outcomes.

The integration of emerging technologies such as augmented reality (AR), artificial intelligence (AI), 3D image scanningof objects and machine learning (ML) should be explored to enhance the VR environment further. These technologies can provide adaptive learning experiences, predictive analytics, and more immersive interactions, making the VR model even more effective and engaging for children with special needs and introducing more complex structures which are not usuallycapable of being seen by impaired people and for education purposes.

REFERENCES

[1] K. R. Mafa and D. W. Govender, "Perceptions of students towards the use of mobile devices in improving academic performance: A case of a senior secondary school in a developing country," *International Journalof Sciences and Research*, vol. 73, no. 4, pp. 220–233, 2016.

[2] J. Salerno, C. Romulo, K. A. Galvin, J. Brooks, P. Mupeta-Muyamwa, and L. Glew, "Adaptation and evolution of institutions and governance in community-based conservation," *Conservation Science and Practice*, vol. 3, no. 1, p. e355, 2021.

[3] D. H. L. Lee and W. O. Lee, "Transformational change in instruction with professional learning communities? the influence of teacher cultural disposition in high power distance contexts," *Journal of educational change*, vol. 19, no. 4, pp. 463–488, 2018.

[4] F. J. Garc´ıa, E. M. Lend´ınez, and A. M. Lerma, "On the problem between devices and infrastructures in teacher education within the paradigm of questioning the world," in *Advances in the Anthropological Theory of the Didactic*, pp. 103–112, Springer, 2022.

[5] K. Smith and J. Hill, "Defining the nature of blended

learning throughits depiction in current research," *Higher Education Research & Devel- opment*, vol. 38, no. 2, pp. 383–397, 2019.

[6] Y. Kong, "The role of experiential learning on students' motivation and classroom engagement," *Frontiers in Psychology*, vol. 12, p. 771272, 2021.

[7] M. Wang and E. Anagnostou, "Virtual reality as treatment tool for children with autism," *Comprehensive guide to autism*, pp. 2125–2141, 2014.

[8] R. F. E. Encarnacion, A. A. D. Galang, and B. J. A. Hallar, "The impact and effectiveness of e-learning on teaching and learning.," *OnlineSubmission*, vol. 5, no. 1, pp. 383–397, 2021.

[9] E. Gedrimiene, A. Silvola, J. Pursiainen, J. Rusanen, and H. Muukkonen, "Learning analytics in education: Literature review and case examples from vocational education," *Scandinavian Journal of Educational Re- search*, vol. 64, no. 7, pp. 1105–1119, 2020.

[10] H. C. Hill and M. Chin, "Connections between teachers' knowledge of students, instruction, and achievement outcomes," *American EducationalResearch Journal*, vol. 55, no. 5, pp. 1076–1112, 2018.

[11] P. Smutny, M. Babiuch, and P. Foltynek, "A review of the virtual reality applications in education and training," in *2019 20th International Carpathian Control Conference (ICCC)*, pp. 1–4, IEEE, 2019.

[12] L. J. Zhang and A. Wu, "Chinese senior high school efl students' metacognitive awareness and reading-strategy use," 2009.

[13] M. Dunleavy and C. Dede, "Augmented reality teaching and learning," *Handbook of research on educational communications and technology*, pp. 735–745, 2014.

[14] G. Michalos, P. Karagiannis, S. Makris, Ö. Tokçalar, and G. Chrys- solouris, "Augmented reality (ar) applications for supporting human- robot interactive cooperation," *Procedia CIRP*, vol. 41, pp. 370–375, 2016.

[15] N. B. Mohamad, K. Y. Lee, W. Mansor, Z. Mahmoodin, C. Che Wan Fadzal, and S. Amirin, "Dyslexic frequency signatures in relaxationand letter writing," in *Intelligent Information and Database Systems: 12th Asian Conference, ACIIDS 2020, Phuket, Thailand, March 23–26, 2020, Proceedings, Part I 12*, pp. 109–119, Springer, 2020.

[16] P. P. Zaveri, A. B. Davis, K. J. O'Connell, E. Willner, D. A. A. Schinasi, and M. Ottolini, "Virtual reality for pediatric sedation: a randomized controlled trial using simulation," *Cureus*, vol. 8, no. 2, 2016.

[17] D. Ravi, N. Kumar, and P. Singhi, "Effectiveness of virtual reality rehabilitation for children and adolescents with cerebral palsy: an updated evidence-based systematic review," *Physiotherapy*, vol. 103,no. 3, pp. 245–258, 2017.

[18] S. Rodr´ıguez-Cano, V. Delgado-Benito, V. Aus´ın-Villaverde, and L. M.Mart´ın, "Design of a virtual reality software to promote the learning of students with dyslexia," *Sustainability*, vol. 13, no. 15, p. 8425, 2021.

[19] L. Kohnke, B. L. Moorhouse, and D. Zou, "Chatgpt for language teaching and learning," *Relc Journal*, vol. 54, no. 2, pp. 537–550, 2023.

[20] K. U. Pereira, M. Z. Silva, and L. I. Pfeifer, "The use of virtual realityin the stimulation of manual function in children with cerebral palsy: a systematic review," *Revista Paulista de Pediatria*, vol. 41, p. e2021283, 2023.

[21] G. R. Lyon, S. E. Shaywitz, and B. A. Shaywitz, "A definition ofdyslexia," *Annals of dyslexia*, vol. 53, pp. 1–14, 2003.