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THE IMPACT OF VIRTUAL REALITY ON LEARNING AND EDUCATION

Praneet Goel, Amit Joshi
ISMA University, Valērijas Seiles iela 1-korpuss 6, Rīga, LV-1019
**Corresponding author's e-mail: praneetgoel.148@gmail.com*
www.isma.lv

Abstract

Virtual reality (VR) technology is rapidly advancing and has potential to transform learning and education. This research investigates the impact of virtual reality on education through a comparative analysis of VR content creation tools, developing a sample educational topic in VR and evaluating it through case studies. The advantages and limitations of tools that allow VR content creation are explored to identify optimal solutions for digitizing educational content. Then I'll make a sample VR lesson to show how it's done and then assess a group of students to try my VR demo and give feedback on it. The expected results include determining which types of educational content benefit most from VR recreation based on student outcomes. Challenges in VR content creation are identified and solutions proposed to streamline development of VR learning environments. This will provide educators guidelines and recommendations for effectively utilizing VR technology for enhanced learning and training. The expected impact is demonstrating the value of thoughtfully implemented VR for increased student engagement, knowledge retention and accessibility. This research aims to facilitate broader VR adoption in education through practical frameworks for digitizing curriculum to take advantage of VR's unique capabilities.

Keywords: Virtual Reality, Education Technology, VR Content Creation, Immersive Learning, Student Engagement

1 Introduction

In the ever evolving landscape of educational technology, Virtual Reality (VR) emerges as a promising frontier with vast untapped potential. This thesis endeavours to delve into the impact of VR on education, exploring its theoretical underpinnings through a comprehensive literature review and practical evaluation of VR tools. As we stand at the intersection of traditional

pedagogy and immersive technological experiences, the need for rigorous research becomes apparent to guide educators in harnessing the benefits of VR effectively.

The first section of this research aims to dissect the intricate mechanisms by which VR influences the learning process. Questions surrounding its ability to enhance student engagement, motivation and overall learning outcomes are pivotal in understanding the transformative power of this technology.

Moving beyond theoretical considerations, the second section of the thesis explores the pedagogical implications of integrating VR into educational settings. This involves investigating how VR can be seamlessly incorporated into diverse subjects and adapted to cater to different learning styles, thereby transforming classrooms into dynamic, interactive learning environments.

Recognizing the challenges and opportunities inherent in the adoption of VR in education, the third section scrutinizes barriers faced by educators. From technological complexities to content development costs, this research aims to identify key challenges and propose innovative solutions, including frameworks and guidelines, to facilitate a smoother integration of VR into educational practices.

The subsequent sections outline a methodical approach to our research goals:

1. Comparative Analysis of VR Content Creation Tools: A thorough examination of existing VR content creation tools and their capabilities in educational contexts.

2. Development of Sample VR Content: Creating a sample virtual reality lecture, activity, and assessments to illustrate the translation of traditional curriculum into the VR environment.

3. Evaluation of Student Outcomes: Conducting case studies to assess student outcomes and perceptions when exposed to VR content compared to conventional teaching methods.

4. Identifying Challenges and Solutions: A focused exploration of challenges educators face in developing and deploying VR learning materials, accompanied by proposed solutions, including frameworks and automation.

5. Recommendations and Best Practices: Offering evidence-based recommendations and best practices for the effective integration of VR into pedagogy, derived from the comparative studies.

The anticipated outcome of this research is a nuanced understanding of how VR can be leveraged to enhance education for all students. Beyond theoretical insights, the research aims to contribute practical solutions, potentially paving the way for the development of new VR-based educational

tools and resources. As we navigate the uncharted territories of VR in education, this study holds the promise of influencing not only teaching practices but also shaping the future design of VR hardware and software tailored to educational needs.

2 The Potential of Virtual Reality Technologies for Transforming Teaching and Learning

2.1 Virtual Reality (VR)

Virtual reality (VR) is a simulated environment that can be experienced through a headset or other device. VR creates an immersive experience that allows users to interact with the environment as if they were actually there. It enables a person to interact with an artificial three-dimensional (3-D) visual or other sensory environment. VR applications immerse the user in a computer-generated environment that simulates reality through the use of interactive devices which send and receive information. [1] [2]

VR technology has been used in various fields such as entertainment, education, gaming, healthcare, etc. VR headsets have become more affordable and accessible with options ranging from high-end devices to smartphone-based VR solutions. According to Jonathan Strickland, “An effective VR experience causes you to become unaware of your real surroundings and focus on your existence inside the virtual environment”. [3]

2.2 Immersive Technology

There are two main types of VR experiences, such as Immersive VR and Non-immersive VR: [4]

Feature	Immersive VR	Non-Immersive VR
Display	Head-mounted display (HMD)	Computer monitor, TV, or smartphone
Input	Controllers, motion sensors, eye tracking	Keyboard, mouse, or touch screen
Sense of presence	High	Low
Immersion	High	Low
Cost	High	Low
Availability	Limited	Widespread

One important aspect of VR is the concept of presence which refers to the feeling of being physically present in the virtual environment. Achieving a strong sense of presence is crucial for creating a truly immersive and realistic VR experience. This can be facilitated through various techniques such as accurate tracking of head and body movements, high-resolution displays,

spatial audio, and haptic feedback. Furthermore, VR applications are not limited to visual experiences alone. The integration of other sensory modalities such as haptic feedback and olfactory stimulation (stimulating the sense of smell) is being explored to create even more realistic and engaging virtual environments.

2.3 Augmented Reality (AR)

A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.[5]

2.4 Mixed Reality (MR)

A hybrid of real and virtual environments that allows users to interact with digital objects in the real world. [6]

2.5 Virtual Reality in Education

The topic of virtual reality (VR) in education is a very timely one. VR is a rapidly developing technology with the potential to revolutionize the way we learn. There is a growing body of research on the impact of VR on education and the results are very promising. [5]

VR can be used to create immersive and interactive learning experiences that can help students to understand complex concepts and to develop new skills. For example, VR can be used to simulate real-world environments such as a medical operating room or a historical battlefield. This can help students to learn by doing and to gain a deeper understanding of the concepts being taught.

In addition to its educational benefits, VR can also be used to improve student engagement and motivation. VR experiences can be very engaging and immersive which can help to keep student's attention and to motivate them to learn.

Fig. 1. Benefits of VR in Education (Adopted from [7])

There are many potential benefits of using VR in education. For example, VR can be used to:

1. Provide students with real-world experiences: VR can be used to create virtual field trips to places that would otherwise be inaccessible to students such as the inside of the human body or the surface of Mars. This can help students to develop a better understanding of the world around them.

2. Help students to learn complex concepts: VR can be used to create simulations that allow students to interact with complex concepts in a safe and controlled environment. This can help students to understand these concepts better and to develop the skills they need to apply them in the real world.

3. Increase student engagement: VR can be used to create highly engaging and immersive learning experiences. This can help to keep students motivated and to improve their learning outcomes.

2.6 Virtual Reality tools used in Education

VR education is still evolving. However, there are a number of companies that are developing VR educational content. There are now a number of VR tools and platforms available and these tools are becoming more affordable and accessible. This is making it easier for educators to incorporate VR into their classrooms. Some of the most popular VR educational applications include:

1. Google Expeditions [8][9]**:** Google Expeditions is a platform that allows teachers to create and share virtual field trips. Expeditions AR uses Google's AR technology to bring 3D objects into the physical classroom, enabling students to interact with and explore them from different angles. This immersive learning experience enhances understanding and engagement, making learning more interactive and enjoyable.

Fig. 2. Visuals which can be seen in Google Expeditions

2. Tilt Brush [10]: Tilt Brush is a VR painting application that allows users to create 3D paintings in a virtual environment. It's used in activities such as creating virtual art galleries, collaborating on projects, exploring cultural and historical sites and visualizing spatial designs. By immersing students in a virtual creative environment, Tilt Brush enhances their artistic skills, collaboration and understanding of various subjects.

Fig. 3. Image created using Tilt Brush ([11])

3. ANATOMEYES [12]**:** ANATOMEYES is a VR anatomy application that allows users to explore the human body in 3D. These are available for a variety of VR devices, including the Oculus Rift.

Fig. 4. Human body anatomy using VR ([13])

4. VRroom [14]**:** VRroom is a free tool which provides a space where students can connect and engage behind playful avatars, making online learning more enjoyable and helping students feel more confident in participating and expressing themselves.

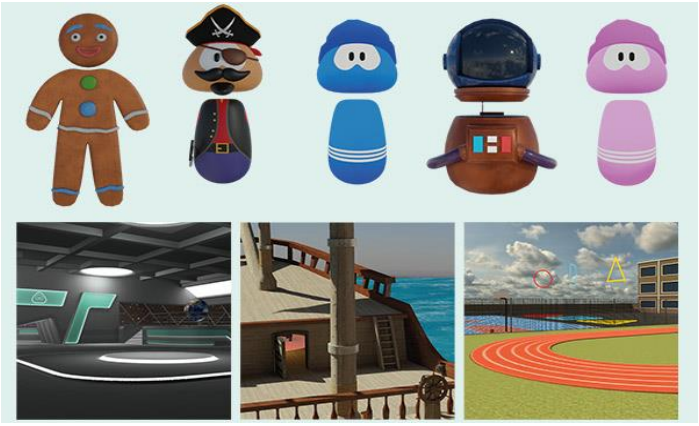

Figure 5: Avatars and Environment in which students interact

2.7 Softwares/Tools used for creation of VR applications [15]

1. Unity [16]**:** It is a game development engine that is mostly used to create VR apps, games, and industrial applications. It is compatible with Oculus, HTC Vive and PlayStation VR. Unity also offers a collection of tools for AR and VR development such as Interact and VisualLive. These tools can be used to create advanced VR system applications and real-time AR experiences. Unity is a powerful tool for VR development and it offers a wide range of features and tools to help developers create high-quality VR experiences. One real life example is: The Khan Academy is using Unity to create interactive 3D models of mathematical concepts. These models allow students to visualize and interact with mathematical concepts in a way that is not possible with traditional methods.

2. Blender [17]**:** It is a free and open-source 3D creation suite. It supports the entirety of the 3D pipeline–modelling, animation, simulation, rendering, compositing and motion tracking, video editing and 2D animation pipeline. Blender is used for a wide variety of purposes, including 3D modelling, 3D animation, visual effects, simulation, rendering, compositing, motion tracking, video editing and 2D animation. It is a powerful and versatile tool that can be used for a wide variety of purposes. Blender is free and open-

source. It has a large community of users and developers who can provide support and resources.

Figure 6. Blender Tools ([18])

3. SteamVR SDK [19][20]**:** It is a software development kit (SDK) that allows developers to create applications for SteamVR. It provides a set of APIs that developers can use to access the features of SteamVR such as head tracking, motion tracking and haptics. It is a powerful and versatile SDK that allows developers to create a wide range of VR applications. It is supported by a wide range of VR headsets such as HTC Vive, Oculus Rift, etc.

4. Unreal engine [21]**:** It is a game engine developed by Epic Games. It is a powerful and versatile engine that is used to create 2D, 3D and virtual reality (VR) games and applications. Unreal Engine is known for its high-quality graphics and its ability to create realistic and immersive experiences. Unreal Engine is used by a wide range of developers from AAA game studios to indie developers. Some of the most popular games that have been created with Unreal Engine such as Fortnite, Gears of War and The Last of Us. Unreal Engine is also used to create a wide range of VR applications such as Tilt Brush, The Lab and Google Earth VR. It is known for its high-quality graphics. It uses a physically-based rendering (PBR) system that allows developers to create realistic and immersive visuals. Also, it has a built-in VR support so that the developers don't have to use any third party tools.

5. Cardboard VR development tool [15]**:** It is a low cost, lightweight and easy to set up way to get started with VR development. It is compatible with most smartphones and has a wide range of support including documentation, tutorials and sample code. The Cardboard VR development tool can display 3D scenes with stereoscopic rendering, track the user's head

movements and detect when the user presses the viewer button. The Cardboard Design Lab is a free app that helps creators understand how to craft a virtual reality experience using their Cardboard VR development tool.

There are several paid tools apart from these mentioned above such as Autodesk Maya 3D Computer Graphics Toolset, Autodesk 3ds Max® modelling and rendering software, Cara VR™ Virtual Reality Plugin Toolkit for Nuke, etc. which are used for development of VR applications.

Feature	Unity	Blender	SteamVR SDK	Unreal Engine	Google Cardboard VR Development Tool
Type	Game engine	3D creation suite	SDK	Game engine	VR development tool
Pricing	Free	Free	Free	Free	Free
Platforms	Windows, macOS, Linux, Android, iOS	Windows, macOS, Linux	Windows, macOS, Linux	Windows, macOS, Linux, Android, iOS	Android
Features	2D, 3D, VR, AR	3D modeling, animation, rendering, texturing	Head tracking, motion tracking, haptics	2D, 3D, VR, AR	Stereoscopic rendering, head tracking, button input
Learning curve	Medium	Steep	Medium	Medium	Easy
Community	Large and active	Large and active	Active	Large and active	Active
Best for	General-purpose VR development	3D modeling and animation	VR development for SteamVR headsets	General-purpose VR development	VR development for Google Cardboard

2.8 Text to Speech Tools

1. Murf.ai [22]**:** It is an AI that generates speech from images. It can customize aspects like gender, accent, etc. It has integration options for things like chatbots.

2. Descript [23]**:** This tool is used to edit audio by editing the text transcript. We could potentially upload an image, generate a synthetic voice transcript and then edit it to put words in the image's mouth.

3. Lyrebird [24]**:** It is an API for descript that can generate a synthetic voice by analyzing just a short audio sample. It could record a little audio to match an image, then generate a full voice.

2.9 Meta Human

1. HeyGen [25]**:** It is a free online tool that uses artificial intelligence to turn photos into realistic talking heads. We can choose from a variety of pre-

recorded voices or record your own audio to make your talking photos come alive. It is not as refined as other tools, such as Synthesia.

2. Wav2Lip [26]**:** It is an open source project for generating lip sync from audio. You could synthesize audio for an image, then animate it.

3. Synthesia [27]**:** It is an AI-powered tool that allows users to create videos with realistic AI avatars and voiceovers through a process called text to video. It can create videos without having to film yourself or hire a professional actor. We just have to type in text, choose an avatar and Synthesia will generate a video. It is used in marketing, educational purpose, etc.

2.10 Challenges in VR education

There are still some challenges that need to be addressed before VR can be widely adopted in education. These challenges include: [28]

Challenges		Solution
Cost	VR headsets can be expensive, which can make it difficult for schools to afford them.	The cost of VR headsets is decreasing as the technology becomes more mainstream. Schools can also purchase shared VR headsets that can be used by multiple students. Schools can also create VR content that can be viewed on smartphones or tablets, which are more affordable and accessible than VR headsets.
Accessibility	Not all students have access to VR headsets, which can create a digital divide.	Schools can make VR more accessible to students by purchasing shared VR headsets or creating VR content that can be viewed on smartphones or tablets. Schools can also work with local libraries or community centers to provide VR access to students who do not have access at home.
Motion Sickness	Motion sickness is a common problem that can occur when using VR headsets. This is because VR headsets simulate movement, which can cause the user's body to feel motion sickness.	Schools can use VR headsets that have built-in motion sickness prevention features. Schools can also create VR content that is less likely to cause motion sickness, such as content that does not involve a lot of movement. Schools can also gradually expose students to VR, starting with short sessions and gradually increasing the length of the sessions over time.
Content Development	Creating high-quality educational VR content requires time, resources and expertise.	Schools can collaborate with VR developers to create educational VR content that is relevant to their subject area and that is aligned with their learning goals. Schools can also

		use open-source VR resources that can be used by teachers to create their own VR content.
Training and Support	Teachers may require training and ongoing support to effectively integrate VR into their teaching practices.	Schools can provide professional development opportunities for teachers to learn how to use VR in the classroom. Schools can also provide technical support to teachers to help them troubleshoot problems with VR headsets and VR content.

Despite these challenges, there is a lot of potential for VR to improve education. As the technology continues to develop and the cost of VR headsets decreases, we can expect to see VR become more widely used in schools.

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Authors

Praneet Goel, 13-03-1998, INDIA
Current position, grades: Student
University studies: MS in Computer Science
Scientific interest: Virtual Reality, Data Engineering
Publications (number or main): main
Experience: NA

Amit Joshi, 18th July 1987, INDIA
Current position: Lecturer at ISMA University
University studies: BA School of business and Finance
Scientific interest: Artificial intelligence and machine learning, iOT
Publications (number or main): 6th
Experience: 14 + years