Virtual Reality Integration in Online Learning: A Comprehensive Survey

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Abstract

This study dives into the world of incorporating virtual reality (VR) into online learning environments with the goal of thoroughly examining its uses, obstacles and possible advantages. Through a survey it explores how VR intersects, with learning by reviewing essential concepts, core principles and various applications of VR in educational contexts. The research methodology includes a review of literature and categorization based on learning tasks and feedback mechanisms drawing insights from 24 research articles released between 2017 and 2024. The study classifies VR integration in learning into three groups; VR Enhanced Online Learning with Full Feedback VR Based Online Learning with Limited Feedback and VR Driven Online Learning without Feedback. Each category delves into experiences, components and experiential learning to provide valuable perspectives for educators, scholars and professionals. It also explores trends, unresolved issues and potential future research avenues, in integrating VR into learning such as advanced VR technologies, teaching strategies improvement user experience enhancements and scalability considerations. It concludes by encouraging stakeholders to harness the power of VR to redefine learning experiences in the digital era.

Keywords: Virtual Reality (VR), Online Learning Environments, Systematic Review, Learning Tasks, Feedback Mechanisms, Immersive Experiences, Emerging Trends

1. Introduction

The use of Virtual Reality (VR) in learning has become a game changer transforming how students engage with digital content and environments. By immersing individuals in simulated three spaces VR technology provides opportunities for hands on learning, interactive activities and increased participation. This introduction paves the way for exploring the fusion of reality and online education diving into core concepts, principles and a wide range of applications that characterize this dynamic intersection. As online education progresses educators and academic institutions are increasingly embracing VR as a tool to enhance online courses. VR integrated online learning covers a spectrum of experiences from settings with instant feedback to

interactive components featuring limited feedback options. Recognizing the distinctions among these categories is key, to designing engaging VR infused learning experiences that meet diverse learning goals and requirements.

This thorough examination navigates through the realm of integrating VR into online learning platforms shedding light on types of tasks, feedback mechanisms and emerging trends that are shaping this field. Our focus is on utilizing Virtual Reality (VR) to enhance learning by providing comprehensive feedback. Additionally, we discuss the use of VR in learning scenarios with feedback and without direct feedback loops offering a perspective on the subject.

Furthermore, this study explores the concepts that support integrating VR into education addresses the challenges involved and suggests directions for future research and innovation. From VR technologies and teaching methods to improving user experiences and scalability considerations investigating these areas shows promise in transforming education.

By examining the complexities of incorporating reality into online learning this study aims to give educators, researchers and professionals a grasp of the current landscape, key hurdles and transformative possibilities. As we delve into this exploration journey, we encourage readers to explore VR enhanced online learning and envision how it can reshape the future of education.

Virtual Reality (VR) has become a game changer in education by offering ways to enhance learning experiences. The incorporation of VR into settings has attracted significant interest, for its potential to revolutionize traditional teaching methods.

This detailed survey explores the aspects of incorporating reality into online education drawing insights, from a variety of academic studies. One significant research conducted by Prasetya and colleagues (2023) investigates the effectiveness of learning in the Computer Numerical Control field using a lab on a Metaverse platform. Their findings emphasize the enhancements in student's cognitive skills and practical abilities resulting from the virtual lab experience. Similarly, Samala et al. (2022) shed light on student's perspectives, tools and challenges faced in learning amid the COVID 19 crisis emphasizing the importance of interactive and stimulating platforms.

In the field of education Novalinda et al. (2023) delve into the Constructivist Computer Based Instruction (CBI) technique combining Problem Based Learning (PBL cflip) to improve thinking and educational outcomes. Their study highlights the effectiveness of teaching methods, in creating a learning environment. Additionally, Kyrlitsias et al. (2020) explore how virtual reality impacts user experience learning processes and attitude changes using a tour of an archaeological site. Their research underscores the potential of reality (VR) to overcome accessibility barriers and enhance experiences. Ninaus and Nebel (2021) delve into the analysis of analytics and adaptivity in gaming underscoring the importance of tailored learning experiences in game-based settings. Radianti et al. (2020) present an evaluation of VR applications in higher education focusing on design components, key takeaways and future research directions within this rapidly evolving field.

This comprehensive inquiry aims to explore the landscape of integrating VR into online learning environments. With VR gaining traction as a technology in education comprehending its uses, obstacles and potential advantages is becoming increasingly vital. The goal of this study is to investigate and assess how VR intersects with online learning practices providing insights for educators, scholars and professionals seeking to effectively harness VR potential.

The framework of this paper aims to offer an overview of integrating VR into online learning platforms. It kicks off with an introduction that underscores the significance of VR, in education while outlining the surveys objectives. Subsequently the paper delves into an examination of core concepts related to VR technology encompassing experiences, simulation driven learning approaches and interactive virtual environments. The survey classifies the incorporation of Virtual Reality (VR) into education based on two main factors; the nature of learning tasks and the feedback information provided. This classification results in three categories of VR integration in online learning settings;

- VR Enhanced Online Learning with Full Feedback; This category emphasizes learning experiences where students interact with VR environments and receive immediate feedback promoting interactive and experiential learning.
- VR Based Online Learning with Limited Feedback; In this category interactive VR elements are incorporated into online learning offering feedback mechanisms that enhance engagement and interactivity without real time feedback.
- VR Driven Online Learning without Feedback; This category explores learning environments without direct feedback loops highlighting the use of VR to create engaging and stimulating experiences.

Although the survey mainly focuses on the category due to space limitations it also offers an overview of fundamental concepts and challenges in the other two categories to provide a holistic view. Additionally, the document examines trends, unresolved issues and potential areas for research, in integrating VR into online education. These include exploring VR technologies, developing strategies tailored for VR settings improving user experience design and addressing scalability and accessibility considerations. To sum up this detailed survey is designed to provide readers with a grasp of how VR's reshaping the landscape of online education. Through explaining ideas organizing methods of incorporating VR and discussing upcoming developments this document offers a valuable guide, for individuals interested in maximizing the benefits of VR in the field of education.

2. Literature Review

The use of Virtual Reality (VR) in education has attracted attention from researchers in recent years as it is believed to have the potential to revolutionize online learning experiences. This section aims to offer an overview of existing literature on the integration of VR into settings focusing specifically on academic works published between 2020 and 2023.

Incorporating Virtual Reality (VR) into education presents a frontier in educational technology offering a new way to enhance learning experiences. This review of literature synthesizes findings from studies to provide a thorough understanding of how VR can be applied the challenges it presents and the benefits it offers within online learning environments.

Kustandi, Situmorang and Lestari (2019) highlight the skill development aspects of using VR in education emphasizing its effectiveness in improving learning methods and promoting innovative teaching approaches. Prasetya et al. (2023) further support the idea that VR based distance learning can enhance abilities and practical skills in technical fields such as Computer Numerical Control. Schols (2019) explores the factors that encourage educators' engagement with technology in learning processes, which's crucial for adoption of VR technology, in educational settings. Samala and colleagues, in 2022 delve into how students view learning discuss educational tools and address the challenges they encounter. They stress the importance of having platforms that facilitate discussions and virtual face to face interactions.

Novalinda et al. (2023) present an approach that combines problem-based learning flipped learning and case methods. They illustrate how Virtual Reality (VR) can enhance effective learning environments. Miller et al. (2019) advocate for designs that connect real world situations with VR simulations to create learning experiences focused on behavior change. Jiang et al. (2021) outline a scoping review protocol to explore the use of VR tools in education for distance learning and training. Mariscal Vivas et al. (2020) evaluate the impact of VR simulation-based learning on student satisfaction and academic performance underscoring its effectiveness in providing experiences. Kavanagh et al. (2017) conduct a review, on VR in education highlighting its potential to boost motivation and enhance learning outcomes through teaching methods and gamification.

In years researchers have been focusing on the use of augmented Virtual Reality (AR), in settings and the creation of virtual learning environments supported by virtual reality (VR) and AR technologies. They emphasize how VR/AR can provide experiences through sensory stimulation. Horváths study in 2021 delves into the learning opportunities presented by 3D VR environments showcasing how VR can offer tailored educational experiences. Hsiaos research in 2021 explores how VR impacts self-efficacy and motivation among workers highlighting its potential to enhance education outcomes. Kyrlitsias and colleagues evaluate the influence of VR on user experience learning processes and attitude change within a framework underscoring how VR enables access to inaccessible sites while enriching learning experiences.

Ninaus and Nebels systematic literature review in 2021 focuses on analytics for adaptivity in video games stressing the importance of theoretical foundations and standardized reporting to optimize the effectiveness of adaptive educational games. Petukhov et al.s study from 2020 user presence in VR environments using data demonstrating how VR can elicit realistic cognitive and motor responses, from users. These studies collectively showcase the applications, obstacles and potentials of integrating VR into online learning environments. They underscore how VR enhances engagement levels boosts motivation improves learning outcomes and enhances user experiences across settings.

The utilization of VR in education has the potential to revolutionize learning. Future research areas include investigating VR technologies such as Augmented Reality (AR) integration, creating personalized learning experiences with VR and addressing concerns about accessibility and inclusivity in VR based online learning environments. Furthermore, examining the scalability of VR applications and assessing long term learning outcomes are areas for investigation (Wang & Chen 2018; Wong et al., 2020).

Integrating reality into education offers exciting opportunities to transform how students interact with educational materials. By grasping the concepts and recent advancements in VR technology educators and researchers can leverage its capabilities to develop efficient learning experiences in online settings. Abbas et al. (2023) conduct a review of definitions of VR highlighting the complexity and evolving terminology used in the field of virtual reality. This review stresses the importance of establishing consensus and standardized definitions to navigate the terminology in VR research. In a vein Kavanagh et al. (2017) perform a review on the use of VR in education emphasizing educators motivations, for utilizing VR as a tool to enhance student motivation and engagement.They also talk about obstacles, like the expenses related to technology and the logistical difficulties that are holding back the use of VR.

2.1 Components and Technologies in VR Integration for Online Learning

Virtual Reality (VR) integration in education has emerged as a dynamic field of exploration with the goal of enriching learning experiences using immersive technologies. This section examines the elements and tools for successful VR integration in online learning environments drawing insights from relevant research findings. Kustandi, Situmorang and Lestari (2019) highlight the importance of VR applications in education in higher education settings. Their research emphasizes how VR can boost motivation enhance learning outcomes and improve teaching methods through simulated learning experiences.

Moreover, research by Tosti and Chiang (2021) as Fan and Wang (2023) investigates the impact of interactive VR applications on learning results and user satisfaction underscoring how VR can heighten immersion, empathy and engagement in educational settings. Horváth (2021) explores personalized learning opportunities within 3D VR environments demonstrating the potential, for VR technologies to customize experiences based on individual learning styles and preferences. Kyrlitsias et al. (2020) and Ninaus and Nebel (2021) shed light on learning mechanisms in video games illustrating how analytics and adaptivity contribute to personalized learning journeys and improved academic achievements.

Finally in their study published in 2020 Petukhov and colleagues delve into how to gauge the sense of presence and authenticity in virtual reality settings using brainwave data shedding light on the meaning connections fostered by VR simulations. Taken together these research works underscore the elements and tools, in integrating VR into online education highlighting its capacity to boost involvement, drive and educational achievements across different academic fields. The infusion of virtual reality tools into learning environments requires a rounded approach that includes immersive settings, instant feedback mechanisms, interactive scenarios, teaching methods, user experience enhancements and scalability considerations. By harnessing

these elements and tools teachers and educational institutions can craft successful and inclusive VR powered learning experiences, for students.

2.2 The using of VR is in educational settings

VR technology has become commonly used in settings especially in online learning environments to enhance the learning experience and outcomes. This review aims to offer an overview of the application of VR, in education with a focus on its integration and impact within online learning platforms. The analysis is based on research articles and summaries that specifically discuss the use of VR components and technologies in learning. In a study by Kustandi, Situmorang, & Lestari (2019) on the implementation of VR in education programs it was found that VR can enhance learning outcomes by boosting motivation introducing simulation based learning models and improving overall efficiency. The study suggests that integrating VR into education can increase levels and effectiveness by simulating real world situations and developing learning methods.

Abbas et al. (2023) conducted a review of definitions of VR found in healthcare literature highlighting the diverse terminologies used within the field. The review emphasizes the importance of establishing consensus and standardized definitions to promote communication and understanding within the VR sector including its applications, in education. Fan & Wang (2023) delved into the realm of online learning space design, with the support of VR/AR technology with the goal of creating interactive learning environments for students. Their study focuses on improving how information is presented enhancing cognition and increasing engagement by integrating VR/AR into online learning spaces.

The literature they reviewed emphasizes the applications of VR in settings especially in online learning environments. The integration of VR provides opportunities to boost engagement, motivation learning outcomes and simulation-based learning experiences paving the way for immersive methods. However, challenges such as standardizing terminology, managing implementation costs and keeping up with advancements must be addressed to harness VRs potential, in transforming online learning experiences.

2.3 Key Principles of Virtual Reality in Online Learning

Virtual Reality (VR) is seen as a technology, with potential for online learning providing interactive experiences for students. In this part we discuss the teaching principles that support the use of VR in education investigate theories and models that enhance effective instruction, through VR and examine the advantages and obstacles of incorporating VR into educational settings.

2.3.1 Exploring Pedagogical Principles

One crucial educational principle that supports the incorporation of VR, into learning is the idea of learning. Experiential learning theories like Kolbs Experiential Learning Theory (Kolb, 1984) suggest that learners gain knowledge and skills through experiences and reflection. Research by Kustandi et al. (2019) and Prasetya et al. (2023) demonstrates the benefits of VR in education enhancing student's abilities through simulations and innovative learning approaches. Schols

(2019) stresses the significance of engagement in technology enhanced learning for educators focusing on elements such as authenticity and relevance to teaching contexts. Collectively these studies highlight VRs role in boosting learner motivation, engagement and skill development in online learning settings.Another essential principle is constructivism, which emphasizes that learners build knowledge and understanding based on their experiences and interactions (Jonassen, 1999). Through its immersive features VR allows learners to develop their comprehension of concepts by participating in practical activities problem solving tasks and collaborative exercises, within virtual environments.

2.3.2 Theories and Frameworks for Effective VR-Based Instruction

Numerous theories and models underpin the use of Virtual Reality (VR), for teaching in online educational settings. For example, the Cognitive Load Theory (CLT) states that learning is impacted by the burden placed on learners (Sweller et al., 2011). In VR strategies like experiences interactive simulations and adaptive feedback can be utilized to manage load efficiently ensuring optimal learning outcomes without overwhelming students (Sweller et al. 2011). Furthermore, the Situated Learning Theory highlights the significance of learning in contexts and communities of practice (Lave & Wenger 1991). Through VR simulations authentic learning environments can be created where learners can apply their knowledge and skills in situations enhancing comprehension and transferability of learning. Miller et al. (2019) stress the importance of designing real world scenarios in VR settings to effectively test theory driven interventions.

2.3.3 Benefits and Challenges of VR in Education

Virtual Reality (VR) technology has attracted attention in the field of education for its potential to transform the way students learn. This review of existing literature aims to delve into the advantages and obstacles related to the incorporation of VR technology, in environments.

Benefits of VR in Education;

- Enhanced Learning Experiences; According to Kavanagh et al. (2017) VR provides experiences that can greatly boost students' internal motivation leading to engaged and effective learning outcomes.

- Improved Cognitive Abilities and Practical Skills; Prasetya et al. (2023) illustrate how VR based distance learning can enhance student's cognitive abilities and practical skills in subjects such as Computer Numerical Control (CNC).

- Increased Engagement and Interaction; Radianti et al. (2020) underscore the role of VR applications in education in fostering engagement, interaction and presence among students thereby creating a dynamic and stimulating learning environment.

- Effective Simulation Based Learning; Mariscal Vivas et al. (2020) demonstrate the impact of VR simulation-based learning (VR SBL) on student learning and satisfaction in contexts like first aid training and laboratory simulations.

Challenges Encountered in Implementing Virtual Reality (VR) in Education;

- Financial and Accessibility Barriers; According to Kavanagh et al. (2017) the expenses and practical obstacles linked to integrating VR technologies into settings could impede their use.
- Technical Hurdles and Training Requirements; As highlighted by Miller et al. (2019) there are impediments and a necessity, for training to effectively leverage VR for educational purposes, such as developing lifelike scenarios and validating models.
- Integration into Teaching Methods; Schols (2019) stresses the significance of integrating VR into teaching strategies underscoring the need for professional development and educator support.
- User. Satisfaction; In a study by Samala et al. (2022) challenges concerning user experience are noted, which encompass issues, like internet connectivity disruptions, instructor performance and student engagement levels that can influence the efficacy of VR based learning platforms.

3. Methodology

The thorough examination of how virtual reality (VR)'s incorporated into education included a methodical review of existing literature and organization by learning tasks and feedback methods. The goal of this approach was to offer an understanding of the ways VR is used in online learning and how it affects educational achievements.

3.1 Data Collection Methods

I gathered information from 24 research papers published between 2017 and 2024 that discussed the use of reality in education. The materials came from sources such, as journals, conference papers and reputable online databases. The selection criteria were determined by the articles relevance to virtual reality integration, their emphasis on online learning settings and their exploration of learning activities and feedback systems.

3.2 Categorization Process

The categorization process involved identifying key themes and trends in VR integration within online learning contexts. We categorized VR integration into three major categories based on the types of learning tasks and forms of feedback information:

- VR-Enhanced Online Learning with Full Feedback
- Description: Immersive VR experiences providing learners with real-time feedback.
- Examples: VR simulations in medical education, language learning platforms with interactive scenarios and comprehensive feedback.
- VR-Based Online Learning with Limited Feedback
- Description: VR elements supplementing online learning with partial feedback.

- Examples: VR-based chemistry lab simulations, historical reenactments offering limited feedback on historical events.
- VR-Driven Online Learning Without Feedback
- Description: VR-driven experiences without direct feedback loops.
- Examples: Virtual field trips in geography courses, architectural design workshops focusing on creativity without direct feedback.

The systematic literature review and categorization of VR integration into online learning are presented in the following (Table 1) format, which includes the title, author(s), year of publication, key findings, and category for each of the 24 research articles:

Table1: Systematic Literature Review and Categorization of VR Integration into Online Learning Based on the Specified Criteria.

Title	Author(s)	Year	Key Findings	Category
A systematic review of virtual reality in education	Kavanagh, S., Luxton-Reilly, A., Wuensche, B., & Plimmer, B.	2017	Analyzing the applications, motivations, and problems associated with using VR in education.	VR-enhanced online learning with full feedback
Education on screens: Histories of co-innovation and convergence between audiovisual media and education sectors	Fiadotau, M., Sillaots, M., & Ibrus, I.	2019	Explores cooperation and co-innovation between audiovisual media and education sectors over the years.	VR-driven online learning without feedback
Intradialytic virtual reality exercise: Increasing physical activity through technology	Segura-Ortí, E., & García-Testal, A.	2019	VR exercise during hemodialysis can improve physical function and quality of life.	VR-enhanced online learning with full feedback
Early virtual reality adopters in Spain: Sociodemographic profile and interest in the use of virtual reality as a learning tool	Sanchez-Cabrero, R., Costa-Roman, O., Pericacho-Gómez, F. J., Novillo-Lopez, M. A., Arigita-García, A., & Barrientos-Fernandez, A.	2019	Describes the social and demographic profile of VR users in Spain and their interest in using VR for learning.	VR-driven online learning without feedback
Integration of properties of VR, artificial neural networks, and artificial intelligence in the automation of software tests: A review	E. S. M., E. A. M., & Alexei Serna, A.	2019	Discusses the potential of using VR, ANNs, and AI in automating software tests.	VR-driven online learning without feedback
Virtual Reality Use in Online Learning	Kustandi, C., Situmorang, R., & Lestari, I.	2019	VR can foster motivation, develop students' skills, and improve teaching practices.	VR-driven online learning with full feedback
Factors that Foster Teacher Educators' Engagement in Technology Learning in the Workplace	Schols, M.	2019	Engagement in technology learning is fostered by factors like authentic teaching contexts.	VR-enhanced online learning with full feedback

Bringing the real world into the experimental lab: Technology-enabling transformative designs	Miller, L. C., Wang, L., Jeong, D. C., & Gillig, T. K.	2019	Testing the effectiveness of theory-driven, evidence-based manipulations in lifelike virtual scenarios.	VR-driven online learning without feedback
Not alone here?! Scalability and user experience of embodied ambient crowds in distributed social virtual reality	Latoschik, M. E., Kern, F., Stauffert, J.-P., Bartl, A., Botsch, M., & Lugrin, J.-L.	2019	Investigates performance and user experience in social VR, highlighting scalability and immersive encounters	VR-enhanced online learning with full feedback
VR Use in Online Learning for Higher Education in Indonesia	Kustandi, C., Fadhillah, D., Situmorang, R., Prawiladilaga, D., & Hartati, S.	2020	VR can foster motivation, develop student skills, and enhance teaching practices in online learning.	VR-enhanced online learning with full feedbac
Virtual reality simulation-based learning	Mariscal Vivas, G., Jiménez García, E., Vivas Urías, M. D., Redondo Duarte, S., & Moreno Pérez, S.	2020	Assessing the impact of VR simulation on student learning and satisfaction in two cases within higher education.	VR-enhanced online learning with full feedback
Augmented reality (AR) learning application based on the perspective of situational learning	Zhao, X., Li, X., Wang, J., & Shi, C.	2020	Investigating the integration of AR learning with situational cognition for various educational psychology aspects.	VR-driven online learning without feedback
A virtual tour of a hardly accessible archaeological site: The effect of immersive virtual reality on user experience, learning, and attitude change	Kyrlitsias, C., Christofi, M., Michael-Grigoriou, D., Banakou, D., & Ioannou, A.	2020	VR enhances user experience, learning, and attitude change, particularly in inaccessible sites.	VR-driven online learning without feedback
Being present in a real or virtual world: an EEG study	Petukhov, I. V., Glazyrin, A. E., Gorokhov, A. V., Steshina, L. A., & Tanryverdiev, I. O.	2020	EEG study shows similarities in brain activity between real and virtual environments, indicating VR realism.	VR-driven online learning without feedback
A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda	Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I.	2020	Reviews VR applications in higher education, identifies gaps in theory application and outcome evaluation.	VR-enhanced online learning with full feedback
Investigating effects of interactive virtual reality games and gender on immersion, empathy, and behavior into environmental education	Tosti, H.-C., & Chiang, H.-C.	2021	Exploring the impact of VR games on students' immersion, empathy, and actual behaviors towards environmental education.	VR-enhanced online learning with full feedback
Virtual reality in medical students' education: A scoping review protocol	Jiang, H., Sunitha, V., Bhone, M. K., & Lorainne, T. C.	2021	Exploring the applications and potential of VR tools in medical education through a scoping review.	VR-driven online learning without feedback
An analysis of personalized learning opportunities in 3D VR	Horváth, I.	2021	Studying the efficiency of 3D VR platforms for personalized learning experiences and adaptive learning environments.	VR-enhanced online learning with full feedbac

Effects of the Application of Virtual Reality to Experiential Education on Self-Efficacy and Learning Motivation of Social Workers	Hsiao, S. C.	2021	VR in experiential education affects self-efficacy and learning motivation among social workers.	VR-enhanced online learning with full feedback
A systematic literature review of analytics for adaptivity within educational video games	Ninaus, M., & Nebel, S.	2021	Analyzes adaptivity in educational games, highlighting efficacy but noting a lack of common theoretical foundations.	VR-based online learning with limited feedback
Online Learning Applications for Students: Opportunities & Challenges	Samala, A. D., Marta, R., Anori, S., & Indarta, Y.	2022	Students perceive online learning positively but face challenges like poor motivation and technical issues.	VR-based online learning with limited feedback
Effectiveness of Distance Learning Computer Numerical Control Based on Virtual Laboratory Using a Metaverse Platform to Improve Students' Cognitive Ability and Practice Skills	Prasetya, F., Fortuna, A., Samala, A. D., Fajri, B. R., Efendi, F., & Nyamapfene, A.	2023	Virtual laboratories enhance cognitive abilities and practical skills in distance learning.	VR-enhanced online learning with full feedback
Constructivist Computer-Based Instruction (CBI) Approach: A CBI Flipped Learning Integrated Problem-Based and Case Method (PBL-cflip) in Clinical Refraction Course	Novalinda, R., Giatman, M., Wulansari, R. E., & Trung Tin, C.	2023	The CBI Flipped Learning approach improves critical thinking, collaboration, and creativity skills in clinical refraction courses.	VR-enhanced online learning with full feedback
Research on online learning space design supported by VR/AR technology	Fan, J., & Wang, C.	2023	Introducing VR/AR technology into online learning space design for improved information presentation and immersive experiences.	VR-enhanced online learning with full feedback

*The table was prepared by the researcher based on a literature review.

This table presents 24 research papers published between 2017 and 2023 grouped into three categories; VR enhanced learning, with feedback VR based online learning with limited feedback and VR driven online learning without feedback. It also outlines the discoveries associated with each category. Feel free to adjust the tables layout or content as necessary. By categorizing these studies, we gain insights into approaches to integrating VR technology into education and their effects on learning outcomes. In this discussion I delve into three types of VR integration in online learning providing examples and case studies for each; VR Enhanced Online Learning with Full Feedback; This category involves VR experiences that offer learners feedback on their actions within virtual scenarios. Through interaction with simulated environments and immediate feedback learners enhance their learning journey. Studies in this category showcase the use of VR to enrich education by providing feedback mechanisms. For instance, Segura Ortí and García Testals (2019) study illustrates how VR exercises, during hemodialysis can enhance function and quality of life underscoring the effectiveness of learning experiences in healthcare education.

In the realm of VR based online learning, with feedback researchers delve into the use of reality in online educational settings that offer restricted feedback but still deliver valuable learning opportunities. For instance, Samala and colleagues (2022) examine how online learning applications can benefit students while addressing challenges like motivation and technical difficulties. Despite the constraints on feedback these mechanisms help educators identify areas for enhancement in VR enhanced online learning environments.

Moving on to VR driven learning without feedback this category encompasses experiences where virtual reality is utilized for learning purposes without incorporating direct feedback mechanisms. Learners navigate through VR environments for hands on learning experiences without feedback loops. Studies within this domain explore how VR is applied in education settings that lack feedback systems. For instance, Fiadotau et al. (2019) explore the connections, between media and education industries by showcasing VR driven online learning scenarios that do not heavily rely on detailed feedback mechanisms.

Furthermore, the research conducted by Miller and colleagues in 2019 explores designs made possible by reality (VR) underscoring the potential of VR driven educational experiences even without immediate feedback systems. The study delves into the integration of VR technology, in online learning stressing the significance of considering learning tasks and feedback mechanisms when creating learning opportunities. Through a review of literature our research categorizes the incorporation of VR in education based on feedback processes offering valuable insights into different approaches to VR implementation and their effects on learning outcomes. These classifications provide a framework for educators and scholars to comprehend the intricacies of integrating VR into online learning settings and customize strategies, for educational experiences.

4. Discussion

Reality (VR) integration, in education with comprehensive feedback offers a wide range of advantages that greatly enhance the learning experience for both students and teachers. In this exploration we examine the impact of this approach drawing on insights from research studies. Increased Student Engagement; Research by Radianti et al. (2020). Tosti & Chiang (2021) underscores how VR enhanced online learning boosts student engagement levels significantly. The immersive quality of VR environments captures students interest leading to attentiveness, participation and motivation to learn. Enhanced Learning Outcomes; Studies by Prasetya et al. (2023). Mariscal Vivas et al. (2020) illustrate the effects of VR enhanced learning on student's cognitive skills, practical abilities and overall academic achievements. Through VR simulations students can apply knowledge in practical settings resulting in a deeper comprehension and retention of concepts.

Personalized and Adaptive Learning; Horváth (2021) explores the effectiveness of VR platforms, in delivering tailored learning experiences and adaptive educational settings. VR technology enables learning paths, customized content delivery and immediate feedback to accommodate individual learning preferences and pace. Engaging Experiences and User Satisfaction; Fan &

Wang (2023) and Hsiao (2021) highlight the significance of virtual reality (VR) in providing learning experiences that boost user satisfaction. Online learning platforms enhanced with VR feature simulations, virtual tours and immersive learning settings that captivate users resulting in increased satisfaction and involvement. Efficient Feedback Systems; VR environments equipped with feedback mechanisms as explored by Prasetya et al. (2023) and Fan & Wang (2023) offer real time feedback, on student performance enabling adjustments, guidance and evaluation. This prompt feedback loop contributes to improvement and mastery of learning goals.

In summary VR enhanced online learning with robust feedback mechanisms presents advantages such as heightened engagement, enhanced learning outcomes, personalized learning experiences, immersive settings and efficient feedback systems. Nevertheless, challenges like expenses, technical prerequisites and educational integration must be tackled to leverage the potential of VR, in education. Future research endeavors should concentrate on overcoming these obstacles to develop scalable and impactful VR enhanced educational solutions.

4.1 Challenges;

1. Technical Complexity; Bringing VR into learning involves using tools, software and tech assistance which can be tough, for both schools and students. For example, Samala et al. (2022) pointed out glitches as a hurdle for students in online learning programs.

2. Cost and Accessibility; VR gear and software can come with a price tag creating obstacles for educational institutions and students. This hinders the adoption and availability of VR enhanced learning experiences (Kustandi et al., 2019; Samala et al., 2022).

3. Content Development; Crafting top notch VR content that meets goals and captivates learners can take up a lot of time and resources (Kustandi et al., 2020). This obstacle is emphasized by Radianti et al. (2020) in their examination of VR applications, in education.

4. Training and Support; Teachers and instructional designers may need guidance and assistance to effectively blend VR into their teaching methods (Kustandi et al., 2020).

5. This involves grasping teaching methods, for VR enhanced education and the technical know-how for creating and managing content.

6. Designing user friendly VR experiences that enhance learning outcomes while prioritizing usability and comfort for users is an endeavor (Radianti et al., 2020). Elements like interface design, interaction mechanics and content delivery significantly influence the user experience and effectiveness of learning.

7. Crafting reliable assessment techniques and evaluating learning achievements in VR settings present difficulties due to the immersive nature of VR enhanced education (Kustandi et al., 2020; Radianti et al., 2020). It is crucial to ensure that assessments accurately gauge intended learning goals while considering the features of VR.

8. Seamlessly incorporating VR into existing teaching frameworks and curricula demands planning and alignment with educational objectives (Kustandi et al., 2020). Educators require guidance on how to utilize VR technology to enrich learning experiences.

4.2 Best Practices

The research has uncovered a number of methods, for integrating VR technology into online learning complete with feedback. These strategies involve crafting interactive virtual reality settings incorporating real time feedback systems and offering support to both students and teachers (Khan, 2022; Evans, 2023). Key Strategies;

- Optimal Approaches for VR Enhanced Online Learning with Detailed Feedback;
- Engaging Learning Environments; Utilize features such as simulations, virtual labs and immersive experiences to boost engagement and enhance learning outcomes. Research like Prasetya et al.s study "Effectiveness of Distance Learning Computer Numerical Control Based on Virtual Laboratory Using a Metaverse Platform" (2023) showcases how virtual labs can significantly enhance abilities and practical skills in distance education.
- Educational Techniques; Employ methods that VR technology to cultivate motivation build skills and improve teaching approaches. Studies such as Kustandi et al.s research "VR Use in Online Learning for Higher Education in Indonesia" (2020) underscore the effects of VR on motivation levels, skill development and teaching practices, within online learning settings.
- User Experience Enhancement; Emphasize the enhancement of user experience by creating user VR environments.

Research studies, like the one conducted by Mariscal Vivas and colleagues in 2020 titled " reality simulation-based learning " look into how VR simulations impact student learning and satisfaction. They stress the significance of user satisfaction in enhancing learning through VR technology. One area worth exploring is learning environments within VR platforms, which aim to tailor learning experiences according to needs and preferences. Horváths study from 2021 "An analysis of learning opportunities in VR " delves into the effectiveness of 3D VR platforms for creating personalized and adaptive educational settings.

It is crucial to conduct outcome evaluations to gauge the efficiency and influence of online learning enhanced by VR technology. For instance, Radianti et al. Study from 2020 "A systematic literature review of virtual reality applications for education " evaluates the use of VR applications in higher education identifies gaps in theory implementation and underscores the importance of outcome assessment for continual enhancement. These recommended practices underscore the necessity of integrating sound, user friendly, adaptable and evaluative components into online learning environments enhanced by VR technology to enhance learning experiences and results effectively.

Specific examples include applications that leverage full feedback, within VR enhanced online education contexts. Let’s explore an examination of this category based on the insights gathered from various research studies; Virtual Reality (VR) Exercise During Hemodialysis; In a study

conducted by Segura Ortí and García Testal in 2019 the utilization of VR exercise, during hemodialysis was investigated, highlighting its potential to enhance physical function and improve the quality of life for individuals undergoing this medical procedure. This case exemplifies how VR can be incorporated into healthcare education to simulate real life scenarios and enhance outcomes. Implementation of Virtual Laboratories in Distance Learning; Prasetya et al. (2023) carried out research on the effectiveness of distance learning in Computer Numerical Control (CNC) using laboratories within a Metaverse platform. Their results underscored how VR enhanced laboratories can significantly boost student's cognitive abilities and practical skills demonstrating the impact of learning environments in education.

Engagement of Teacher Educators in Technology Learning; Schols study in 2019 focused on identifying factors that promote teacher educators' involvement, in technology learning within settings. This research highlights the significance of teaching environments and immersive experiences facilitated by VR technologies resulting in increased engagement and improved learning outcomes among educators. The study, by Mariscal Vivas et al. (2020) explored how VR simulation-based learning impacts education. Their findings suggest that VR simulations can enhance student learning and satisfaction by offering a learning environment alongside teaching methods. In a research Horváth (2021) delved into learning opportunities in 3D VR platforms. The study emphasized the potential of VR technology to create tailored and adaptive learning environments that cater to preferences and styles ultimately improving the effectiveness of learning. These specific applications of VR highlight the ways in which this technology is being integrated into online learning environments with feedback mechanisms. From healthcare simulations to learning experiences, VR enhanced education is leading the way, towards engaging and successful educational outcomes.

4.3 Impact on Learning Experience

The researcher explored how receiving feedback enriches the learning journey by offering learners instant feedback, on their actions and decisions within the virtual setting. This ongoing feedback loop boosts engagement, encourages participation. Supports the application of knowledge in real world scenarios (Nguyen, 2023).

Effects on Educational Outcomes;

- Utilizing VR technology in learning with feedback notably enhances student engagement, retention of knowledge and acquisition of skills across diverse subject areas.
- Discussion on Comprehensive Feedback Enhancements;
- In virtual reality environments, comprehensive feedback heightens the learning experience by delivering learners with real time updates immediate corrective measures and chances for learning and advancement.

This text presents an examination of VR integrated learning featuring extensive feedback addressing its advantages, obstacles recommended approaches and influence on the educational journey. This examination stems from a review of literature and classification of VR

incorporation into education with a specific focus on VR enhanced online learning, with detailed feedback.

4.4 VR Based Online Learning, with Restricted Feedback

This particular approach involves integrating reality (VR) into online learning to offer learners limited feedback. The main focus is on utilizing VR elements to improve aspects of learning tasks without providing feedback mechanisms. It represents a category where VR technology is incorporated into online learning environments with feedback methods aiming to enhance the learning experience through VR elements while offering learners only partial feedback. Various studies have examined the effectiveness and challenges associated with this approach; Online Learning Tools for Students; In a study by Samala et al. (2022) focusing on students views on online learning tools it was found that students generally favored learning but encountered issues such as motivation and technical challenges. This suggests that while VR enhanced elements can boost learning limited feedback may affect motivation and engagement.

Immersive Virtual Reality Applications in Education; Radianti et al. (2020) analyzed VR applications in education emphasizing design aspects and key takeaways. They highlighted the potential of VR to enhance learning but also identified gaps in application and outcome evaluation, due, to restricted feedback mechanisms.

Adaptivity, in Educational Video Games; The study by Ninaus and Nebel (2021) delved into the concept of adaptivity in games highlighting its effectiveness while pointing out the absence of accepted theoretical foundations. The lack of feedback mechanisms for adaptivity poses a challenge in offering consistent and personalized feedback within VR enhanced learning settings.

4.5 VR Driven Online Learning Without Feedback

This category covers experiences where Virtual Reality (VR) is used for learning without incorporating feedback into the process. Students immerse themselves in VR environments for hands on learning without direct feedback loops. In this context VR driven online learning without feedback represents a scenario where VR technology is heavily utilized in education. Lacks robust feedback mechanisms. Here are key findings from studies supporting this category; Integration of VR, Artificial Neural Networks (ANNs) and AI in Automation; In their 2019 paper E.S.M., E.A.M., & Alexei Serna discussed the applications of VR, artificial neural networks (ANNs) and artificial intelligence (AI) in automating software tests. This points to a growing trend of utilizing VR for purposes and automation even though direct feedback mechanisms are not prominently featured.

Virtual Reality, in Medical Education; Jiang et al. (2021) examined the uses and future prospects of using virtual reality tools in education. While Virtual Reality (VR) provides experiences the main focus often lies on creating simulations and facilitating learning rather than providing immediate feedback aligning well with the educational aspects of VR. Exploring Presence in Virtual Environments; A study, by Petukhov et al. (2020) used EEG to compare brain activity in virtual settings revealing similarities in brain responses that underscore the immersive quality of

VR albeit without delving into feedback related mechanisms. These research findings collectively suggest that while VR driven approaches offer learning opportunities, the lack or limited availability of feedback mechanisms poses challenges in optimizing learning outcomes and sustaining student engagement. Grasping these dynamics is essential for implementing and enhancing VR based online learning environments.

5. Conclusion

The use of Virtual Reality (VR), in education has provided valuable insights into the various ways this innovative technology can be applied. The survey results show that VR integration can be categorized based on learning tasks and feedback mechanisms resulting in three types; VR enhanced learning with comprehensive feedback VR based online learning with limited feedback and VR driven online learning without feedback. Each category presents its benefits and challenges contributing to a nuanced understanding of how VR enhances the learning experience. The surveys impact on understanding VR integration in education is extensive. It has established a framework for evaluating and classifying VR applications, identified trends and new technologies and emphasized the significance of pedagogical strategies and user experience improvements in educational settings driven by VR. Furthermore, the survey has highlighted how VR has the potential to revolutionize online learning methods by providing immersive personalized and engaging experiences for learners.

These findings have implications for educators, researchers and professionals, in the field of education. Educators can utilize VR technologies to create interactive learning environments that accommodate learning styles while increasing student engagement and retention rates. Researchers have chances to explore virtual reality (VR) technologies, teaching methods and improvements, in user experience. This contributes to the development of integrating VR into education. Educators can gain insights from practices and case studies highlighted in the survey helping them implement VR based learning initiatives.

In conclusion the importance of VR in revolutionizing learning experiences cannot be overstated. It signifies a shift towards immersive, experiential and student-centered education. Providing opportunities for innovation and creativity in teaching and learning. As VR technologies advance and become more accessible their potential to transform education and empower learners across subjects and settings is immense. Embracing VR integration in learning is more than a passing trend; it's a transformative journey, towards shaping the future of education in the digital era.

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