A Framework for the Implementation of Virtual Reality (VR) in the Higher and Tertiary Education Sector in Zimbabwe

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ABSTRACT

The progression of technology has prompted tertiary educators to incorporate technology-friendly tools to engage adult learners and encourage their adoption of technology. In response to the COVID-19 pandemic, the tertiary education system in Zimbabwe has embraced various technologies, such as Learning Management Systems and mobile learning platforms, in the teaching and learning processes for tertiary students. Among these technologies, Virtual Reality (VR) has emerged as a promising tool for both learners and educators. This paper proposes a framework for implementing VR to simulate real-world scenarios in tertiary education within the Zimbabwean context. Through an exploratory study, the aim is to gain a comprehensive understanding of VR technology to support its effective integration into tertiary education in Zimbabwe. A systematic literature review was conducted to explore how VR has been utilized in education by others, thereby uncovering its potential in higher and tertiary institutions. The paper highlights how VR technologies can enhance teaching practices in tertiary institutions in Zimbabwe. Existing literature demonstrates that VR technology provides a powerful means of simulating real-world situations in tertiary education. Implementing VR in higher and tertiary education in Zimbabwe can address challenges such as limited access to physical resources and inadequate access to educational materials. VR can be applied across various disciplines, including science, engineering, medicine, and arts while accommodating diverse learning styles and preferences. Tertiary institutions in Zimbabwe are encouraged to consider incorporating this framework into their educational programs to ensure the effective utilization of VR technology. Furthermore, long-term studies are necessary to assess the impact of VR on learning outcomes, student engagement, and retention rates. Comparative studies can also be conducted to evaluate the effectiveness of VR-enhanced learning in comparison to traditional instructional methods.

Keywords: Virtual Reality, Education, Higher and Tertiary

INTRODUCTION

Virtual Reality (VR) technology has garnered considerable attention across various industries, including education. In the context of Zimbabwe's education system, which emphasizes innovation through Education 5.0, the integration of technology can play a vital role in fulfilling the goals of this approach. Blazauskas and Gudoniene [1]defined VR as an educational tool that enriches the learning process by providing immersive and interactive experiences across different subject areas. Implementing VR in the Higher and Tertiary Education sector in Zimbabwe holds significant potential for enhancing teaching and learning experiences, promoting student engagement, and granting access to immersive educational resources [2], [3]. However, the successful integration of VR into the education sector necessitates careful planning, infrastructure development, and pedagogical considerations [4], [5], [6], [7]. To facilitate this process, the development of a framework aims to assist in the effective implementation of VR in Higher and Tertiary Education institutions in Zimbabwe.

Despite the potential benefits of VR technology, its implementation in the Higher and Tertiary Education sector in Zimbabwe faces several challenges [8]. These challenges include the lack of awareness and knowledge about VR among educators and administrators, limited infrastructure and resources to support VR implementation [8],[9], outdated teaching methodologies, inadequate access to educational materials, and the absence of a comprehensive framework to guide the integration of VR into the curriculum [8].

Traditional classroom settings often fail to provide students with immersive and experiential learning opportunities, hindering their ability to grasp complex concepts effectively. Virtual Reality technology has the potential to address these challenges by offering a simulated environment that can enhance learning experiences, increase student engagement, and bridge the gap between theoretical knowledge and practical application [2], [3]. Therefore, overcoming these challenges requires a structured framework that provides clear guidelines, strategies, and recommendations for Higher and Tertiary Education institutions in Zimbabwe to effectively implement VR technology.

Background of Study

Ongoing research is currently investigating the use of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) technologies and simulations in higher education [10]. Glowatz et al. [10]provided an overview of these technologies in the context of higher education, specifically focusing on their pedagogical implications and merits for assessment purposes.

Although VR and AR are not widely used, Blazauskas and Gudoniene [1]developed a model for integrating VR and AR learning objectives in higher education. Conversely, Ding and Li[11]argue that VR applications in higher education mainly target undergraduate students. The main findings reveal that VR technology is gaining attention in higher education, particularly in science, engineering, and medical-related majors among undergraduates. Furthermore, these studies demonstrate the positive effects of VR applications on students' behaviors and learning outcomes when compared to traditional education [3].The purpose of this paper is twofold:

1. To explore the challenges and opportunities associated with integrating VR into the tertiary education system in Zimbabwe.
2. To propose a framework for the implementation of VR in tertiary institutions in Zimbabwe.

Through developing a comprehensive framework for the implementation of VR in the Higher and Tertiary Education sector in Zimbabwe, this study aims to advance educational practices, enhance student learning experiences, and equip educators with the necessary tools to effectively integrate VR technology into the curriculum.

METHODOLOGY

To gain a deeper understanding of the current landscape of VR implementation, exploratory research was conducted using a systematic literature review. The goal of the review was to identify key issues and research gaps that could inform the development of a framework for implementing VR in tertiary education in Zimbabwe. This method ensures the inclusion of relevant and high-quality studies, minimizing bias and providing a comprehensive understanding of VR's effectiveness in higher education. Boolean operators (AND, OR) were used to refine the search and ensure focus. Table 1 shows some of the reviewed literature and the gaps and limitations identified.

A. Search Strategy

A comprehensive search was conducted across three electronic databases. The databases, Scopus, Google Scholar, and Web of Science were chosen for their comprehensive coverage of education research and peer-reviewed academic literature on education and technology. The search terms employed were; “Virtual Reality"

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OR "VR", "Education" OR "Higher Education" OR "Tertiary Education". A sample search is which was used,"Virtual Reality" OR "VR", "Implementation" OR "adoption" OR "use" "Education" OR "Higher Education" OR "Tertiary Education" AND "Instructional design". Reference lists of retrieved articles were also scanned for additional relevant studies (snowballing technique).

B. Inclusion and Exclusion Criteria

Articles that reported on adoption, use and implementation of VR in education were considered. The emphasis on selection was based on peer-reviewed journal articles, published in English between 2018 and 2024 so as to capture recent advancements in VR technology in education. Studies that focused on the implementation of VR in higher or tertiary education settings were included. In addition, studies that presented empirical research or theoretical frameworks relevant to VR integration and that explores the pedagogical applications, benefits, and challenges of VR in educational settings were also included. Studies from both the developed and developing context were considered for comparison on the benefits and challenges of VR in education. Studies were excluded if they were non-academic publications (e.g., editorials, opinion pieces, dissertations). Also, studies that focused solely on technology in education or educational technology without a specific emphasis on VR technology were excluded.

C. Selection Process

In May 2024 a search was conducted on specific databases. Four phases were used in this systematic literature review. The initial search yielded a total of 1737 articles (SCOPUS 384, Google Scholar 734 Web of Science 619) After conducting the initial search, duplicate studies were removed using Mendeley reference management software. Titles and abstracts of the remaining articles were screened based on the inclusion and exclusion criteria. Articles that could not be accessed in full were also eliminated. The authors then independently reviewed the full texts of the shortlisted articles to ensure they met the inclusion criteria. The final articles considered were 20. Any discrepancies were resolved through discussion.

D. Data Extraction and Synthesis

A data extraction form was developed to capture key information from the included studies, such as research methods, VR applications in specific disciplines, reported benefits and challenges, and pedagogical considerations. The researchers then performed a narrative synthesis, integrating the findings from the various studies. This approach allowed for the comprehensive examination of themes and patterns across the literature, providing a deeper understanding of VR's role in higher education.

RESULTS AND FINDINGS

This exploration of the existing research, studies, and best practices related to the implementation of VR in the Higher and Tertiary Education sector helps examine the benefits and challenges of using VR technology in education, the impact on student learning outcomes, and examples of successful VR integration in other educational settings.

Additionally, the review explores pedagogical frameworks and instructional strategies that support effective VR implementation, as well as the infrastructure requirements and considerations for VR adoption in educational institutions.

A. Current Challenges in Higher and Tertiary Education in Zimbabwe.

The Zimbabwean education sector faces numerous challenges especially in achieving Education 5.0. Some of the challenges include limited access to internet sources and data costs which are high to perform the education 5.0 tasks [12]. Gwakwara and Niyitunga[12],mentioned of low teachers' morale within the education sector as another challenge. Additionally, there is the lack of quality experts [13] in the educational fields especially technology field [14]. The results from a study by [13] revealed that universities face challenges in research and publication, quality assurance, loss of qualified and experienced staff, high student dropouts, and lack of funding. With the current challenges in Zimbabwe's education sector and introduction of Education 5.0, Gwakwara and Niyitunga[12] and Mbunge et al.[15] highlighted that Education 5.0 curriculum could integrate the use of virtual reality (VR) as a learning tool to improve outcomes, particularly in the learning of science, maths, social sciences, and art, at elementary levels.

B. Virtual Reality Conceptualisation

According to Earnshaw et al.[16]

"VR is characterized by the illusion of participation in a synthetic environment than external observation of such an environment. It relies on three-dimensional, stereoscopic, head-tracked displays, hand/body tracking, and binaural sound. VR is an immersive, multisensory experience. It is also referred to as virtual environments, virtual worlds, or microworlds"

VR is defined from three angles according to Sagnier et al.[17] and these are the purpose, potential functionality and technical characteristics. VR is further defined as computer systems with several peripherals and is characterised on the following:

1. **Immersion**- the user has the real sensation of being inside the virtual world of the computer. This is done through the use of digital helmets and digital cave. The learners' cognitive faculties make him feel present and involved in the virtual space with little knowledge of what is happening in the real-world around him[18]
2. **Interactivity**- the user manipulates the virtual environment and test variables. virtual objects are manipulated using digital gloves [18]. The learner can interact with virtual avatars, objects or other real-life users within that virtual space.
3. **Information intensity**- it is the notion that a virtual world can offer special quality such as telepresence and artificial entities that show a certain degree of intelligent behaviour [19].

C. Benefits of VR in the Education Sector

Literature indicated the benefits of using VR to improve the learning outcomes and student's motivation [20].Stojšić et al.[20] emphasised on the technological and pedagogical aspects, VR integration and evaluation criteria in the Republic of Serbia. Students are able to explore complex subjects in a way that traditional teaching methods cannot through the use of high-fidelity graphics and immersive content using head mounted-displays (HMD) [18]. The use of VR has the potential to improve students' confidence and offer flexible learning [21]. The positive impacts can be seen from the different subject areas in education where VR has been implemented. A study by Blazauskas and Gudoniene[1]have identified that VR multimedia can provide an effective teaching and learning environment by incorporating realistic images and visual features. Moreover, they recommended researches which can explore ways of designing educational virtual reality multimedia for different topics. Virtual Reality makes learning more interesting and fun with the idea of improving the motivation and attention that is lacking in online classes [22]. Research consistently shows that virtual reality (VR) experiences are more memorable than conventional laboratory-based demonstrations[23], [24], [25]. This is due to the immersive qualities of VR, which create a more extensive autobiographical associative network [24]and engage recollection-based mnemonic processes [23]. VR has been found to enhance student knowledge, learning motivation, and cognition in engineering laboratory courses[26], and to improve overall performance, particularly in the area of 'remembering' [25]. Depending on the subject area it makes it possible to explore things that were difficult to explore in real world such as the planet, and in biology where one can travel in the human body. VR have the potential to provide more beneficial, interesting and interactive learning experiences, without neglecting the related issues and challenge [22]. 96% of universities and 79% of colleges in the UK are now utilising augmented or virtual reality in some capacity [18].

Tertiary education incorporates experimental learning to students through field trips, site visits, laboratories, workshops etc. All these enhances students learning and prepares them for the future. However, including all these activities in the curriculum especially given the pandemics like COVID 19 will be difficult. Hence VR can help students to do the experimental learning process by assisting them model the real-world scenarios

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alluded by[27].

VR Technology simulations allow comfortable interaction with computers and increase the interest of students and their understanding of scientific concepts and phenomena. Active learning approaches increases knowledge acquisition [28]. Their study observed digital storytelling, VR escape rooms where users can have live action, team-based rooms with players competing or executing different tasks. They recommended further researches on social VR as it necessitates education. Virtual mixed reality gives students an immersive experience of more specific biological processes like digestion, vision formation and cell structures [29]. Students do not forget things they have experienced therefore the use of VR in biology can assist the students in coming up with innovations on how to reduce blindness and improve the visions of others.

In Mechatronics for example tutors face challenges such as unavailability of modern technologies that are in use on the market for example, expensive tools used in robotics, electronic components, chemical reagents, medical materials, etc. Thus, the use of VR in the form of 3D models with identical physical properties mainly in developing communities and countries around the world. VR environment allows educators to conduct learning activities which are difficult to implement during regular laboratory lessons [30].Students with disabilities live in a quite different reality than the typical children and any attempt to make the educational process easier and more efficient is appreciated.

VR technology when tested provided the ability to present information in an attractive way and helped in virtually transporting the disabled learner to some locations inaccessible to them. VR also has the ability to present realities otherwise unimaginable for these children. Some of the specialists considered this technology useful for relaxation as it is capable of capturing children's attention. VR also increases self-esteem and sense of empowerment [31]. However, each individual should be considered differently for this group of learners as VR may not be a suitable education method for some of them for example learners with epilepsy, claustrophobia, photosensitivity and autism [31].

D. Challenges and Limitations in VR Adoption and Implementation

VR technologies come with its own share of challenges and limitations especially in the tertiary sector. The major limitations being technical problems, cost, reduced human interaction [32]and lack of training [21]. Taylor et al.[21] identified overhead costs when purchasing VR hardware, software and training staff as one of the limitations to VR use in the higher and tertiary education sector.

Technical problems that arise from the use of VR such as bugs within the system can also be challenges to VR adoption [21]. VR also removes the human interaction [21], which according to [32] has been named as Missing Realistic Visual-Haptic Interaction. VR also causes health related problems such as cybersickness[32].

E. Requirements for VR implementation

VR technology is a fully immersive environment which affects an individual's sensory inputs such as sound, touch, smell and sight. Sagnier et al.[17]identified VR infrastructure in the following categories

1. display devices;
2. motion and position capture devices;
3. proprioceptive and cutaneous feedback devices;
4. sound input and presentation devices.

There is need to set aside resources for staff training in VR usage in teaching and engage educational practitioners in the implementation of VR in tertiary education [21]. Its implementation requires hardware and software components [33]. Additionally, new skills need to be acquired for one to use VR. Marks and Thomas[9], explained the practical implementation of VR by having lab technicians with skills in 360° video filming and 3D content creation and using hardware for 360° filming included a GoPro 360° Max camera, Kandao Obsidian stereo 360° camera and SP360 Drone mounted with a Kodak PixPro 4 K360° camera in the VR labs. Additional software was provided for content editing, such as Adobe Creative Suite. Headsets and

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sensors based on the area to be used are also needed in the implementation of VR in education. Use of hardware already on the market will be an advantage especially for developing countries. VR Tools and implementation must be fit for the specific purpose[34]. VR interactivity as well as its integration in the curriculum should be considered when implementing VR in education. Most studies considered implementation on a small population and recommended an implementation of VR on the growing population especially in tertiary education where the number of students increases.

F. Instructional Design Models as requirements for implementation

Andrews and Goodson,[35] andBranch and Kopcha[36] emphasized the importance of selecting the right instructional design model, with Andrews cautioning about the varying quality of models and the need for careful consideration, and Branch highlighting the role of models in visualizing, directing, and managing the design process. Magliaro and Shambaugh[37]provide a specific example of this, by analysing student-created instructional design models and finding that they most frequently represented the design component, followed by program evaluation, needs assessment, development, and implementation. These findings underscore the need for a systematic approach to instructional design, such as the ADDIE or SAM models, to ensure that VR-based learning experiences are effectively aligned with educational goals and support learning outcomes. VR can be integrated into educational settings through considering the pedagogical approaches and instructional design principles**.** This will maximize the educational benefits and enhance the learning experiences for students. Active learning pedagogies, such as problem-based learning, project-based learning, and inquiry-based learning, can be integrated with VR experiences. Students actively engage with the VR environment to explore, investigate, and solve problems, promoting deeper learning [38], [39]. Virtual reality (VR) has been identified as a powerful tool for experiential learning, offering a unique opportunity to engage students in a holistic learning cycle [40]. It has been found to enhance students' experiential learning across various subject areas, including medical, engineering, language, and social learning [41]. The immersive nature of VR, particularly when using head-mounted-display-based technologies, has been shown to improve tactile interactivity, presence, and learning effects [42].VR can facilitate collaborative learning experiences by allowing students to interact and collaborate within a shared virtual environment. Students can engage in group activities, problem-solving tasks, or simulations, fostering teamwork, communication, and cooperation. Applying game-based learning principles to VR experiences can enhance engagement and motivation. Games or simulations can provide challenges, rewards, and feedback, making learning enjoyable and stimulating. VR can support personalized learning by adapting the content, pace, and level of difficulty to meet individual student needs. VR experiences can be customized based on learner preferences, learning styles, and proficiency levels, allowing for personalized and differentiated instruction. There are opportunities for authentic assessment, where students demonstrate their knowledge, skills, and competencies within realistic contexts. VR simulations can be used for performance-based assessments, portfolio assessments, or simulations of real-world scenarios. VR can provide authentic learning experiences in tertiary education, supplementing real-world experiences, offering simulations and virtual tours, and creating virtual scenarios for dangerous situations [27].

When integrating VR in the teaching and learning process and tertiary institutions, there is also need to consider the instructional designs to be used. There is need to design VR experiences that align with specific learning objectives. In addition, provision of appropriate scaffolding to support students' learning experiences in VR. That is gradually introducing complex tasks, providing guidance, and offering feedback to facilitate skill development and understanding is necessary. The integration should incorporate reflection activities within VR experiences to promote metacognition and deeper understanding. In this case students should be encouraged to reflect on their experiences, make connections to prior knowledge, and articulate their thoughts and insights. VR designs should provide options for different learning styles, accommodate diverse needs, and ensure that the content is accessible to students with disabilities. The integration of VR into instructional designs should also balance between the immersive aspects of VR and the instructional content, without overwhelming students with excessive sensory stimuli and ensure that the instructional objectives are not overshadowed by the technology itself. Above all there is need to continuously evaluate and refine the instructional design based on feedback from students, educators, and assessment data.

A summary of some of the literature reviewed is shown in table 1 below:

Table 1: A summary of some of the reviewed Literature

Authors and Publication Year	**Title**	**Methodology**	**Results and Findings**	**Limitations**
E. Mbunge et al. [15], 2020	"COVID-19 Pandemic in Higher Education: Critical Role of Emerging Technologies in Zimbabwe"	Literature review	Highlighted the role of emerging technologies in education and recommended their inclusion in Zimbabwean education.	Suggested use of VR without detailed implementation strategies; specific challenges in Zimbabwe not fully addressed.
Christian P. Fabrisa et al. [34], 2019	"Virtual Reality in Higher Education"	Literature review of VR in biomedical sciences	Identified potential benefits of VR for improving learning outcomes in biomedical sciences.	Focused only on biomedical sciences; mixed results in benefits of VR.
M. Cook and Z. Lischer-Katz [7], 2020	"Practical steps for an effective virtual reality course integration"	Literature review	Increased affordability of VR hardware has improved adoption; deployment considerations are crucial.	Primarily focused on VR integration in academic libraries.
Benjy Marks and Jacqueline Thomas [9], July 2021	"Adoption of virtual reality technology in higher education: An evaluation of five teaching semesters in a purpose-designed laboratory"	Practical laboratory study	Demonstrated necessary adoption rates for VR teaching; recommended development of VR frameworks.	Emphasized practical implementation; limited to a specific VR laboratory setup.
Di Natale et al. [43], 2020	"Immersive virtual reality in K–12 and higher education: A 10-year systematic review of empirical research"	Systematic review	Promoted student engagement and motivation through IVR; highlighted methodological flaws in existing studies.	Identified flaws such as small sample sizes and non-randomized trials; suggested need for future research.
A. U. S. Veena Tewari et al. [23], 2023	"Impact of Virtual Reality (VR) and Augmented Reality (AR) in Education"	Literature review	VR and AR have potential to enhance learning and knowledge retention.	No specific framework or strategy proposed.
Hamilton et al. [44], 2021	"Immersive virtual reality as a pedagogical tool in education: a systematic literature review"	Systematic literature review	Most studies showed significant advantages of IVR; restricted to certain subject areas like engineering and science.	Limited to specific subjects; may not generalize across all disciplines.
Athanasios Christopoulos et al. [45], 2023	"Escaping the cell: virtual reality escape rooms in biology education"	Survey	Active learning approaches such as VR escape rooms increase knowledge acquisition.	Research focused on biology students only.
Qiao et al. [46], 2022	"How Will VR Enter University Classrooms? Multi-stakeholders Investigation of VR in	Qualitative analysis with 23 participants	Identified key stakeholders essential for VR implementation in higher education.	Based on a developed context; may not apply universally.

	Higher Education"			
Lampropoulos and Kinshuk [47], 2024	"Virtual reality and gamification in education: a systematic review"	Systematic review	Gamification and VR support various pedagogical theories and approaches.	Focused more on gamified VR learning environments.
Bridget Taylor et al. [48], 2023	"Immersive virtual reality for pre-registration computed tomography education of radiographers: A narrative review"	Literature review	Explored VR as a solution for radiography students to gain CT scanning experience; potential for VR in CT practicum.	Focused on incorporating VR into radiography education; does not address broader VR implementation.
B. M. Kyaw et al. [49], 2019	"Virtual Reality for Health Professions Education: Systematic Review and Meta-Analysis"	Systematic literature review	VR shows potential in improving health professionals' knowledge and cognitive skills compared to traditional methods.	Limited to the medical field; more research needed on attitudes and satisfaction.
Devon Allcoat and A. Mühlenen [50], 2018	"Learning in virtual reality: Effects on performance, emotion, and engagement"	Non-RCT experiment	VR improves learning performance, emotion, and engagement compared to traditional and video learning methods.	Concentrated on VR's effects on performance, emotions, and engagement.
J. Pirker et al. [51], 2021	"The Potential of Virtual Reality for Computer Science Education - Engaging Students through Immersive Visualizations"	Systematic review	360° VR videos improve learning performance, motivation, and knowledge retention; enhances presence and engagement.	Focused mainly on VR videos; may not generalize beyond this technology.
S. Shen et al. [52], 2022	"Exploring the factors influencing the adoption and usage of Augmented Reality and Virtual Reality applications in tourism education within the context of COVID-19 pandemic"	Survey sessions with students	Perceived usefulness, hedonic motivation, and price value are key factors for adoption of VR and AR in education.	Focused on tourism education and adoption factors; may not generalize to other fields.
J. Kisker et al. [53], 2021	"Experiences in virtual reality entail different processes of retrieval as opposed to conventional laboratory settings: A study on human memory"	Survey	VR experiences promote autobiographical retrieval mechanisms; conventional lab events require more effort to recall.	Study conducted in a developed country; need for similar research in developing contexts.
Wang Jiawei et al. [54], 2024	"Enhancing higher education art students' learning experience through virtual reality: A comprehensive literature review of product design courses"	Systematic review	Despite growing interest, few applications of VR in product design education; calls for further research.	Limited application to arts students; requests for broader research in VR education.

Babajide Tolulope Familoni and Nneamaka Chisom Onyebuchi [55], 2024	"Augmented and virtual reality in U.S. Education: A review: Analyzing the impact, effectiveness, and future prospects of AR/VR tools in enhancing learning experiences"	Systematic literature review and content analysis	AR and VR significantly enhance learning by providing immersive and engaging environments; improve student engagement and retention.	Study based on U.S. education; may not reflect experiences in other regions.
Xiaoqin Ding and Zhe Li [56], Nov 2022	"A review of the application of virtual reality technology in higher education based on Web of Science literature data as an example"	Literature analysis method	VR applications mainly in science, engineering, and medical fields; less in humanities and social sciences; lack of VR equipment guidance.	Limited to Web of Science data; does not explore VR application across all higher education majors.
Musa Nyathi [57], Oct 2022	"Virtual campuses in developing countries: An evaluation of the 'right connectors' for effective e-learning in higher education institutions in Zimbabwe"	Survey involving 130 learners	Identified technological self-efficacy and social presence as key factors for effective e-learning in developing countries.	Focused on specific facets of e-learning in developing economies; may not generalize beyond Zimbabwe.

THEORETICAL LENSES

This paper considered theories that speak to the student as someone who needs to use his body to understand knowledge, be actively involved in a real-life scenario and in a context that is relevant to the scenario. The theory of constructivism emphasizes that learners actively construct knowledge through their experiences and interactions with the environment. Learning activities in constructivist settings are characterized by active engagement, inquiry, problem solving, and collaboration with others. Rather than a dispenser of knowledge, the teacher is a guide, facilitator, and co-explorer who encourages learners to question, challenge, and formulate their own ideas, opinions, and conclusions[58],[59].

VR can provide learners with opportunities to engage with simulated real-world scenarios in a safe and controlled environment. This can help them to develop a deeper understanding of the concepts they are learning. The theory of situated learning on the other hand helps students to develop the skills and knowledge they need to be successful in the real world. Donaldson et al.[60]postulates that use of the theory of situated learning can help students be more proficient in their subjects.

According toMahon and Caramazza[61], [62], the theory of embodied cognition states that cognition is embodied in the physical body and knowledge is incorporated into the body’s sensorimotor system, which facilitates learning and understanding different concepts. VR can provide learners with opportunities to interact with simulated real-world scenarios in a physical way. This can help them to develop a deeper understanding of the concepts they are learning and to make better connections between their learning and their experiences in the real world. Kolb's experiential learning theory, which emphasizes the importance of concrete experiences, reflection, conceptualization, and application, has been widely applied in various educational contexts.

Pamungkas et al.[63] highlighted the effectiveness of this approach in course design and vocational education, respectively. Chan[64] further demonstrates the potential of virtual reality (VR) in providing realistic and immersive experiences that facilitate active engagement and experiential learning, aligning with Kolb's theory.

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Chan's research[64] shows how a community service project can be used to apply Kolb's learning cycle, leading to deep learning and the development of graduate attributes. Cognitive Load Theory, emphasizes the importance of managing cognitive load in learning activities[65], [66], [67].

This can be achieved through the design of Virtual Reality (VR) environments that present information in a visually and spatially coherent manner, reducing extraneous cognitive load, and optimizing the use of working memory capacity. Incorporating these theories and principles into the implementation framework, educational institutions in Zimbabwe can create a solid foundation for the successful integration of VR technology into the Higher and Tertiary Education sector.

DISCUSSION OF FINDINGS

The review of the literature demonstrates that research has been conducted in a variety of educational fields and topic areas. When integrating VR in postsecondary and higher education, the investigation highlighted the advantages, challenges, and instructional design factors to be taken into account. Enhanced learning outcomes and student motivation are among the recognized advantages and potentials of virtual reality [20].Students' interest, engagement, and investigation of difficult subjects can all be improved by using virtual reality [1]. Furthermore, through immersive learning experiences, it fosters enhanced knowledge retention[23], [24], [25] and skill development through immersive learning experiences[56].

Through simulations, VR also helps with experience learning across a range of subjects[57].It enables students to engage in hands-on activities, conduct experiments, explore complex concepts [16], and practice skills in a safe and controlled environment. Additionally, it offers a fresh and stimulating learning environment that draws students in and promotes involvement. By allowing students to interact with virtual settings or objects as well as with one another, virtual reality (VR) can support collaborative learning.

Even in remote learning environments, group projects, collaboration, and conversations are supported by VR technology. Furthermore, by offering multi-sensory experiences and chances for active learning, virtual reality (VR) can accommodate learners that are kinesthetic, auditory, or visual in addition to meeting varied learning styles and preferences [50].

Despite the identified benefits and potentials s authors [48],[32], identified challenges of VR adoption. The main challenge being limited technical infrastructure and high costs associated with VR hardware and software[48]. In addition, inadequate pedagogical frameworks and staff training hinder the successful creation and execution of VR-based learning activities[9]hinders its adoption. VR has the potential for cybersickness and limitations for some learners with particular sensitivities[49].

VR integration in Zimbabwe's higher and tertiary education can help with issues including restricted access to real resources and facilities for hands-on training. As a result, students may be able to acquire real-world experience and abilities in virtually identical virtual situations. Numerous fields, including science, engineering, medicine, and the arts, can make use of this technology. Nonetheless, it is imperative to take into account the instructional design methodology and material that correspond with the targeted users.

It is important to take accessibility into account in order to accommodate different learning styles and needs. VR should be used in accordance with established educational frameworks and explicit learning objectives for its implementation. Furthermore, its integration with inquiry-based, project-based, and problem-based learning pedagogies is necessary.

The reviewed literature included studies from other developed countries so as to guide the framework design.

Studies by Kyaw et al.[49] and Christopoulos et al. [45] concentrated on VR in science subjects. The proposed framework can be used for any subject area. The analysis of existing research suggests VR has significant potential to enhance learning in Zimbabwe's Higher and Tertiary Education sector.

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However, challenges like cost and infrastructure limitations need to be addressed. The proposed framework, informed by the reviewed literature and theoretical perspectives, will be presented in the subsequent sections of the paper. This framework will provide a roadmap for effective VR implementation, considering the specific context of Zimbabwean institutions.

PROPOSED FRAMEWORK

The authors propose the following framework for the implementation of VR in higher and Tertiary education in Zimbabwe:

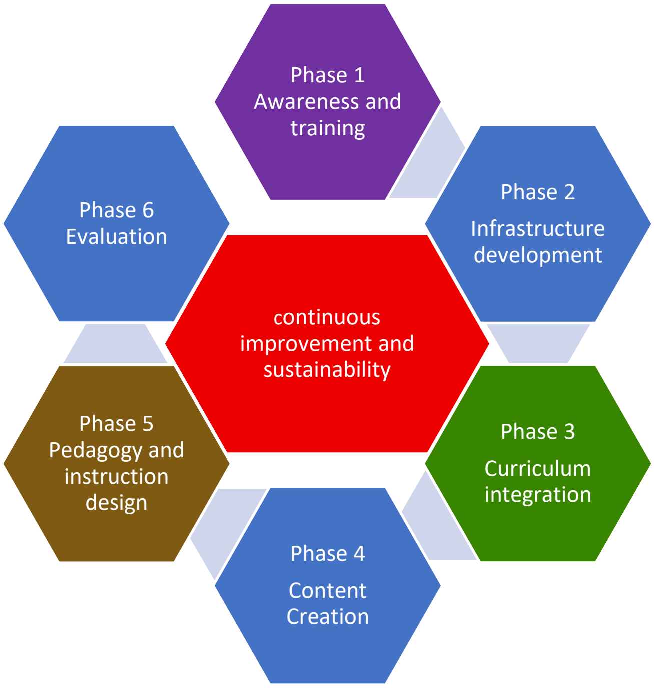

Fig1: Proposed Framework for the implementation of VR in tertiary education

Phase 1: Awareness and Training

Educators can be introduced to the constructivist principles underlying VR technology, highlighting how VR can provide immersive and experiential learning opportunities aligned with constructivist approaches. Workshops and training sessions can be designed to provide hands-on experiences with VR, allowing educators to engage in concrete experiences, reflect on them, and conceptualize the potential applications in their teaching practices.

Phase 2: Infrastructure Development

When setting up the VR infrastructure, considerations should optimize the design and usability of VR equipment and software, minimizing cognitive load and ensuring a smooth user experience. There is a need to create a VR lab or space that provides a strong sense of presence as this can enhance the immersive nature of the experiences and promote engagement among users. Since the use of VR in education requires special technologies as highlighted in this paper this phase includes

1. Assessing the existing technological infrastructure in educational institutions to determine the readiness for VR implementation.
2. Identify and acquire necessary hardware and software resources, including VR headsets, computers with appropriate specifications, and VR content creation tools.
3. Set up dedicated VR labs or spaces with proper ventilation, seating arrangements, and safety protocols.
4. Ensure access to high-speed internet connectivity to support the streaming and downloading of VR content.

Phase 3: Curriculum Integration

The objective of this paper is also to integrate VR with the curriculum. The curriculum integration phase can focus on identifying subject areas and courses where VR can facilitate constructivist learning experiences, allowing learners to actively construct knowledge and meaning through VR interactions. The principles of Universal Design for Learning(UDL) can guide the selection and design of VR experiences to ensure accessibility, offering multiple means of representation to accommodate diverse learner needs. Considering that higher and tertiary education sectors cater for a number of programs this phase will therefore help in

1. Identifying subject areas and courses where VR can enhance learning experiences and align with educational objectives.
2. Collaborating with subject matter experts and instructional designers to develop VR-based lesson plans, activities, and assessments.
3. Integrating VR experiences as supplementary resources to complement traditional teaching methods, rather than replacing them entirely.
4. Ensuring that VR activities are designed to be interactive, immersive, and aligned with the intended learning outcomes.

Phase 4: Content Creation and Curation

VR content creation can be approached from an experiential learning perspective, where educators and content creators reflect on their experiences, conceptualize the knowledge to be conveyed, and design VR experiences that provide meaningful learning opportunities. Instructional design models, such as the ADDIE or SAM model, can be applied during content creation to ensure systematic development and alignment of VR experiences with the curriculum and learning objectives. This can be achieved through:

1. Developing or source high-quality VR content that aligns with the curriculum and addresses specific learning objectives.
2. Collaboration with VR content creators, educational publishers, and relevant stakeholders to acquire or develop VR simulations, virtual field trips, and other educational experiences.
3. Regularly update and expand the VR content library to provide a diverse range of learning opportunities across different disciplines.

Phase 5: Pedagogy and Instructional Design

Pedagogical approaches within the framework can incorporate strategies that promote learner autonomy, competence, and relatedness, fostering intrinsic motivation and engagement in VR-based learning experiences. UDL principles can guide the instructional design phase to provide multiple means of engagement, allowing learners to interact with VR experiences in ways that suit their preferences and abilities. This phase will involve

1. Training educators on effective pedagogical approaches and instructional strategies for integrating VR into their teaching practices.
2. Encouraging educators to design VR experiences that promote active learning, critical thinking, problem-solving, and collaboration.
3. Fostering a learner-centered approach by allowing students to explore and interact with VR environments at their own pace.
4. Providing guidelines for scaffolding and debriefing VR experiences to help students reflect on their learning and connect it to real-world contexts.

Phase 6: Evaluation and Assessment

Evaluation methods can consider cognitive load factors to assess the effectiveness of VR experiences in managing cognitive load and optimizing learning outcomes. Assessment approaches can include reflective activities where learners articulate their experiences and demonstrate the knowledge acquired through VR interactions. The evaluation phase will consider

1. Establishing evaluation criteria and assessment methods to measure the impact of VR implementation on student engagement, learning outcomes, and overall educational experiences.
2. Collecting qualitative and quantitative data through surveys, interviews, observation, and performance assessments to evaluate the effectiveness of VR integration.
3. Analysing the data to identify strengths, weaknesses, and areas for improvement in the VR implementation process.
4. Use feedback from students and educators to refine and enhance VR experiences and instructional strategies.

Continuous Improvement and Sustainability

The continuous improvement phase can encourage educators to reflect on their VR implementation experiences, share insights, and collaboratively refine their instructional practices based on constructivist principles. Continuous improvement efforts can be guided by instructional design models, allowing for iterative design, implementation, and evaluation of VR-based learning experiences. This can be achieved through:

1. Establishing a feedback loop to gather feedback from educators, students, and other stakeholders involved in the VR implementation process.
2. Regularly update the VR technology, software, and content to keep up with advancements and emerging trends.
3. Encouraging collaboration and knowledge sharing among educators through communities of practice, workshops, and online platforms.
4. Secure long-term funding and support for sustaining the VR implementation in the Higher and Tertiary Education sector in Zimbabwe.

CONCLUSION

The study's conclusion was based mainly on the literature review. The study concluded that tertiary institutions in Zimbabwe should consider integrating VR into their educational programs. However, careful planning and implementation strategies are necessary to ensure effective utilization of the technology as suggested by the proposed framework. The framework needs to be put into practice in specific disciplines in education to see if VR can be implemented. Further research is needed to explore the specific benefits and assess the impact of VR on learning outcomes, student engagement, and retention rates. Comparative studies can be conducted to evaluate the effectiveness of VR-enhanced learning compared to traditional instructional methods in a developing country setting. Finally, accessibility and affordability of VR technology should be addressed to ensure equitable access for all students. Institutions can explore partnerships, funding opportunities, or VR loan programs to make the technology accessible to students who may not have personal VR devices. Collaboration among tertiary institutions, industry partners, and VR developers can facilitate the development of customized VR content and applications that align with the Zimbabwean tertiary education curriculum and industry needs.

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