K-Media

VIRTUAL REALITY IN EDUCATION

Designing Immersive and Innovative Learning Experiences

Dwi Sulisworo
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FOREWORD

We praise and thank God for the presence of Almighty God because of His abundance of Grace and Grace so that the book *"Virtual Reality In Education: Designing Immersive and Innovative Learning Experiences"* can be prepared smoothly and on time. This book has been prepared systematically so that elementary school teachers can understand technology-based learning models and to improve students' critical thinking skills. This book contains types of learning models, types of learning media, virtual reality, and student HOTS. Finally, our thanks and appreciation go to:

1. Ministry of Education and Culture, Research and Technology, which has funded the creation of a book on *Virtual Reality In Education: Designing Immersive and Innovative Learning Experiences*
2. All parties who helped in compiling this guidebook.

Future improvements and changes to this guidebook are always open and possible considering ongoing developments in the situation, policies and regulations. The compiler realizes that this book is still very far from perfection, both in terms of the form of preparation and the material. The authors really hope for suggestions from readers for further improvement of this book. Finally, I hope this book can provide benefits to elementary school teachers.

Yogyakarta, November 2023

Compiler

TABLE OF CONTENTS

FOREWORD ..... **iii**
TABLE OF CONTENTS ..... **iv**

CHAPTER 1 INTRODUCTION **1**
1.1. Interactive learning and VR as innovative learning tools 1
1.2. Increase Student Engagement and Motivation 1
1.3. Deeper Understanding of Concepts 3
1.4. Experience Based Learning 4
1.5. Collaboration and Communication 5
1.6. Enrichment of Learning Experiences 6
1.7. A brief history of the development of VR and its impact on education 7
1.8. Theoretical Framework: VR for Enhanced Learning 9

CHAPTER 2 VR FUNDAMENTALS IN LEARNING **12**
2.1. Basic definitions and concepts about VR 12
2.1.1. Immersion 12
2.1.2. Interaction 13
2.1.3. Environment Customization 15
2.1.4. Stereoscopy 16
2.1.5. Realism 18
2.1.6. Sensory-motor 19
2.2. Main components of VR 21
2.3. Types of VR in learning 23

CHAPTER 3 APPLICATION OF VR IN LEARNING 26
3.1. Fields of learning that can be integrated with VR 26
3.1.1. Knowledge (Science) 26
3.1.2. Mathematics 28
3.1.3. Art and Design 29
3.1.4. History 31
3.1.5. Language and Culture 33
3.1.6. Practical Skills 35
3.2. Virtual Reality: A Tool for Immersive Science Experiences 37
3.3. Virtual Lab Simulations 37
3.4. Field Trips and Expeditions 39
3.5. Data Visualization 41
3.6. A concrete example of implementing VR 43
3.7. The benefits and advantages of using VR in achieving external learning 45

CHAPTER 4. 47CHALLENGES AND FUTURE USE OF VR IN LEARNING 47
4.1. Challenges and constraints in using VR 47
4.2. Ethics and Safety in VR Use 48
4.3. VR development potential in future learning 49
4.3.1. Improved Immersion and Realism..... 49
4.3.2. Collaborative Based Learning 52
4.3.3. More Complex Simulation 54
4.3.4. Data-Driven Learning 56
4.3.5. Better Accessibility 57
4.4. Predict the latest trends and innovations in the use of VR for educational purposes. 59

CHAPTER 5. GUIDELINES FOR SAFETY AND ETHICAL CONSIDERATIONS FOR USE OF VR IN BASIC EDUCATION 62

5.1. Long Term Effect and Prolonged Exposure..... 63

5.2. Exacerbating pre-existing psychological or emotional problems 65

5.3. (Un)Reality and Less Real World Interaction 66

5.4. Privacy and Data Collection 67

BIBLIOGRAPHY 70

WRITER BIOGRAPHY 77

CHAPTER 1
INTRODUCTION

1.1. Interactive learning and VR as innovative learning tools

Interactive learning is a learning approach that gives students active opportunities to be involved in the teaching and learning process. In interactive learning, students are not only recipients of information, but also actively participate in exploration, problem solving, and collaboration (Kim, 2006). This learning method can increase student engagement, motivate them to learn, and help strengthen understanding of the concepts being taught. Virtual Reality (VR) is a technology that allows users to feel and interact with an artificial environment that looks and sounds real through the use of a VR headset. VR has been widely applied in various fields, including education. The use of VR in learning offers an innovative and engaging approach to providing students with a more immersive and engaging learning experience (Johnston et al., 2018). Here are some reasons why interactive learning and the introduction of VR as an innovative learning tool are important.

1.2. Increase Student Engagement and Motivation

By enabling students to interact directly with learning content through immersive VR experiences, learning becomes more engaging and engaging (Lartigue et al., 2014). In a VR environment, students can actively engage with realistically replicated objects, environments, or situations. They can explore, observe, experiment, or interact in ways

that are not possible in conventional learning. Students' confidence in learning materials can be increased because they can see and feel concepts or phenomena directly (C. K. Lee & Shea, 2020). For example, in science lessons, students may conduct virtual experiments in a laboratory or explore different natural environments to study biodiversity. In history lessons, they can visit historical sites and experience important moments in historical events. Immersion in a VR environment can also trigger students' emotions, such as curiosity, awe, or excitement, which can increase their motivation to learn more deeply (Sanderink, 2018). They feel personally involved in the learning process, because they have control over their experiences and can explore according to their interests and wishes. In addition, the use of VR can also increase student involvement through its interactive aspects. Students can actively participate in simulations or activities in a virtual environment, make decisions, solve problems, or collaborate with fellow students (Wu et al., 2021). This encourages their critical thinking, creativity, and problem solving skills. Overall, the use of VR in learning creates a more engaging and engaging experience for students. They feel more involved in the learning process and feel the use of learning materials in real contexts. Students' motivation increases because they see the value and relevance of learning in their daily lives. Thus, the use of VR can increase the effectiveness of learning and encourage students to learn deeper and more actively.

1.3. Deeper Understanding of Concepts

Through the use of VR, students can experience abstract or difficult-to-understand concepts firsthand. The 3D environment generated by VR allows students to explore a virtual created world and visualize concepts that previously existed only in text or static images (Sanchez et al., 2000). In a VR environment, students can observe objects or phenomena on a more real scale. They can see objects or objects from different points of view, approach or move away from them, or zoom in and out of them (Wu et al., 2021). The ability to see and manipulate objects interactively provides a better understanding of the characteristics and relationships between these objects. In addition, interactive simulations in VR allow students to carry out experiments or explorations in a safe and controlled context. For example, in the field of physics, students can do simulation experiments where they can change certain variables and see the effect in real time. This helps them understand physics concepts in a practical and intuitive way. By experiencing concepts in a VR environment, students can gain a deeper understanding and reinforce the concepts being taught. They can see and feel the real application of the concept, making it easier for them to relate theory to practical experience. It also helps students overcome difficulties in understanding abstract concepts, because they can see them visually and interact with them directly. Overall, the use of VR in learning allows students to experience concepts firsthand, visualize them in 3D environments, and carry out interactive simulations. This helps them gain a deeper understanding, reinforce concepts, and relate them to practical experience. As such, VR becomes an invaluable tool in enhancing student learning in areas that are difficult to understand conventionally.

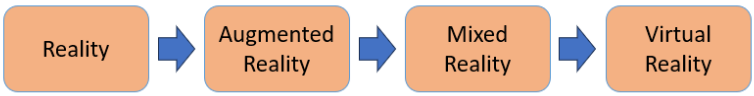

Figure 1. Extended Reality

1.4. Experience Based Learning

VR allows students to learn through hands-on experience, which can improve their information retention and understanding. In a VR environment, students can be actively involved and participate in simulations, experiments or real-world situations that are difficult to access in conventional learning. In a VR simulation, students can enter a virtually replicated environment, such as a laboratory, space chamber or animal habitat. They can see the object, environment, or phenomenon being studied in real terms, and even feel the sensation of being physically there. This allows students to gain immersive and immersive hands-on experience (Arini, 2023). In addition, students can participate in virtual experiments where they can change variables and see firsthand their impact on the outcome or event being studied. They can make observations and analyze the situation, and gain a stronger understanding of cause- and-effect relationships. In the context of learning history or culture, VR can take students to historical or cultural places that are far away or difficult to physically access. They can explore the pyramids of ancient Egypt, walk through historical cities or experience important historical events (Youngblut, 1998). This gives students an immersive visual experience and helps them understand the historical or cultural context better. Through interaction with the

environment that is represented virtually, students can see, feel and interact with objects, characters or the environment in ways that are not possible in conventional learning. They can gain deeper experience and more active involvement in the learning process. Overall, the use of VR in learning allows students to learn through immersive hands-on experience. They can participate in simulations, experiments or real-world situations that are difficult to access in conventional learning. Seeing, feeling, and interacting with a virtually represented environment helps students gain a better understanding and increases information retention.

1.5. Collaboration and Communication

VR also allows students to collaborate in the same virtual space. In a VR environment, students can interact with fellow students or teachers in real-time, even if they are in physically different locations. They can communicate, share knowledge, and work together to complete tasks or solve complex problems. The ability to collaborate in VR takes the learning experience to another level. Students can have discussions, share ideas, or provide feedback to one another through their virtual avatars (Suri et al., 2023). This opens up space for multiple perspectives and approaches to solving problems, as well as enhancing students' communication and teamwork skills. In addition, collaboration in virtual spaces prepares students for life and work in an increasingly connected world. In today's work environment, working virtually with colleagues from multiple geographic locations is becoming increasingly common. By collaborating in VR, students can develop important teamwork, communication, and project

management skills in a digitally connected environment. Collaboration in virtual spaces also allows students to benefit from expertise or knowledge shared by others around the world. They can connect with experts or specialists in a particular field, participate in collaborative discussions or projects, and expand their social network. This opens up new opportunities for

Cross-cultural learning, knowledge exchange, and joint problem solving. Overall, the ability to collaborate in virtual spaces brings significant advantages in learning. Students can interact, share knowledge, and cooperate with fellow students or teachers in a virtually represented environment. It strengthens students' communication and teamwork skills, and prepares them for life and work in a world that is increasingly connected and dependent on collaboration.

1.6. Enrichment of Learning Experiences

Experiences delivered through VR can provide opportunities that are not possible in traditional learning contexts. VR allows students to visit historic sites, explore natural environments, or dive into the underwater world in a way they have never done before. In history lessons, for example, students may experience travel through time and space, visiting historical places that may be difficult or expensive to physically access. They can walk through ancient ruins, interact with historical characters, or witness key moments within history (Cao & Feng, 2019). These experiences enrich students' understanding of the historical context and help them connect more deeply to the subject matter. In science, VR allows students to explore underwater worlds, see rare animals in their natural habitat, or study

complex ecosystems. Students can virtually interact with sea creatures, study their behavior, or even see the effects of climate change on coral reefs. This experience broadens students' horizons about biodiversity and the environmental challenges facing our planet. In addition, VR also allows students to dive into complex and abstract disciplines, such as physics or mathematics. In a VR environment, they can visualize complex concepts, interact with three-dimensional models, or run simulation experiments. This helps students develop a deeper and intuitive understanding of the concepts. The experiences presented through VR open up new insights for students. They can gain real experience that was previously not possible in conventional learning contexts. This enriches their learning, sparks interest and builds strong curiosity. As such, VR becomes an invaluable tool in providing opportunities that broaden students' understanding and take learning to a more immersive and enjoyable level. Interactive learning and the introduction of VR as an innovative learning tool bring many benefits and potential to change the way we learn and teach. By making good use of VR technology, education can be more interesting, relevant, and provide a better learning experience for students.

1.7. A brief history of the development of VR and its impact on education

The history of the development of Virtual Reality (VR) began in the 1960s, when several scientists and researchers began to develop the basic concepts and technologies that became the basis of modern VR. The following is an overview of the history of VR development and its impact on education:

1. The Beginning: In the 1960s, researchers such as Ivan Sutherland and Myron Krueger began developing the technology that became the basis of VR. Ivan Sutherland created "The Sword of Damocles", which is considered the first VR system. At the same time, Myron Krueger developed "Videoplace", an interactive space that allows users to interact with virtual objects.
2. Early Developments: In the 1980s and 1990s, VR saw further advancements. In 1989, Jaron Lanier coined the term "Virtual Reality" and founded the first VR company, VPL Research. More sophisticated VR systems were developed, including the development of VR headsets, motion sensors and other means of interaction. However, VR technology at that time was still limited and expensive, so it was not widely used in education.
3. Application in Education: In the 2000s, VR began to be applied in education. Educational institutions and software developers are leveraging VR technology to create more interactive and immersive learning experiences. VR applications in learning include scientific simulations, virtual tours, practical skills training, and customized learning environment experiences.
4. Decreasing Costs and Increasing Availability: In recent years, VR has become more affordable and accessible. The development of smartphone-based VR technologies, such as Google Cardboard and Samsung Gear VR, has made VR use more affordable and easier to implement in educational settings. Major companies such as Oculus Rift and HTC Vive have also released high-end VR headsets that provide a more immersive VR experience.

5. Benefits in Learning: The use of VR in education has had a significant positive impact. VR allows students to experience and explore environments and concepts that are difficult to access in person. For example, students can visit distant historical sites, explore the galaxy or conduct scientific experiments in a virtual environment. This experience increases students' understanding, engagement, and motivation in learning.
6. Future Developments: VR continues to experience development and innovation in the future. New technologies such as augmented reality (AR) and mixed reality (MR) have integrated elements of the real world with the virtual world, opening up new opportunities in learning. With further development, VR could become an important part of future education, changing the way we learn and teach.

The use of VR in education has had a significant impact on improving student learning experiences. As technology continues to evolve, VR can bring about greater changes in education, helping students learn interactively, broaden their horizons, and prepare them for the demands of an increasingly advanced world.

1.8. Theoretical Framework: VR for Enhanced Learning

The use of virtual reality (VR) in science classes has the potential to enhance student learning by bridging deep knowledge learning community with science instruction. When virtual environments reflect students' culture, it has the potential to influence their attitudes

towards the value of science in their communities (Bae, 2023). As virtual reality (VR) becomes more affordable, educational institutions are starting to integrate this technology into their curricula. Additionally, the increasing power of personal computers and supporting hardware has resulted in a revolution in graphic clarity, with increasingly complex simulations and realistic virtual worlds (Slater 2018). As Dickey (2005) notes, this has challenged and expanded the basic notion of what constitutes a learning environment. While previously limited to classroom instruction or field trips, VR's built-in capacity to give users a sense of presence and immersion has opened up new opportunities in education when done right (Hafner et al. 2018). The use of technology-assisted education approaches is not a new occurrence, and research into their effectiveness has been underway for about half a century. Ellinger and Frankland (1976) found that the early use of computers to teach economic principles provided learning outcomes comparable to traditional didactic approaches such as lectures in the 1970s. However, as Jensen and Konradsen (2018) point out, VR is new to HMD-based VR since the advent of the Oculus Rift in 2013. This has several consequences. Additionally, VR has enabled students to enhance cognitive skills through experiential learning, such as being exposed to settings that would be logistically difficult to visit in reality (Alişkan, 2011). For example, Bailenson et al. (2018) used HMD to immerse students in underwater settings to enhance learning about climate change. VR has made important contributions to education by enabling students to directly experience locations or scenarios that would be impossible to replicate using traditional teaching techniques such as lectures, image

presentations or 2D films. Due to the ever-changing nature of technology, it is difficult to provide a concise description of the fundamental properties of VR. However, Sherman and Craig (2003) stated "There are several important factors that must underlie a VR experience, which ultimately results in a virtual environment sensation similar to real life." This includes the need for immersive VR, Where participants' cognitive skills provide the sensation of being there and participating in a virtual world, often with limited awareness of what is going on around them in the real world. In addition, the virtual space must be interactive in the sense that the user can change the environment and test variables. Interacting with objects, virtual avatars, or even working with other real-life users in computer-generated areas is one example.

CHAPTER 2.
VR FUNDAMENTALS IN LEARNING

2.1. Basic definitions and concepts about VR

Virtual Reality (VR) is a technology that creates interactive and immersive experiences that mimic real or digitally created environments. In VR, users can experience and interact with the virtual world through the use of devices such as VR headsets, motion sensors and controllers. Some of the basic concepts related to VR are described below

2.1.1. Immersion

Immersion is an important concept in Virtual Reality (VR). This refers to an experience in which the user feels fully involved in the virtual environment created by VR technology. The main goal of VR is to create an immersive experience that provides real sensations and removes the user's awareness of the real world around them (Calvert & Abadia, 2020). Through the use of a VR headset that includes sight and hearing, users can feel as if they are in a virtual world. Stereoscopic vision and 360-degree view allow users to see and explore the environment in an immersive and realistic way. Meanwhile, spatial sound and 3D audio provide an immersive audio experience, allowing users to feel the immediacy and direction of sound in a virtual environment. In addition, VR can also use additional features such as vibrating devices or haptic devices to give the user physical sensations, such as touch or vibration, which enhances overall immersion. It aims to create a multisensory experience that

resembles the real world. By removing the user's awareness of their physical environment, VR immersion allows them to truly engage in the experiences provided by the virtual world. Users can explore the environment, interact with objects or characters, and experience events within the virtual environment. Immersive experiences in VR have the potential to enhance learning and understanding. In the context of education, students can experience it directly abstract or hard- to-understand subject matter through deep immersive experiences. They can learn concepts in a more practical and intuitive way, and develop a stronger understanding of the topic being studied. Overall, immersion is a key element in VR which aims to create fully immersive and realistic experiences within virtual environments. By leveraging VR technology, users can experience sensations and experiences similar to the real world, which open up new opportunities in education, entertainment and other fields.

2.1.2. Interaction

Interaction is one of the important aspects of Virtual Reality (VR). It refers to the user's ability to interact with objects, environments or characters in a virtual world created by VR technology. The goal of interaction in VR is to provide a responsive experience and allow users to feel the impact of their actions in a virtual environment (Bonner & Reinders, 2018). In VR, users can interact by using motion sensors and controllers connected to the VR system. Motion sensors, such as hand or body controllers, can detect

the user's physical movements and transfer them to the virtual environment. This allows users to move their hands, body or even legs in a virtual environment with appropriate gestures. The connected controller or joystick also allows the user to interact with objects or the environment in the virtual world. They can use the controller to select, manipulate or move objects, as well as perform other actions such as pressing buttons or moving levers. With this interaction capability, users can explore virtual environments, interact with objects such as picking up or placing things, solving puzzles, or even communicating with virtual characters. They can perform actions similar to those in real life, which provides a more immersive and involved experience. Interaction in VR has the potential to enhance student learning and experience. For example, in science lessons, students can perform interactive experiments or simulations in virtual environments, where they can change variables, observe results, or run different scenarios. This allows them to learn through exploration and experimentation, as well as understand concepts in a practical way. In addition, interaction in VR also allows collaboration between users. In a virtual space, users can interact with each other, work together on tasks or projects, or even communicate in the form of avatars or virtual characters. This opens up opportunities for team-based learning, discussion and joint problem solving. Overall, interaction is an important element in VR that allows users to interact with virtual objects and environments using motion sensors and controllers. This ability provides experiences that are more responsive and allow users to

feel the impact of their actions in virtual environments. Interaction in VR takes learning and exploration experiences to a higher level, allowing users to be actively and deeply engaged in the virtual environment they create.

2.1.3. Environment Customization

Environment customization is the ability in Virtual Reality (VR) to create and modify virtual environments according to user needs and goals. In VR, users can experience customizable environments, which range from simulated real environments to completely fictional or imaginative environments. In VR, virtual environments can be replicated with high precision to create simulations of real environments (Cardona-Reyes et al., 2020). For example, a virtual environment can mimic a classroom, scientific laboratory, historic site, or natural environment with a near-real level of detail. This allows users to interact with the environment as they would in the real world, gain immersive experiences and engage in learning. In addition, virtual environments can also be completely fictitious or imaginative environments. In this case, the user can experience a specially created world with elements that do not exist in the real world (Chang et al., 2023)impact. For example, virtual environments can create fantasy worlds, futuristic scientific worlds, or abstract environments that allow creative exploration and differential learning. Environment customization in VR gives users the flexibility to customize their experience. Users can choose the environment that is most relevant to their learning materials or goals. They

can also modify the environment according to their preferences, such as changing the lighting, texture, scale, or replacing existing objects. The use of environmental customization in VR has great potential in learning. For example, in an educational context, teachers can create learning environments that suit students' needs and learning objectives (Cardona-Reyes et al., 2021). They can choose or create environments that support effective learning experiences and gain deeper understanding. In addition, environmental customization also allows adaptation for students with special needs. For example, students with visual impairments can adjust the virtual environment to suit their needs, such as magnifying text or adjusting contrast. This ensures that the VR experience is accessible and useful for all students. Overall, environment customization is the ability in VR to create and modify virtual environments according to the user's needs and goals. It provides flexibility and creativity in VR experiences, allows users to experience real or imaginative environments, and supports effective and engaged learning.

2.1.4. Stereoscopy

Stereoscopy is a viewing method used in Virtual Reality (VR) to create a more realistic perception of depth and space. In stereoscopy, VR uses the principle that the human eye perceives slightly different images and combines them to produce three-dimensional perception. In VR, each user's eye sees a slightly different image. Typically, these two images are presented separately to each eye using a VR headset. By

combining these two images, the human brain can recognize differences in viewing angles and produce the illusion of depth (Chen et al., 2007). This principle takes advantage of the difference in perspective that occurs when the human eye is in a slightly different position. When looking at an object in the real world, our eyes see it from a slightly different perspective, and our brain uses this information to interpret the depth and distance of the object. In VR, stereoscopy technology generates two slightly different images and displays them to each eye. This creates an effect similar to a real- world experience, where the user is able to see objects with greater depth and dimension. The stereoscopic effect in VR provides a more immersive and involved visual experience. Users can experience the sensation that virtual objects or environments actually have real depth and distance. This provides a level of clarity and realism that enhances the overall VR experience (Cardona-Reyes et al., 2022). Stereoscopy also aids in navigation and interaction with virtual environments. With accurate depth perception, users can see distances between objects and navigate through the environment more easily. They can also interact with objects and manipulate them more precisely because of the depth perception provided by stereoscopy technology. Overall, stereoscopy is a visual method used in VR to create the perception of depth and space. By using two slightly different images presented to each user's eye, VR creates the illusion of depth and provides a more immersive and involved three-dimensional visual experience. Stereoscopic technology enhances realism and clarity in VR

experiences, helping users navigate environments and interact with objects more accurately.

2.1.5. Realism

Realism in the context of Virtual Reality (VR) refers to the degree to which virtual environments reflect the real world or have similarities to the objects, physics, lighting, and interactions we experience in everyday life. The degree of realism in the virtual VR environment may vary. At one end of the spectrum, there are virtual environments that are precisely replicated using 3D scanning or 360-degree photography of real environments. This environment tries to imitate every detail and texture at its best, providing an experience very close to real life. On the other hand, there are also virtual environments that are more abstract or stylistic. These environments may not try to replicate the real world in detail, but they still provide an interesting and unique visual representation. They can incorporate fantasy, scientific, or artistic elements for a different and creative experience. The level of realism in VR is influenced by the capabilities of the hardware and software used. The more sophisticated a VR device is, the higher the level of detail and quality of graphics that can be presented in a virtual environment. For example, high resolution, high refresh rates, dynamic lighting, and realistic sound effects can enhance the realism of a VR experience. Software also plays an important role in creating realism in VR. Sophisticated rendering technology allows for a more realistic simulation of visual effects such as shadows, reflections and textures. Physics

algorithms are also used to produce more natural simulations of object movements and interactions in virtual environments. The level of realism in VR can affect the user experience. Highly realistic virtual environments can create stronger feelings of presence and involvement, triggering more intense emotional and sensory responses. However, environments that are more abstract or stylistic can provide a unique experience, spark creativity, and open up spaces for freer exploration. It is important to remember that the purpose of using VR in learning is not always related to a perfect level of realism. Sometimes, a simpler or abstract environment can provide a clearer focus on the concepts being taught or provide an experience that is easier for students to understand. Overall, the level of realism in virtual VR environments ranges from representations that closely resemble the real world to more abstract or stylistic environments. This level of realism is affected by the capabilities of the hardware and software used in the VR system. The selection of the appropriate level of realism can be adjusted according to the learning objectives and context, as well as providing a suitable experience for VR users.

2.1.6. Sensory-motor

Sensory-motor is an important concept in Virtual Reality (VR). This refers to combining sensory and motor experiences to create more immersive and responsive experiences in virtual environments. In VR, users rely not only on visual and auditory experiences, but also use their body movements to interact with the virtual environment (Figueiredo et al., 2018). Some

sensors connected to VR devices, such as motion sensors, allow users to control and participate in VR experiences with their physical movements. One of the most important sensori-motor aspects of VR is the use of head movements. By using a VR headset equipped with motion sensors, users can move their heads in various directions. These head movements are used to change the user's perspective within the virtual environment. For example, if the user moves their head to the right, their view of the virtual environment will also change according to the change in viewing angle. In addition, sensory-motor also allows users to interact with the virtual environment using their hand movements. Hand controllers or motion controllers connected to a VR system allow users to control objects, select options, or perform other actions in a virtual environment. The user's hand movements in the real world are captured and transferred to the virtual world, creating appropriate responses and interactions. Sensori-motor use in VR provides greater responsiveness and engagement in the VR experience. By using gestures, users can feel more physically involved in virtual environments and have more control over their actions and interactions. The application of sensory-motor in VR learning provides broad opportunities. For example, in science lessons, students may use their hand movements to manipulate objects in virtual simulations or experiments (Suri et al., 2023). They can experience how physical interactions affect outcomes and gain a deeper understanding of the concepts being studied. Overall, sensory-motor is an important concept in VR that combines sensory and

motor experiences to create a more immersive and responsive experience. By paying attention to the movement of the user's head and hands, VR allows for a change of perspective and interaction in a virtual environment. Sensori-motor application in VR learning provides opportunities for more active exploration and interaction, increasing student engagement and understanding. Understanding the basic concepts of VR is important for applying this technology in a learning context. With a solid understanding of VR fundamentals, developers and educators can design appropriate and effective learning experiences using VR technology.

2.2. Main components of VR

The main components of Virtual Reality (VR) include VR headsets, motion sensors and controllers. The following is an explanation of each component:

1. Headset VR. A VR headset is a piece of hardware that is worn on the user's head to create immersive visual and audio experiences in a virtual world. VR headsets generally consist of two screens that display a stereoscopic image to each of the user's eyes. This is possible the user sees the virtual environment in three dimensions. VR headsets are also equipped with speakers or earphones to provide immersion-strengthening three-dimensional sound. Some of the latest VR headsets have additional features such as eye tracking to track the user's eye movements, focus adjustments for visual comfort, and sensors to detect head movements.

Figure 2. VR Headset

2. Motion sensor. Motion sensors are used in VR to track the user's body movements, particularly head movements. These sensors allow users to see and interact with virtual environments in a more natural way. By tracking head movement, the motion sensor updates the visual display according to changes in the user's viewing angle, creating the illusion that the user is in a moving virtual environment. Motion sensors can use various technologies, such as inertial motion tracking technology, magnetic motion tracking technology, or camera-based tracking technology. These motion sensors are usually attached to VR headsets or placed around the room for whole body monitoring.
3. Controller. The controller in VR is the input device used by the user to interact with the virtual environment. This controller can be a hand controller, motion controller, or other input device. They allow users to manipulate objects, explore the environment, and perform other actions required in a VR context. Controllers usually come with various buttons, action buttons, joysticks, touchpads or additional motion

sensors such as accelerometers or gyroscopes. Users can use this controller to move their hands or virtual objects, select options in the VR interface, or interact with objects and characters in a virtual environment.

The combination of a VR headset, motion sensor and controller allows users to experience an immersive and interactive VR experience. They work together to create the sensation as if the user were in a real virtual environment. As technology develops, VR components continue to evolve to improve the quality and realism of the VR experience.

Figure 3. VR Controller

2.3. Types of VR in learning

In the context of learning, there are several types of VR that are generally used, among others:

1. Desktop Based VR. Desktop-based VR involves using a powerful computer or laptop to provide a VR experience. In this case, the VR headset is connected to the computer via cable or wireless. Desktop-based VR often uses VR headsets that are more sophisticated and

have higher visual and audio capabilities. The advantages of desktop-based VR are better graphics capabilities, support for more complex VR applications, and wider availability of VR content. This allows for more in-depth and interactive learning. However, the drawbacks of desktop-based VR are limited mobility and the need for more expensive and complex hardware.

Figure 4. VR Rig Oculus Rift Sensor For PC Desktop

2. Mobile-Based VR. Mobile-based VR involves using a smartphone or tablet to provide a VR experience. In this case, a special VR headset or VR adapter connected to a smartphone is used to deliver the VR experience. Smartphones serve as screens and computing resources to run VR applications. The advantages of mobile-based VR are wider availability, lower costs, and ease of use. Mobile-based VR also provides greater mobility, thus enabling VR learning anywhere. However, mobile-based VR may have limitations in terms of graphics and audio capabilities compared to desktop-based VR.

In addition, there are also standalone VR devices that have a computer and screen integrated into the headset itself, so no connection is required with a computer or smartphone. Standalone VR devices like the Oculus Quest and HTC Vive Focus have the advantages of mobility and ease of use, while still providing rich VR experiences(Freund & Rossmann, 1999). The choice of the type of VR used in learning depends on needs, budget and usage scenarios. Whether desktop-based VR, mobile-based VR, or standalone VR devices can provide meaningful and immersive VR learning experiences, taking into account the factors of visual quality, audio, content availability, mobility, and ease of use.

Figure 5. VR Mobile: Oculus Quest 2 lest, HTV Vive Focus Right

CHAPTER 3
APPLICATION OF VR IN LEARNING

3.1. Fields of learning that can be integrated with VR

Virtual Reality (VR) can be integrated in various learning areas to create interactive and immersive experiences that support understanding of concepts. Here are some examples of learning areas that can be integrated with VR.

3.1.1. Knowledge (Science)

Science, or science, is a branch of knowledge that studies nature and the phenomena in it through observation, experimentation and reasoning. In the context of Virtual Reality (VR), VR can be used as an effective tool for visually presenting complex and difficult-to-understand science concepts. With VR, students can explore and experience science concepts interactively and immersively (Anggara et al., 2021). For example, in a lesson about the solar system, students can use VR to travel across the planets, observe their orbits and rotations, and learn about the unique properties of each planet. They can sense the relative sizes and distances between the planets, providing a deeper understanding of the structure of the solar system. Apart from that, VR can also be used to present a virtual laboratory where students can observe and interact with chemical reactions. They can combine different chemicals, see the color changes and physical changes that occur, and observe their impact on the overall chemical reaction (Calvert & Abadia,

2020). In this virtual environment, students can conduct experiments without the risks or limitations that may exist in a physical laboratory. VR also allows students to attend simulations of organisms in ecosystems. For example, they can explore coral reefs, observe marine life and study the complex interactions between different species in the ecosystem. By using VR, students can experience life in these ecosystems in real terms and gain a deeper understanding of ecological balance and interdependence between organisms. The application of VR in science provides significant benefits. By enabling direct experience and interaction with concepts science, VR can increase student engagement, strengthen their understanding, and increase their interest in science (Hamilton et al., 2021). The visual and interactive experiences offered by VR can assist students in overcoming comprehension barriers they may face in learning science. Overall, VR can be used in science to visually present complex and difficult-to-understand concepts. Through the use of VR, students can explore the solar system, observe chemical reactions in a virtual laboratory, or attend simulations of organisms in ecosystems. The application of VR in science takes learning to a higher level by providing students with immersive and interactive experiences.

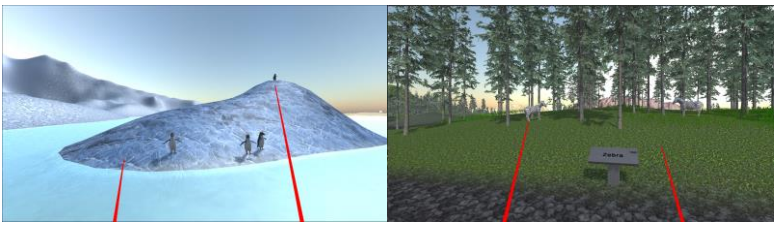

Figure 6. Zoo VR Application

3.1.2. Mathematics

Mathematics is a field of study that involves understanding and applying mathematical concepts such as numbers, patterns, space and relationships. In a Virtual Reality (VR) context, VR can be a useful tool to help students visualize math concepts that are often abstract. By using VR, students can explore geometric concepts in three-dimensional space. They can manipulate geometric objects, see the relationships between mathematical forms, and build an understanding of geometric principles more clearly and interactively (Harron et al., 2019). For example, students can build math models in VR to understand the concepts of volume, surface area or symmetry in a more visual and fun way. In addition, VR can also help students visualize algebraic concepts in a more concrete context. In a virtual environment, students can interactively view graphs of mathematical functions, manipulate algebraic equations, or see relationships between variables in a more tangible form. This helps students gain a deeper understanding of algebraic concepts and apply them in a variety of situations. In statistics, VR can assist students in understanding the concepts of data collection and analysis. They can explore graphs and data distribution in an engaging and interactive virtual environment (Helmie et al., 2022). VR can also provide simulations of statistical situations that allow students to explore data and develop statistical problem-solving skills. The use of VR in learning mathematics provides significant advantages. By visualizing math concepts in a virtual environment,

VR can help students gain a deeper understanding of and connect with these concepts. The interactive experiences offered by VR can also increase student engagement and strengthen their math skills. Overall, VR can help students visualize geometric, algebraic, and statistical concepts in mathematics. In VR, students can explore mathematical forms in 3D space, building mathematical models interactively, or view graphs and data in a virtual environment. The use of VR in learning mathematics can improve students' understanding, increase their engagement, and strengthen their math skills.

Figure 7. VR Math Application for Android

3.1.3. Art and Design

Art and Design is a creative field that involves exploration of self-expression, aesthetics and visual skills. In the context of Virtual Reality (VR), VR can be a very useful tool for students to develop their creativity and explore the world of art and design in new and exciting ways (Hidayat et al., 2021). By using VR, students can create three-dimensional art in a virtual

space. They can use the special tools and applications available in VR to create sculptures, paintings or other works of art with their own hands. In a virtual environment, students have the freedom to create shapes, textures and colors in unlimited ways. This allows for more free and creative exploration, and provides a highly interactive experience in the art creation process. In addition, VR can also provide opportunities for students to explore virtual art galleries. They can visit famous art galleries around the world and see famous works of art on a life-like scale. This experience allows students to experience the beauty and uniqueness of works of art, as well as gain a deeper understanding of the context and history of art (Jatmika et al., 2022). In the field of music, VR can also provide a virtual music concert experience. Students can attend music concerts in a virtual environment, listen to music with three- dimensional sound, and experience the atmosphere and energy of the concert realistically. This provides an immersive experience in music appreciation and allows students to engage in the world of music in new ways. The use of VR in art and design provides a wide range of creative opportunities for students. With VR, they can expand their imagination, transcend physical boundaries, and explore new ideas in art and design. VR can also assist students in developing visual skills, aesthetic perception, and understanding of various artistic mediums. Overall, VR provides creative and exploratory experiences for students in art and design. Using VR, students can create three-dimensional art in virtual spaces, explore virtual art galleries, or attend

virtual music concerts. The application of VR in art and design provides an interesting opportunity for students to develop their creativity, broaden their artistic horizons, and gain unique experiences in the world of art and design.

Figure 8. Google's VR Painting

3.1.4. History

History is the study of past events and human development in the context of time. In the context of VR, VR can provide immersive experiences and realistic in learning history. With VR, students can visit distant historical places and view significant historical events in a virtual environment (Kool, 2016). For example, they can explore ancient ruins, visit historic palaces or witness important battles. In a virtual environment, students can experience the atmosphere, architecture, and everyday life of that time. This helps them understand the historical context visually and emotionally, and relate historical concepts to deeper experiences. In addition, VR can also present visual and audio archive recordings of significant historical events. Students can witness important speeches,

political events or historical moments through recordings reproduced in a virtual environment. This allows them to experience first-hand the atmosphere and emotional impact of these historical events. The use of VR in history learning provides significant advantages. By providing hands-on and realistic experiences, VR can help students understand history more clearly and relate concepts to real experiences. They can develop historical empathy, deepen understanding of conflict and social change, and develop skills of historical analysis and interpretation (Lartigue et al., 2014). Overall, VR provides an immersive and realistic experience in learning history. With VR, students can visit distant historical places and view significant historical events in a virtual environment. The application of VR in history learning enables students to understand historical context visually and emotionally, develop historical empathy, and increase their understanding of past events and developments.

Figure 9. National Geographic Explore VR

3.1.5. Language and Culture

Language and culture are closely related. In the context of Virtual Reality (VR), VR can be an effective tool in supporting language and cultural learning by providing immersive experiences for students. In language learning, VR can immerse students into the target language environment. Students can interact with virtual characters who speak the foreign language being studied (Johnson et al., 2001). They can practice speaking, listening and communicating in realistic contexts. It provides hands-on and interactive experience in strengthening language understanding and increasing confidence in communicating. Apart from that, VR also allows students to explore different cultural places. They can visit cities or locations that have a different culture, and experience the atmosphere and daily life in that culture. Through virtual environments, students can gain insight into the customs, traditions and values of different cultures visually and emotionally. This helps them broaden their understanding of the world and increase tolerance for cultural differences. In addition, VR can also provide simulations of everyday life situations in different cultures (Johnson et al., 2002). For example, students can participate in shopping simulations at traditional markets, eat at local restaurants, or attend cultural festivals. In a virtual environment, students can interact with virtual characters representing that culture and practice skills in a real context. This assists them in gaining a practical understanding of the culture, as well as enhancing cross-cultural communication skills. The

application of VR in learning language and culture provides significant benefits. By providing an immersive experience, VR allows students to interact directly with the target language and experience life in a different culture. This helps in strengthening language understanding, improving communication skills, and developing a deep understanding of culture. Overall, VR supports language and cultural learning by providing immersive experiences for students. Through VR, students can interact with virtual characters in the target language, explore places of different cultures, and participate in simulated situations of everyday life in different cultures (Johnston et al., 2018). The application of VR in language and cultural learning enables students to develop language skills, broaden cultural understanding, and enhance cross-cultural communication.

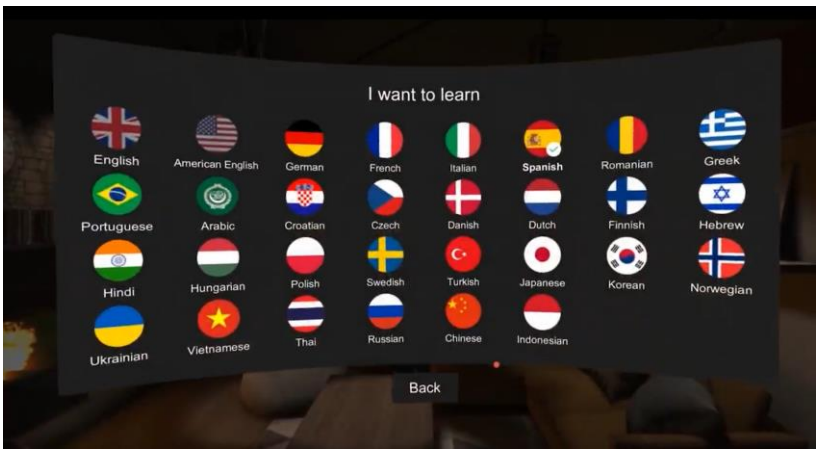

Figure 10. Mondly: Practice Language in VR

3.1.6. Practical Skills

Practical skills are skills that involve physical abilities and direct experience in performing certain tasks or activities. In the context of Virtual Reality (VR), VR can be used to train practical skills by providing safe and realistic simulations. In the medical field, VR can be used to train medical skills. Students can practice medical procedures such as catheter insertion, patient transfer, or surgical procedures in virtual simulations (Bonner & Reinders, 2018). In a virtual environment, they can interact with highly detailed models of the human body and practice techniques and procedures with real-time feedback. This provides an opportunity for students to hone their medical skills in a safe and controlled environment. In engineering and architecture, VR can help students build interactive architectural models. They can design buildings and environments in virtual environments, realistically visualize 3D designs, and interact with the models. In this process, students can hone planning, design, and problem-solving skills in a more visual and interactive context. Apart from that, VR can also be used to train manufacturing and crafting skills. For example, students can use VR to practice welding techniques, wood-cutting, or making other crafts in real time virtual environment (C.

K. Lee & Shea, 2020). They can practice the hand movements, hand-eye coordination and techniques necessary for manufacturing skills in a realistic and controlled manner. The application of VR in training practical skills provides significant benefits. By

providing safe, realistic and controllable simulations, VR enables students to practice practical skills in an environment similar to the real world. This helps them to develop physical skills, manual skills and technical abilities in areas that require hands-on experience. Overall, VR is used to train practical skills in areas such as medical skills, engineering, and craft skills. In VR, students can practice medical procedures in a safe virtual simulation, build interactive architectural models, or practice manufacturing skills in a virtual environment. The application of VR in training practical skills allows students to hone their skills in a controlled, realistic and effective environment. Apart from these fields, VR can also be applied in fields such as geography, psychology, physical education, and many more. By integrating VR into learning, students can have more immersive, interactive and engaging experiences that enhance their understanding, engagement and motivation in learning.

Figure 11. Hand Physics Lab VR Application

3.2. Virtual Reality: A Tool for Immersive Science Experiences

The implementation of Virtual Reality in education is beneficial because of its interactive and immersive nature. (Checa, 2020) Immersive technology offers a safe and controlled learning environment. In fields such as medicine or hazardous industrial settings, students can practice skills and procedures in a virtual environment without risk to themselves or others. This allows repeated practice and mastery of skills before they are applied in real-life situations. Simulations and virtual scenarios created through VR, AR and MR can provide opportunities for collaborative learning. Students can engage in virtual group activities, simulations, or problem solving assignments, which promote teamwork and communication skills. Technologies for virtual reality allow users to enter computer-generated environments and interact with them as if they were physically present. VR can provide invaluable and interactive experiences that can enhance student learning and scientific exploration. Here are some ways VR can be used for intense scientific research:

3.3. Virtual Lab Simulations

Virtual Lab Simulations are the use of Virtual Reality (VR) technology to create a laboratory environment that can be accessed and used virtually. In this VR environment, students and researchers can conduct experiments, practice laboratory techniques, and run a simulation similar to the actual experience in a physical laboratory (Blanchard et al., 1990). One of the main advantages of virtual lab simulations is safety and cost efficiency. In a virtual environment, students can learn and explore without the need for

expensive physical equipment or materials. They can conduct experiments and practice lab techniques in a safe environment, free from risk of injury or equipment damage. In addition, the use of virtual lab simulations also reduces costs associated with procuring and maintaining laboratory equipment. Virtual lab simulations also provide greater flexibility and accessibility. Students can access this virtual environment from anywhere and anytime via compatible VR devices. They are not limited by schedules or physical limitations of real laboratories. This allows students to learn and practice laboratory skills independently or in groups without being constrained by time or space constraints. In addition, the use of virtual lab simulations allows students to gain prerequisite knowledge and build cognitive abilities prior to working in a physical laboratory. Using a virtual environment, students can learn theory, master experimental steps, and develop an understanding of important concepts before moving on to practice in a physical laboratory(H. S. Lee & Lee, 2021). This allows students to focus fully on relevant activities in a real laboratory without being overwhelmed by basic understanding or practical instruction. The application of virtual lab simulations in education is a significant development. Studies and research have shown encouraging results in replacing or complementing physical laboratory work with virtual lab simulations(J. B. Lee & Kwon, 2022). VR can be a useful tool for acquiring prerequisite knowledge and developing cognitive abilities before undertaking practical work in the physical laboratory. This allows students to optimize their experience in a real laboratory and enhance their understanding and practical skills. Overall, virtual lab simulations enable students and researchers to conduct experiments and practice lab

techniques in a safe and cost- efficient virtual environment. This expands the potential use of virtual laboratories in education, helps students acquire prerequisite knowledge and cognitive abilities before working in real laboratories, and enhances the effectiveness of learning and exploration in science and research.

Figure 12. Car Mechanic Simulation

3.4. Field Trips and Expeditions

Field trips and expeditions are experiences where students can travel to places that are remote or physically inaccessible. In the context of Virtual Reality (VR), the use of VR allows students to take virtual journeys to places such as beautiful coral reefs, the vast outer space, or historical monuments located in distant locations. With the use of VR, students can explore and learn about the natural world and scientific phenomena in an up-close and personal way. For example, they can observe marine life on coral reefs in incredible detail, see stunning views of the universe or visit historical monuments with architectural beauty and rich cultural heritage. These experiences provide a unique

opportunity for students to see, hear, and feel these places, even if they cannot physically visit them. These virtual field trips and expeditions have great potential in arousing student curiosity and discovery. With the immersive experiences offered by VR, students can develop a deeper understanding of the topics studied, as well as gain real-world experience in studying natural and historical phenomena. They can observe and interact with the virtual environment in a way that is not possible in conventional learning. This can spark their imagination, strengthen their emotional connection with the subject matter, and increase their motivation to learn more. In addition, field trips and virtual expeditions can also provide students with broader and inclusive access. For example, students who are unable to take a physical trip due to physical limitations or other constraints can

experience the same virtual journey as everyone else. This ensures that every student has an equal opportunity to explore and learn about the wide world. The use of VR in field trips and expeditions provides significant benefits in learning. Through VR, students can explore remote or physically inaccessible places, study natural phenomena and history in depth, and develop a strong sense of curiosity and discovery. It opens doors for more inclusive learning and provides immersive experiences in understanding the world around us. Overall, field trips and virtual expeditions through the use of VR allow students to travel to places that are remote or physically inaccessible. In this experience, they can study the natural world, scientific phenomena, and historical heritage in a deep and personal way. The use of VR on field trips and expeditions fosters student curiosity and discovery, ensures greater accessibility, and enhances learning in understanding the wider world around us.

Figure 13. OtherSight VR Application

3.5. Data Visualization

Data visualization is the process of presenting data in a visual form that can be understood more easily. In the context of Virtual Reality (VR) .The use of VR in data visualization allows scientists and researchers to view and evaluate scientific data in a more immersive and interactive way in a three-dimensional environment. In VR, complex scientific data can be presented in a more dynamic and attractive visual form. Scientists can transform data into three-dimensional models, interactive graphs, or other visualizations that allow them to more clearly visualize relationships, patterns, and trends in data. By entering a VR environment, users can interact with the data using motion sensors or controllers, move, zoom, or rotate objects and graphics in 3D space. The use of VR in data visualization provides several advantages. First, the three-dimensional environment allows scientists to view data from multiple perspectives and gain a more comprehensive understanding of data structure and relationships. They can explore data in a more natural and intuitive way, allowing them to

discover new patterns and insights that might not be visible in two-dimensional visualization. Second, interactivity in a VR environment allows scientists to interact directly with data. They can change parameters, filter data, or get a closer look at details with hand or controller gestures. This provides an opportunity for scientists to carry out in-depth exploration and experimentation in understanding scientific data. The use of VR in data visualization also facilitates collaboration between scientists. Within the same VR environment, multiple users can view, interact, and discuss data together. This enables a richer exchange of ideas and perspectives, and promotes teamwork and shared learning in the understanding of scientific data. Overall, the use of VR in data visualization enables scientists and researchers to visualize and explore complex scientific data in an interactive three-dimensional environment. With the ability to transform, interact, and manipulate data in natural and engaging ways, scientists can gain deeper new understandings and knowledge about scientific data. This provides the potential to identify new patterns, relationships and insights that contribute to the advancement of scientific research and understanding.

Figure 14. Noda VR Application

3.6. A concrete example of implementing VR

The integration of VR technologies in primary education opens up new possibilities for immersive and interactive learning experiences. Virtual Reality (VR) can be used as a learning medium that can increase student involvement in learning (Utami et al., 2021). VR technology creates immersive, interactive, and multisensory virtual environments that simulate real-world experiences. By integrating VR into the learning environment, educators can provide primary school students with unique opportunities to explore, experiment, and engage in their educational journey (Cao & Feng, 2019). VR technology offers a unique platform to foster creativity and critical thinking skills in elementary school students. The immersive and interactive nature of VR encourages students to think critically, solve problems and make decisions in a virtual environment. Through virtual scenarios and simulations, students can explore different perspectives, analyze complex situations, and develop creative solutions. VR also provides opportunities for collaborative learning, allowing students to work together on solving challenges and developing communication and teamwork skills. The main benefit of computer-assisted instruction (CAI), also known as computer-based training (CBT), is the use of virtual reality (VR) in education. Several studies conducted since the 1990s have concluded that the use of VR enhances learning (McLellan 1996, 2003). Youngblut (1998) conducted a review of the use of VR in education since the early 1990s and found that VR has several unique capabilities, including components for constructivism-based instruction, accessible use by blind students, and a function as a learning facilitator. According

to some teachers, the use of VR is more accessible, more affordable, and easier for students and teachers to use. Virtual reality, also known as virtual reality, is a technology simulated by a smartphone or computer that allows users to interact with real or simulated environments by computer. In other words, the computer projects a virtual environment on VR media, so users feel as if they are entering the virtual world or environment (Abdillah et al., 2018). In general, virtual reality can be accessed via smartphones through special applications or YouTube videos. Students can improve their cognitive abilities by using VR in science learning. VR can be used in various educational contexts for various reasons. VR has the potential to inspire and motivate students in learning and encourage them to become creative learners. Winn (1993) mentions several benefits of VR in education, including:

1. VR provides non-symbolic human resources specifically created to assist students in learning course material.
2. The use of VR creates interactions with a third-person perspective that are similar to real life, although not always in everyday conversation.
3. Constructivism is the best philosophical framework for creating VR educational apps.
4. Allows students to resize any object in the Islamic world using a material not visible in the physical world (for example, warping hard objects).

According to Panthelis (1995), there are several reasons for using virtual reality in education:

1. VR offers new visualization formats and techniques by harnessing the power of visual representation. It provides a new way of conveying information. Because

VR can sometimes show characteristics, processes, and so on more accurately than anywhere else, close-up observations, remote observations, and observing and examining areas and events that are not available by other methods.

2. VR provides motivation to students. Education requires active interaction and involvement, not a passive attitude. Some VR applications, such as collaborative VR, incorporate text into a virtual world and require students to participate in a social environment.
3. VR allows students to study at their own pace and over longer periods of time without being tied to a schedule.

The teacher or instructor must be able to distinguish between material that can be integrated with virtual media and material that cannot be integrated. Usually, subjects have various learning classes in schools. If the use of virtual reality is used as an alternative to conventional media, teachers can use it in some of these learning classes with appropriate terms and conditions.

3.7. The benefits and advantages of using VR in achieving external learning

VR is usually understood as a technology that produces virtual immersion in a digital environment, thanks to which computer graphic simulation allows users to immerse themselves in an interactive three-dimensional world where various types of sensory and emotional experiences are encountered. Currently, with advances in technology, VR technology has

spread to various fields and sectors (Aznar, et al., 2017). For example, VR has been implemented in surgical education (e.g. Harrington et al., 2018; Yoganathan, Finch, Parkin, & Pollard, 2018), sports training (e.g. Panchuk, Klusemann, & Hadlow, 2018), language learning (e.g. Parmaxi, 2020). In education, the main reason why VR has become so popular is its immersive, imaginative and interactive features (Gavish et al., 2015). Blascovich et al. (2002) highlighted that its application allows students to be placed in a different environment with a realism that cannot be achieved with textbooks, while avoiding certain elements that can hinder learning. Its use in education allows students to become immersed in countless settings and time periods (Pe´rez- Martí´nez, 2011). Cuesta and Manas (2016) describe this technology as a tool capable of breaking through the space-time barriers of educational contexts, thereby achieving experiential learning. Two concepts can be considered key about VR: immersion and presence. They are often used interchangeably, but formally immersion describes the experience of using what is called an immersive technology, (Jensen & Konradsen, 2018), whereas presence refers to a subjective user's response to a VR situation in a way similar to that. that would occur in similar situations in the real world (Slater, 2003).

CHAPTER 4.
CHALLENGES AND FUTURE USE OF VR IN LEARNING

4.1. Challenges and constraints in using VR

The development and use of VR applications need to study the various dimensions of this technology. The VR challenge is one of the most important dimensions to define. Despite the benefits of using technology (such as VR) in healthcare, there are limitations. Individual variables, such as gender, age, personality and history of motion sickness, as well as other psychological, cognitive, physical and functional characteristics present in many clinical situations, are of great importance and must be taken into account (Annetta et al., 2009). The sensitivity of some patients must be taken into account, including their discomfort with using a head-mounted display (HMD), their ability to learn how to behave in a virtual environment, and the duration and potential adverse effects of the reality test itself. Due to ethical considerations, as well as the efficiency of VR-based teaching and care, these challenges must be addressed. According to Bricken, 1991, "Despite its obvious benefits, connecting VR to the learning process poses a unique set of difficulties. This is mostly related to the price and the technical competency of the teacher to use VR technology successfully. Commercial VR systems that are sophisticated enough to provide complex models and multiple features come at a hefty price." Commercial VR systems that are sophisticated enough to provide complex models and multiple features come at a hefty price (Bricken, 1991). To

avoid performance issues when creating their own VR environment, teachers need a machine with adequate specifications.

4.2. Ethics and Safety in VR Use

Ethical considerations and safety measures must be taken into account when integrating VR in basic education. Schools should establish clear guidelines regarding the use of VR technology, including ethical behavior, responsible use and data privacy. Additionally, ensuring students' physical and emotional safety during the VR experience is critical (Setyawan et al., 2019) . Educators must provide proper supervision, consider the potential for motion sickness, and create a supportive environment for students to express concerns or discomfort. Ethical guidelines and security measures should be created to address considerations such as responsible use, data privacy, and the physical and emotional well-being of students. Prolonged use of VR headsets may cause discomfort, fatigue, or motion sickness in some students. Adequate breaks and guidelines for responsible use must be established to ensure student well- being during VR sessions. In addition, privacy and security issues (De Guzman, 2019), namely those related to data collection and tracking of students in VR experiences must be addressed to protect students' personal information. Related to privacy issues, ethical considerations also arise in the use of VR. Educators should pay attention to the potential impact of VR experiences on students' emotions, beliefs, and attitudes. Careful selection and curation of VR content, especially when dealing with sensitive or controversial topics, is essential to ensure students' psychological well-being and values are respected. In conclusion, implementing virtual

reality in Basic Education classes offers many benefits, including increased student engagement, personalized learning experiences, visualization of abstract concepts, and opportunities for authentic learning. However, challenges such as cost, accessibility, curriculum integration, educator training, technical limitations, health and safety, privacy, and ethics must be overcome to fully exploit the potential of VR technology in educational settings (Sulisworo et al., 2023). By addressing these challenges, educators can harness the power of VR to enhance teaching and learning experiences, preparing students for a technologically immersive future.

4.3. VR development potential in future learning

The potential for developing Virtual Reality (VR) in learning in the future is very promising.

4.3.1. Improved Immersion and Realism

With the development of technology, future VR experiences can become more immersive and realistic. More advanced hardware, higher visual resolution, more realistic sound and more accurate motion tracking devices enhance the feeling of presence in a virtual environment (Suri et al., 2023). This will provide a more immersive and engaging learning experience for students. The trend of increasing immersion and realism in VR is leading to the development of more immersive and engaging experiences for users. Here are some of the noticeable developments in terms of increased immersion and realism (Tabrizi et al., 2020):

1. More advanced hardware: Developments in VR hardware such as headsets and controllers are

continuing. Higher processing speeds, higher visual resolutions and more realistic graphical displays help create a more immersive visual experience. More ergonomic hardware also increases user comfort in long-term use.

2. More realistic sound technology: Clear and realistic sound is essential in creating an immersive experience. Advances in sound technologies such as 3D audio or spatial sound technologies allow for more accurate placement of sound in virtual environments. This helps create a more immersive atmosphere and enhances the student experience.
3. More realistic graphics: Advances in graphics rendering allow for more realistic representations in virtual environments. Improvements in lighting, texture, and visual details create a more immersive and immersive experience. Techniques such as more advanced ray tracing produce more realistic light and shadow effects.
4. More accurate motion tracking devices: Developments in motion tracking devices enable more precise interactions in virtual environments. More sensitive motion sensors and more sophisticated algorithms allow for more accurate motion detection and more real-time responses. This provides a more natural and immersive interactive experience.

The trend of further interaction in VR carries the potential to create more interactive and personalized learning experiences. Some of the visible developments in this regard are (Tarng et al., 2010):

1. Hand gesture recognition: More advanced hand gesture recognition technologies allow students to interact with virtual objects and environments by using their hand gestures. For example, students can grab, move, or manipulate virtual objects using intuitive hand movements. This provides a more natural level of interaction and allows for deeper exploration in virtual environments.
2. More advanced eye tracking: Developments in eye tracking allow VR systems to more accurately track a user's eye movements. This enables a more precise visual response in a virtualized environment. Students can look at or focus on certain objects to activate actions or get additional information. More advanced eye tracking can also provide a more immersive experience by changing the visual perspective or focus according to eye movement.
3. Biofeedback devices: The use of biofeedback devices in VR allows students to interact with a virtual environment based on their physiological responses. For example, heart rate or stress sensors can be used to change the atmosphere of the virtual environment or adjust the level of difficulty in learning. This allows for a more personalized and adaptive learning experience, by accommodating students' emotional or physiological states.
4. Enhanced social interaction: In addition to interactions with virtual environments, the trend for more advanced interactions also includes the ability to interact with virtual characters or other students in virtual environments. Speech

recognition technology or facial recognition can provide more complex verbal or non-verbal interactions in learning. Students can participate in discussions, role simulations, or virtual group work which enhances collaboration and social engagement.

With the development of more advanced interactions, students can experience learning experiences that are more natural, personal, and involved in virtual environments. This enriches learning by providing opportunities for exploration, creativity, and deeper interaction, increasing student understanding and motivation.

4.3.2. Collaborative Based Learning

VR development can enable collaboration and interaction between students or groups of students in a virtual environment. In the future of VR-based learning, students can collaborate, communicate, and share knowledge in a connected virtual environment. This will increase engagement and allow students to build social and collaborative skills (Trivedi & Bollmann, 2013). The trend of collaboration-based learning in VR reflects the importance of cooperation and social interaction in the learning process. Here are some aspects of this trend:

1. Virtual collaborative environment: VR development can enable the creation of virtual environments that allow students to work together in real-time in the same environment. They can interact, communicate, and collaborate on joint

problem solving, projects, or assignments. This creates a collaborative learning experience and strengthens students' teamwork skills.

2. Verbal and non-verbal communication: VR can enable students to communicate verbally as well as non-verbally in a virtual environment. Voice recognition technology and realistic 3D avatars enable natural verbal conversations. In addition, gestures, facial expressions or hand signals can be used to convey non-verbal communication in collaboration.
3. Sharing knowledge and resources: In a VR environment, students can share virtual knowledge, resources, or artifacts with fellow students. They can access, edit, or contribute to shared projects or documentation. This enables co-learning and a rich exchange of ideas in collaboration.
4. Problem solving and collaborative projects: VR can be used as a platform for problem solving and collaborative projects. Students can work together on complex tasks, explore solutions together, or face challenges in a virtual environment. It promotes critical thinking, teamwork and creativity in learning.

With the trend of collaboration-based learning in VR, students can develop the social, collaborative and communication skills needed to work in teams and face real-world challenges. This collaborative and interactive learning experience encourages active student participation, increases motivation, and creates an environment that supports growth and shared learning.

4.3.3. More Complex Simulation

VR may deliver more complex and realistic simulations in the future. For example, accurate and detailed medical simulations, natural environment simulations realistic, or safe simulation of a dangerous situation (Upayanto & Wuryandani, 2020) . This simulation allows students to practice skills in a real context without any actual risk. The trend towards more complex simulations in VR denotes developments in creating more realistic, immersive, and context-specific simulations. Here are some aspects of this trend (Utami et al., 2021) :

1. Medicine and health simulation: In the medical and healthcare field, VR can be used to create accurate and detailed simulations of medical procedures, disease diagnoses, or clinical skills training. Students can practice in virtual environments that mimic real experiences, gaining a better understanding of anatomy, medical procedures and patient- doctor interaction.
2. Simulation of natural environments: In environmental studies and natural sciences, VR can be used to simulate realistic environments, such as rainforests, desert areas or coral reefs. Students can explore and study flora, fauna and natural processes in a real virtual environment. It provides an experience that is close to a real natural environment.
3. Hazardous situation simulation: VR can create simulations of dangerous situations, such as fires, natural disasters, or other hazardous environments.

Students can practice emergency reaction, quick decision and safety skills in a safe virtual environment. This simulation helps increase students' preparedness in dealing with dangerous situations without any real risk.

4. Industrial and engineering simulation: VR can be used to deliver complex industrial and engineering simulations, such as operating machines or manufacturing process simulations. Students can practice practical skills and better understand work processes in a virtual environment that mimics real-world experiences.

With more complex simulations in VR, students can get a more realistic and immersive experience in learning. These simulations enable skill practice in real contexts, increase understanding of concepts, and better prepare students to deal with real-world situations.

Figure 15. UbiSimVR Training for Nursing

4.3.4. Data-Driven Learning

In the future development of VR, we can expect a tighter integration of VR with learning analytics and data processing. Data collected from student interactions in virtual environments can provide insight into students' level of comprehension, pace of learning, or learning preferences (Upayanto & Wuryandani, 2020). This can help educators and developers to provide more adaptive and customized learning experiences. The trend of data-driven learning in VR shows the integration between the use of VR with learning analytics and data processing. Here are some aspects of this trend (Wu et al., 2021) :

1. Monitoring and analysis of student interactions: In a VR environment, data can be collected about student interactions with the virtual environment, such as movement, interactions with objects, or responses to questions or tasks. This data can be analyzed to understand students' learning patterns, level of understanding, and their learning preferences.
2. Individual student understanding: Data collected in a VR environment can provide insight into a student's learning pace, which areas are most challenging, or which learning style is more effective for an individual. With this understanding, learning experiences can be tailored to the needs of individual students, helping them achieve better results.
3. Adaptive learning: With learning analytics and collected data, VR can be used to deliver adaptive

learning. The virtual environment can adjust difficulty levels, provide relevant feedback, or adapt content to students' abilities and needs in real-time. This allows for a more personalized and effective learning experience.

4. Evaluation and assessment: Data collected from student interactions in the VR environment can also be used for evaluation and assessment of learning. By looking at student performance data, teachers can assess student understanding, identify additional needs, or measure learning progress objectively.
5. With data-driven learning in VR, educators can use insights from data to provide learning experiences that are more adaptive, effective, and tailored to students' needs. The data collected provides a deeper understanding of student progress and enables more informed decision making in designing effective learning.

4.3.5. Better Accessibility

It is hoped that VR in the future will become more accessible to more people. A more affordable, lighter, and easier-to-use VR device will allow this technology to be adopted in more schools and educational institutions (Yeh & Meng, 2020) . This will expand VR learning access and opportunities for students around the world. The trend for greater accessibility in VR shows progress in making VR technology more affordable, lighter, and easier to use. Here are some aspects of this trend (Villena-Taranilla et al., 2022):

1. Decreased prices of VR devices: It is expected that

in the future, VR devices will become more affordable for consumers and educational institutions. Innovations in technology and mass production can reduce the production costs of VR devices, making them more affordable for schools and educational institutions with limited budgets.

2. Lighter, more portable VR sets: Developments in hardware design can result in lighter, more portable, and more user-friendly VR sets. This will reduce physical discomfort and allow the user to use it for a longer time without feeling burdened.
3. More intuitive and easy-to-use interfaces: The trend for greater accessibility in VR also involves developing more intuitive and easy-to-use interfaces. Simpler use of gesture, voice or gesture recognition can make the operation of VR devices easier to understand and accessible to a wide range of users.
4. Web-based platforms and applications: The emergence of web-based VR platforms and applications is enabling better accessibility for users. By using existing devices such as computers or smartphones, users can access VR content without the need for expensive special devices. This opens up VR learning opportunities for more people.

With greater accessibility, VR technology can be adopted in more schools and educational institutions, expanding VR learning opportunities for students around the world. This provides an opportunity for more people to experience the enhanced learning

benefits that VR has to offer. The development of VR in learning continues to move forward, and the future promises innovations that are more sophisticated and relevant to educational needs. This will help create a more interactive, immersive, and engaging learning experience for students across a variety of disciplines.

4.4. Predict the latest trends and innovations in the use of VR for educational purposes.

Here are some predictions of the latest trends and innovations in the use of VR for educational purposes (Yilmaz & Goktas, 2017) :

1. Development of Standalone VR Devices: Standalone VR devices, such as the Oculus Quest and HTC Vive Focus, are expected to continue to develop and improve their capabilities and quality. They will become lighter, more powerful, and more affordable, enabling more schools and educational institutions to adopt VR as a learning tool.
2. Use of Augmented Reality (AR) in Combination with VR: The combination of VR and Augmented Reality (AR) can be a significant trend. These two technologies can be used together to create richer and more varied experiences. For example, users can use AR devices to view physical objects in the real world and use VR to explore objects in virtual scenarios.
3. Integration of Artificial Intelligence (AI) and Machine Learning: The use of artificial intelligence (AI) and machine learning within VR content can lead to more adaptive and personalized learning experiences. AI can be used to recognize student behavior patterns, provide

customized feedback, and tailor learning experiences to individual student needs.

4. Improved Interactive and Simulation Content: VR content will continue to evolve to be more interactive and provide more realistic simulations. Advances in 3D modeling, real- time graphics, and simulated physics will create more immersive and real experiences for students. They can involve interactions with virtual objects and characters, as well as engage students in more complex situations and challenges.
5. Game-based Learning: The combination of VR and game-based learning will be a significant trend. By using game elements, such as missions, challenges, and a point system, VR can increase student engagement and their motivation in learning. Students can learn through interactive and immersive gameplay experiences.
6. Global Collaboration in VR Environments: Use of VR can connect students and teachers from around the world in a connected virtual environment. This opens up opportunities for global collaboration, where students can interact, share knowledge, and work together on joint projects without being physically in the same place.
7. Development of VR Content Accessible Online: VR content accessible online and sharing via the internet will be increasingly popular. This will enable students and teachers to access VR content from a variety of places and devices. Apart from that, it also enables VR content developers to share and distribute content more widely.

8. VR Learning Analytics: The use of learning analytics in VR content will be increasingly important. Data collected from student interactions in VR environments can provide valuable insights into student learning progress, levels of engagement, and learning preferences. These analytics can be used to improve content and the overall VR learning experience.

The development of VR technology and the growing needs of education will continue to spur innovation in the use of VR for educational purposes. The above trends will shape the direction of development and application of VR in the learning space in the future.

CHAPTER 5.
GUIDELINES FOR SAFETY AND ETHICAL CONSIDERATIONS FOR USE OF VR IN BASIC EDUCATION

In a recently published article, researchers Michael Madary and Thomas K. Metzinger of Johannes Gutenberg University in Germany review a series of ethical considerations when implementing VR. The illusion of embodiment may provide VR's greatest value for education, but it also lies at the heart of its ethical implementation. Madary and Metzinger believe that VR is not just an evolution of television screens and video games, but a revolution that will have a huge social impact. In their paper, they claim that:

> "VR technologies will eventually change not only our common image of humanity but also our understanding of deeply rooted ideas, such as "conscious experience," "self," "authenticity," or "reality."

The implications, then, are not only social, but push to the core of our being by influencing ideas of identity and self-perception. It's important to remember that many of today's VR uses in schools, such as Google Expeditions, are not interactive VR, but simply 360-degree video experiences. In these cases, students experience immersive 3D images or panoramas, but don't interact deeply with the content. Embodiment illusions are interactive content products and motion tracking, where users can change and influence their environment and engage with others who share their virtual space. Headsets like the Vive and Oculus Rift fall into this

latter category, but it won't be long before most, if not all, consumer-oriented VR technology will be truly immersive and interactive. Madary and Metzinger develop ethical guidelines for VR research, but also make recommendations for everyday public use. Educators and parents should be aware of these before children and youth take the plunge, and it should be added that they apply to adults as well. These five areas are by no means exhaustive and in some cases speculative, but they address some of the more pressing issues to be aware of as VR headsets enter everyday use.

5.1. Long Term Effect and Prolonged Exposure

The little research that has been done on the psychological and physiological effects of VR has occurred in clinical settings and has only studied short-term use. There are no studies on the long-term effects of VR on children, or on the effects of prolonged exposure. It's not uncommon for school-age children and teens to spend dozens of hours a week consuming media and playing games, but what will happen when VR goggles are added to the mix? Madary and Metzinger characterize addiction, agency manipulation, unconscious psychological changes and mental illness as some of the potential dangers of prolonged exposure. This is especially relevant for young people because their developing minds and bodies may, for better or for worse, be especially vulnerable to the power of immersive technology. Presumably, use in schools will be limited in time and scope, but the availability of high-end equipment at home will raise all the same questions about the levels of prolonged use and addiction that have plagued the internet, video games, and other media, especially as VR is likely to join all of the above.

Associations such as the United States Public Health Service and the American Academy of Pediatrics do not currently have guidelines regarding VR. Meanwhile, parents and teachers must curate content, limit exposure and monitor responses and reactions.

Environmental Impact on Agencies and Behavior. Research in psychology supports the idea that our environment, both social and structural, exerts a subtle effect on our behavior. Our senses regularly relay environmental cues that inform and influence our attitudes and reactions. This sensitivity to context has been identified in some of the most well-known studies in psychology, including the Stanford Prison Experiment and Milgram's obedience experiment, in which participants were unknowingly forced to apply what they thought were painful electric shocks to another participant. This is of major consequence for VR, where the user operates in an immersive, built environment. As the German researchers note, our everyday environment is relatively stable, but we don't really know how our minds and bodies will respond to a diverse and rapidly changing virtual world, which can potentially lead to a number of unintended consequences. The results may be positive or negative, but as it stands, research on the specifics is scant. As our responses are better understood, virtual worlds can be deliberately designed for certain outcomes, but these are also ethically loaded. On the one hand, environments can be created to encourage empathy, joy, fulfillment and a host of prosocial emotions and outcomes. But where do our true nature end and emotional engineering begin? Also, and more sinisterly, this context can also be manipulated to give the user the illusion of being in full control of their decisions, but subtle and subtle environmental cues can unwittingly lead us

to change our political and religious views, and open up new horizons for commercial exploitation. This, of course, can disproportionately impact children, eternal targets for advertisers because of their vulnerability and the influence they exert on their parents. There is also the danger of so-called social hallucinations, or the perception that we have rich (albeit virtual) social interactions with artificial intelligence-guided avatars. Again, these false friends can reshape our views and influence how we spend our hard earned money. Again, there is a need to proceed with caution to ensure the use of technology by students and children falls on whose sideGood.Research, awareness, regulation and monitored use will all prove beneficial.

5.2. Exacerbating pre-existing psychological or emotional problems

No two humans are the same and most people regularly cycle through a variety of complex emotions and thought patterns. Disposition has a significant effect on how individuals perceive media, and has complicated studies exploring media effects, because content and media will affect different people in different ways at different times. In some cases, VR use may trigger or exacerbate pre-existing and latent emotional or psychological disturbances. For this reason, it's important to screen individuals before subjecting them to a VR experience, and to monitor them while the session is in progress, because what may be emotionally productive for one may prove devastating to another.

It is also important to contextualize the session with questions and answers and discussion. "A student's past experience and level of knowledge also have an impact," says

Castaneda. "Even with things like being in the air, seeing large creatures, or being underwater, we've seen situations with students where they trigger anxiety and discomfort. So even though most educators would not put their students very intensely in VR, from an ethical point of view, it's very, very important that educators are aware of some of the psychological research." As previously noted, VR has been shown to be effective in treating PTSD, for example, and will likely be leveraged to generate further mental health benefits. VR's potential to help rather than worsen, however, hinges on its judicious use based on empirical research.

5.3. (Un)Reality and Less Real World Interaction

Even though we currently inhabit a diverse and pervasive media ecology, few would argue with the idea that the real world still has a lot to offer. There are many advantages or "improvements" to interacting socially in virtual environments, but existing technology is still only an approximation of real-life nuanced multisensory tangibility. We have evolved to accept the intricacies of smells, body language, tactility and the vast complexities of the natural world, and their loss or imperfect replacement may have disastrous consequences. For example, limited and potentially shallow social interactions in virtual spaces – such as the reductive "likes" on Facebook – could normalize and we could, theoretically, collectively lose knowledge and memory of the intricacies of face-to-face communication. However, on the plus side, these virtual and online spaces also allow closed, anti-social, geographically isolated and disabled or handicapped individuals to take part in a rich social life that may be limited or unavailable.

Madary and Metzinger speculate that heavy use of VR can lead to dissociative states such as Depersonalization/ Derealization Disorder, a kind of dream-like state that results in the feeling that one's body or surroundings are not real. They wrote that "VR heavy users may begin to experience the real world and their real bodies as unreal, effectively shifting their sense of reality exclusively to virtual environments." VR's capacity to blur the real from the unreal can also deepen children's tendency to mix fantasy with reality.

"The most high-end headsets aren't recommended for younger kids, for a variety of reasons," says Castaneda. "One of the most interesting cases we've seen of younger children having a hard time separating virtual reality from reality. They struggle to frame, especially at first, the fact that they've just seen a dinosaur and are now in the living room." Castaneda suggests that it's important to err on the side of caution and provide age-appropriate experiences, which should be discussed beforehand, contextualized and include debriefing upon completion.

5.4. Privacy and Data Collection

Data and education have a tentative relationship. Granular assessment prospecting using all kinds of data from keystrokes to heartbeats holds the promise of better understanding and responding to the individual needs of our students. However, that same data can fall into the wrong hands, now or later, with life-changing consequences. The relationship between data and privacy is fast emerging as one of the defining social questions of the 21st century, and VR is likely to take the debate to the next level. The further we join

cyberspace, a condition we are currently in, the more data we will release, often without our knowledge or consent.

As social networks and the Internet become virtual, 3-D spaces, we will more closely identify and be identified by our online avatars, whose use and misuse raises complex questions of identity, ownership, and privacy. Madary and Metzinger use a base case to offer a small glimpse at the legality of brewing as it relates to our online self: "Let's say a user creates an avatar that is similar but not pixel-for-pixel identical to another user's avatar. Where exactly should we draw the line between theft?" and acceptable similarity?" Where, indeed? As it already is, technology is advancing faster than legal and regulatory systems can keep up, and the widespread use of VR will only widen the gap.

Another privacy issue raised by German researchers is that, if our online avatars mirror our real-world movements and gestures, the "motor intent" and "kinematic fingerprints" of our unique movement signatures can be tracked, read, and exploited by advertisers. or other predatory entity. The virtual environment will respond to our body language, producing precise laser-targeted advertising and "neuromarketing," including strategies for placing us in ads and ads that we encounter. Of course, it's not all grim and doom, as these same technologies can help read our moods for more productive mental health counseling and treatment, as well as improve healthcare in general. It can also help realize the elusive dream of completely different instruction, making learning a happier and more equitable place.

Instead of sparking new moral panics a la comic books, rock 'n' roll and video games, the use of VR in homes and schools calls for sustainable awareness and responsible citizenship, registering democratic processes to ensure that

laws and regulations are appropriate, research- based and ethically exist to increase the benefits and minimize the potential harms of VR technology. As in all media use cases, parents and teachers should adopt media and digital literacy best practices. This includes engaging, being aware and informed about their children's media use, encouraging critical thinking and having frequent dialogue about their experiences.

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Pembelajaran interaktif merupakan pendekatan pembelajaran yang memberikan siswa kesempatan aktif untuk terlibat dalam proses belajar-mengajar. Dalam pembelajaran interaktif, siswa tidak hanya menjadi penerima informasi, tetapi juga berpartisipasi aktif dalam eksplorasi, pemecahan masalah, dan kolaborasi. Metode pembelajaran ini dapat meningkatkan keterlibatan siswa, memotivasi mereka untuk belajar, dan membantu memperkuat pemahaman konsep yang diajarkan.

Virtual Reality (VR) adalah teknologi yang memungkinkan pengguna untuk merasakan dan berinteraksi dengan lingkungan buatan yang tampak dan terdengar nyata melalui penggunaan headset VR. VR telah diterapkan secara luas dalam berbagai bidang, termasuk pendidikan. Penggunaan VR dalam pembelajaran menawarkan pendekatan yang inovatif dan menarik untuk menghadirkan pengalaman belajar yang lebih mendalam dan memikat bagi siswa.

Berikut adalah beberapa alasan mengapa pembelajaran interaktif dan pengenalan VR sebagai alat pembelajaran yang inovatif penting:

1. Meningkatkan Keterlibatan dan Motivasi Siswa: Dengan memungkinkan siswa untuk berinteraksi langsung dengan konten pembelajaran melalui pengalaman VR yang imersif, pembelajaran menjadi lebih menarik dan memikat. Siswa merasa lebih terlibat dalam proses belajar, yang pada gilirannya dapat meningkatkan motivasi mereka untuk belajar lebih lanjut.
2. Pemahaman Konsep yang Lebih Mendalam: Melalui penggunaan VR, siswa dapat mengalami konsep-konsep abstrak atau sulit dipahami secara langsung. Mereka dapat menjelajahi lingkungan 3D, mengobservasi objek atau fenomena dalam skala yang lebih nyata, dan melakukan simulasi interaktif. Hal ini membantu siswa memperoleh pemahaman yang lebih mendalam dan memperkuat konsep-konsep yang diajarkan.
3. Pembelajaran Berbasis Pengalaman: VR memungkinkan siswa untuk belajar melalui pengalaman langsung, yang dapat meningkatkan retensi informasi dan pemahaman mereka. Siswa dapat berpartisipasi dalam simulasi, eksperimen, atau situasi dunia nyata yang sulit diakses dalam pembelajaran konvensional. Mereka dapat melihat, merasakan, dan berinteraksi dengan lingkungan yang direpresentasikan secara virtual.
4. Kolaborasi dan Komunikasi: VR juga memungkinkan siswa untuk berkolaborasi dalam ruang virtual yang sama. Mereka dapat berinteraksi dengan sesama siswa atau guru, berbagi pengetahuan, dan bekerja sama untuk menyelesaikan tugas atau masalah. Hal ini memperkuat kemampuan komunikasi dan kerja tim siswa, serta mempersiapkan mereka untuk kehidupan dan pekerjaan di dunia yang semakin terhubung.
5. Pengayaan Pengalaman Pembelajaran: Dalam beberapa kasus, pengalaman yang dihadirkan melalui VR dapat memberikan kesempatan yang tidak mungkin dilakukan dalam konteks pembelajaran tradisional. Misalnya, siswa dapat mengunjungi tempat-tempat bersejarah yang jauh atau menyelami dunia bawah laut tanpa meninggalkan ruang kelas. Ini memperkaya pengalaman pembelajaran mereka dan membuka wawasan baru.

Pembelajaran interaktif dan pengenalan VR sebagai alat pembelajaran yang inovatif membawa banyak manfaat dan potensi untuk mengubah cara kita belajar dan mengajar. Dengan memanfaatkan teknologi VR dengan baik, pendidikan dapat menjadi lebih menarik, relevan, dan memberikan pengalaman pembelajaran yang lebih baik bagi siswa.

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