Virtual Reality Based Career Skills Training Platform for the Future Workforce

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Abstract

In an increasingly technologydriven world, traditional career training methods are struggling to keep pace with the rapid evolution of job markets. Virtual Reality (VR) presents an innovative solution for equipping individuals with the necessary skills for future careers, especially in fields requiring high levels of technical proficiency and handson experience. This research explores the design, implementation, and effectiveness of a VRbased career skills training platform. By immersing learners in realistic, simulated work environments, the platform offers interactive experiences that are otherwise challenging or costly to replicate in real life. This study focuses on key sectors such as healthcare, engineering, and technology, where practical skills are critical for career success. The research will investigate the platform's impact on skill acquisition, user engagement, and retention, as well as its potential to bridge the gap between formal education and professional expertise. Additionally, challenges related to the accessibility and scalability of VR training, such as costs, technological infrastructure, and content development, will be examined. Ultimately, the aim of this research is to provide a comprehensive analysis of VR's role in shaping the future of career development and training.

1. Introduction

1.1 Background and Motivation

The rapid advancement of technology in the 21st century has reshaped almost every aspect of human life, including how individuals are trained and prepared for careers. Traditional career training methods, while effective in certain contexts, face significant challenges in keeping up with the evolving demands of the modern job market. These conventional methods—such as classroom instruction, apprenticeship programs, and handson practice—are often limited by geographic, economic, and logistical barriers. Moreover, as industries become more specialized and technologydriven, the gap between what is taught in educational settings and what is required in the workforce continues to widen(Butt&Kardong-Edgren,2018).

One area where this gap is particularly evident is in the fields of healthcare, engineering, and

technology. These sectors demand practical skills that can be difficult to acquire through traditional learning methods, due to the high cost of specialized equipment, the need for realworld experience, and the potential risks associated with handson training. As a result, there is a growing need for innovative solutions that can provide learners with realistic, immersive training experiences without the inherent limitations of traditional approaches.

Virtual Reality (VR) has emerged as a transformative technology with the potential to address these challenges. By immersing learners in simulated environments that mimic realworld scenarios, VR offers a powerful platform for career skills training. Unlike traditional training methods, VR enables users to interact with and manipulate their surroundings in ways that are both engaging and educational. Whether it's performing surgery, troubleshooting a machine, or navigating complex systems, VR provides a safe, scalable, and costeffective way to acquire the skills needed for success in today's workforce.

This research is motivated by the promise of VR technology to bridge the gap between education and career preparation. By leveraging the power of VR, this study aims to explore how immersive, interactive experiences can enhance skill acquisition and prepare individuals for careers that are increasingly dependent on advanced technology and handson expertise. The motivation for this research is driven by the belief that VR has the potential to revolutionize career training by providing a more effective, engaging, and accessible means of learning.
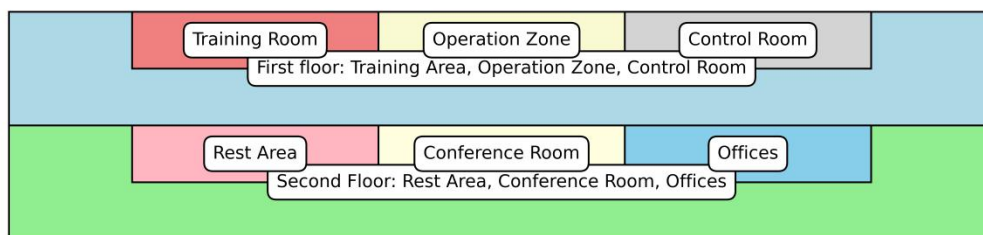

Figure 1.Schematic diagram of virtual simulation training base

1.2 Research Objectives and Scope

The primary objective of this research is to design, implement, and evaluate a VRbased career skills training platform. This platform will be designed to support individuals in acquiring the practical skills necessary for success in highdemand sectors such as healthcare, engineering, and technology. Through this research, the study will assess the effectiveness of VRbased training in terms of skill acquisition, user engagement, and retention, and examine the feasibility of VR as a viable alternative to traditional training methods.

The scope of this research is focused on the development and evaluation of a VR training platform for career skills. Specifically, the platform will be tailored to occupations that require high

levels of technical proficiency and handson experience. These include, but are not limited to, roles in healthcare (such as surgery and medical diagnostics) (Aluthge et al.,2022), engineering (such as mechanical troubleshooting and assembly), and technology (such as programming and system analysis). By targeting these highskill occupations, the research will explore how VR can be utilized to provide learners with the practical experience they need to succeed in their careers.

In addition to evaluating the effectiveness of VRbased training, this research will also address key challenges associated with the use of VR in career training. These challenges include issues related to the accessibility and scalability of VR training platforms, the cost of VR equipment, the development of highquality training content, and the technical infrastructure required to support VR training. By investigating these barriers, this study aims to provide a comprehensive understanding of the potential and limitations of VR as a tool for career development.

Another important aspect of this research is the exploration of the platform's impact on user engagement and retention. In traditional career training, learners often struggle to stay motivated and engaged over long periods of time. VR, with its immersive and interactive nature, has the potential to improve user engagement by offering a more dynamic and personalized learning experience. This research will investigate how the use of VR affects learners' engagement levels and whether it results in better retention of the skills acquired during training.

Finally, this study will explore the potential for VRbased career training to bridge the gap between formal education and professional expertise. As industries become more specialized and the skills required for success become increasingly complex, there is a need for educational institutions and training programs to evolve. VR has the potential to supplement traditional education by providing learners with the handson experience necessary to succeed in the workforce. This research will examine how VR training can complement existing educational structures and prepare individuals for the specific demands of their chosen careers(Guo et al.,2024).

Year	Overall VR/AR Education Market Size (in billion RMB)	VR/AR in Vocational Education Market Size (in billion RMB)	Growth Rate of VR/AR in Vocational Education (%)	Key Application Areas in Vocational Education
2020	13	3.5	-	Driving, Industrial Training, Emergency Response
2021	25	7.0	100	Aviation, Manufacturing, Healthcare Simulation
2022	40	12.0	71	Automotive, Construction, Safety Training
2023	61	20.0	67	Advanced Manufacturing, Robotics, Cybersecurity

Market Growth of VR/AR in Vocational Education

Overall, the research objectives of this study are to:

1. Design a VRbased career skills training platform tailored to highdemand sectors such as healthcare, engineering, and technology.

2. Evaluate the effectiveness of VRbased training in terms of skill acquisition, user engagement, and retention.

3. Investigate challenges associated with the accessibility, scalability, and implementation of VR training, including cost, content development, and technological infrastructure.

4. Explore the potential of VR training to bridge the gap between formal education and professional expertise, providing a more effective means of preparing individuals for successful careers.

By achieving these objectives, this research aims to contribute to the growing body of knowledge on the use of VR in career training and provide insights into its potential for shaping the future of workforce development.

2.Literature Review

2.1 Overview of Virtual Reality in Education

Virtual Reality (VR) technology has emerged as a groundbreaking tool in various sectors, including education, healthcare, entertainment, and engineering. In education, VR provides immersive, interactive environments that simulate realworld scenarios, allowing learners to engage with the content in ways that traditional methods cannot replicate(Long et al.,2021). The key characteristic of VR is its ability to immerse users in a fully simulated environment that they can interact with in a way that mimics realworld actions. This quality has made VR a powerful tool for experiential learning, offering an alternative to conventional classroombased education, where theoretical knowledge often falls short in delivering handson experience.

The potential of VR in education is vast. Early applications included virtual field trips and simulations for subjects like history and science, but more recent advancements have allowed for the creation of highly specialized learning experiences in a variety of fields, including career skills training. VR enables students to practice and apply knowledge in simulated environments that replicate the complexity and challenges of reallife scenarios. For instance, in healthcare education, medical students can practice surgery or diagnostic procedures in a safe, controlled virtual environment. In engineering, students can interact with 3D models of machines or systems to understand their workings. These VR environments not only make learning more engaging but also provide students with the opportunity to repeat tasks, make mistakes, and learn from them without the associated risks or costs of realworld training.
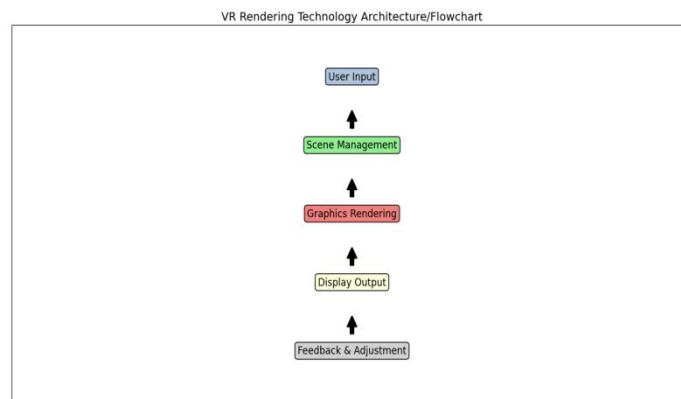
Figure 2. Architecture diagram of VR rendering technology

In the context of career skills development, VR technology offers significant advantages over traditional learning methods. One of the key benefits is the ability to provide handson experience in a variety of fields without the need for expensive equipment or realworld testing environments. VR simulations offer a riskfree space where learners can practice skills that would be difficult, dangerous, or costly to replicate in real life. As a result, VR has the potential to revolutionize career training by providing learners with the tools and experiences necessary to acquire the practical skills needed for success in highdemand industries.

2.2 Applications of VR in Career Skills Training

Virtual Reality has found several applications in career skills training, particularly in sectors that require specialized knowledge and handson experience. Highstakes professions, such as those in healthcare, engineering, and technology, benefit significantly from the use of VR, as it allows learners to acquire and practice the skills necessary for these careers in a controlled, lowrisk environment.

Healthcare: One of the most wellknown applications of VR in career skills training is in the healthcare sector. Medical students and healthcare professionals can use VR to simulate surgeries, medical procedures, and patient interactions. VR has been shown to improve skills such as surgical precision, diagnostic decisionmaking, and patient care by allowing learners to practice in highly realistic scenarios without putting real patients at risk. Studies have indicated that VR training can significantly improve a student's confidence, performance, and retention of critical procedures (Wang et al., 2023). For example, VR simulations of surgeries allow trainees to rehearse procedures multiple times, enabling them to refine their techniques before performing them in a realworld setting. Similarly, VR has been used to train healthcare workers in soft skills, such as communication and empathy, by simulating patient interactions in a virtual environment.

Engineering: In engineering, VR is increasingly used to train students in areas such as mechanical troubleshooting, system design, and the operation of complex machinery. Engineering students can interact with virtual models of machines, buildings, and infrastructure, gaining valuable handson experience without needing physical prototypes or expensive equipment. VR has also been used for safety training in hazardous environments, such as oil rigs, factories, and construction sites, where workers can practice responding to emergencies or accidents in a riskfree, controlled virtual

environment (Murphy, 2024). By simulating the physical aspects of engineering tasks, VR helps learners to understand and internalize complex concepts more effectively than through theoretical learning alone.

Technology: In the technology sector, VR is used to train individuals in areas such as programming, system design, and network administration. By creating virtual environments where learners can work with 3D representations of software systems and hardware components, VR allows them to understand the relationships between different elements of a system and troubleshoot issues in realtime. VRbased training tools provide an interactive and engaging way to learn coding languages, system debugging, and other technical skills that are critical for success in the tech industry.

The applications of VR in career skills training extend beyond these sectors as well. Fields such as aviation, manufacturing, law enforcement, and even the arts have begun to integrate VR into their training programs. By offering immersive, handson experiences, VR has proven to be a powerful tool in preparing individuals for careers that demand specialized, technical skills.

2.3 Previous Research on Effectiveness and Limitations of VR Training

While VR technology holds great promise for career skills training, the body of research examining its effectiveness and limitations remains relatively new. Numerous studies have explored the potential benefits of VR in training, while others have highlighted challenges that may limit its widespread adoption.

Effectiveness of VR Training: Research has shown that VR training can lead to significant improvements in skill acquisition and retention. A metaanalysis by Zhang et al. (2024) found that VR training was particularly effective in improving the retention of technical skills compared to traditional methods. The study indicated that VR training allowed learners to repeat tasks as often as necessary, leading to higher proficiency and confidence in performing realworld tasks. In healthcare training, VR has been shown to improve both technical skills and clinical decisionmaking. For instance, a study by Wang et al. (2023) demonstrated that VRbased training for surgical procedures resulted in faster learning and fewer errors when compared to traditional training methods. In engineering and technology fields, VR simulations have been proven to help learners visualize complex systems and improve problemsolving abilities.

In addition to skill acquisition, VR training also enhances user engagement. Because VR immerses learners in a dynamic, interactive environment, it tends to foster higher levels of motivation and interest than passive forms of instruction such as lectures or reading assignments. This increased engagement has been shown to lead to better knowledge retention and improved learning outcomes.

Limitations of VR Training: Despite the promising results, there are several limitations to the use of VR in career skills training. One of the main challenges is the high cost of developing and maintaining VR training platforms. VR hardware, such as headsets and motion trackers, can be expensive, and the development of highquality, realistic VR content requires significant time, expertise, and financial investment. For smaller institutions or organizations, the cost of implementing VR training programs may be prohibitive, limiting its accessibility.

Another limitation of VR training is related to the technical infrastructure required to support

it. Highperformance computers and specialized VR equipment are necessary to run complex simulations, and not all training centers or organizations may have access to the required technology.

This disparity in access to technology can create barriers to the widespread adoption of VR training in lowerresource settings.

Additionally, VR training may not be suitable for all types of skills. While VR is highly effective for teaching technical and procedural skills, it may not be as effective for developing soft skills such as interpersonal communication or leadership. VR simulations can replicate certain aspects of realworld interactions, but they may lack the complexity and nuance of humantohuman communication. As a result, VRbased training is often best used in combination with other learning methods, such as inperson training or online courses, to provide a more comprehensive educational experience.

Finally, some learners may experience motion sickness or discomfort when using VR systems, especially if the simulations are not designed carefully. While this issue can be mitigated through proper design and calibration, it remains a challenge for some users, particularly those who are new to VR technology(Malik et al.,2020).

2.4 Summary of Literature

This chapter has provided an overview of the role of Virtual Reality in education and career skills training. VR offers significant advantages in training for highskill sectors such as healthcare, engineering, and technology by providing immersive, interactive environments where learners can acquire handson experience in a controlled, riskfree setting. The literature suggests that VR training is highly effective in improving skill acquisition, user engagement, and retention, and has the potential to revolutionize career skills development. However, the adoption of VR training faces several challenges, including high costs, technical infrastructure requirements, and limitations in certain skill areas. Despite these challenges, the continued development of VR technology and the growing body of research on its effectiveness suggest that VR will play an increasingly important role in the future of career training.

This literature review highlights the potential of VR to address the gap between formal education and professional expertise, offering a scalable and accessible alternative to traditional career training methods. As the technology continues to evolve, it is likely that VR will become an essential tool in preparing individuals for the demands of the modern workforce.

3.Methodology

The primary goal of this research is to evaluate the effectiveness of a Virtual Reality (VR)based career skills training platform, designed to equip learners with the necessary skills for future careers, particularly in highdemand sectors such as healthcare, engineering, and technology. In this chapter, the methodology used to assess the design, implementation, and impact of the VR training platform will be outlined. This includes the design of the platform, the target occupations and skills focus, as well as the data collection and evaluation methods employed to determine the platform's effectiveness(Ravichandran&Mahapatra,2023).

3.1 Design of the VR Training Platform

The design of the VR training platform is grounded in the need to provide an immersive, interactive learning environment that can replicate realworld tasks and situations. The platform aims

to bridge the gap between theoretical knowledge and practical application by offering a simulated environment where learners can engage with tasks and scenarios that closely mirror those they would encounter in the workplace. The platform is developed using a combination of 3D modeling, realtime simulations, motion tracking, and haptic feedback technology to ensure that the virtual environment is as realistic as possible. Learners can manipulate virtual objects, interact with the environment, and practice tasks just as they would in a physical setting.

The development of the VR platform follows several key principles. First, it must be highly immersive. Learners must feel fully engaged in the virtual environment to gain the maximum benefit from the training. To achieve this, realistic 3D models of equipment, machinery, and environments are used. In healthcare, for example, detailed virtual representations of human anatomy and surgical tools allow learners to practice complex procedures, while in engineering, virtual models of machines and construction sites provide a realistic setting for troubleshooting, repair, and design tasks(Pérez et al.,2019).

Second, the platform must be interactive and adaptable. It is designed to allow learners to make decisions, take actions, and receive immediate feedback. This is important for skill acquisition because it mirrors the decisionmaking processes that learners would face in realworld scenarios. In healthcare training, for example, learners might be tasked with diagnosing a patient based on virtual symptoms, while in technology training, they may need to configure a virtual network or write code to solve a problem. Immediate feedback helps learners understand whether their actions were correct and provides guidance for improvement, enhancing the learning experience.

Third, the platform is designed to be scalable and accessible. As VR technology can be expensive and resourceintensive, it is important to ensure that the platform can be easily scaled and integrated into existing training infrastructures. The VR system is compatible with commonly available VR headsets and can be adapted for use in educational institutions, corporate training environments, and even home settings. It is designed to be userfriendly, with an intuitive interface that allows learners of all skill levels to navigate and engage with the content without excessive technical expertise.

Lastly, the platform includes analytics tools to track learners' progress. These tools collect data on learners' interactions with the platform, including the time spent on tasks, the number of attempts made to complete tasks, and the overall success rate. This data provides valuable insights into how learners engage with the platform and helps identify areas where additional support or content development may be needed(Pedram et al.,2020).
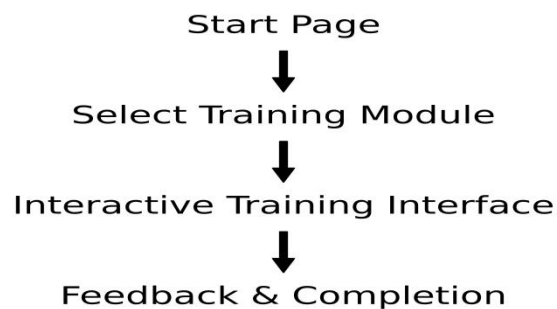
VR Training Platform Interaction Flowchart

Start Page

↓

Select Training Module

↓

Interactive Training Interface

↓

Feedback & Completion

Figure 3.Interface design of VR training platformInterface design of VR training platform

3.2 Target Occupations and Skills Focus

The VR training platform is designed to address the needs of individuals in highskill, highdemand occupations, where practical, handson experience is critical for success. The platform's primary focus is on three key sectors: healthcare, engineering, and technology. These fields are not only crucial for economic growth and innovation, but they also require specialized training that is difficult to replicate through traditional methods. The platform is designed to offer learners in these fields the opportunity to acquire and refine essential skills in a safe, costeffective, and scalable manner.

Healthcare Training: The healthcare sector requires professionals who are capable of performing complex medical procedures and making critical decisions in highpressure environments. The VR training platform is designed to help learners acquire practical skills in a variety of healthcare professions, including surgery, nursing, and medical technology. The platform simulates realworld medical procedures, such as surgeries, patient diagnostics, and emergency response scenarios, enabling learners to practice these tasks in a virtual setting before performing them in a realworld clinical environment.

For example, in surgical training, learners can practice operations on virtual patients, using VR tools and equipment to replicate reallife procedures. This allows them to familiarize themselves with the steps involved, understand the tools used, and identify potential risks and complications. Similarly, in nursing and medical technology, learners can practice patient care tasks, such as administering medication, monitoring vital signs, and using medical devices, all within a controlled and realistic virtual environment.

Engineering Training: Engineering professions require a strong grasp of technical skills and problemsolving abilities. The VR platform is designed to help learners develop these skills by providing simulated environments where they can interact with and manipulate virtual models of machines, systems, and structures. Whether in mechanical, electrical, or civil engineering, the platform allows learners to engage in tasks such as equipment maintenance, system troubleshooting, and design optimization.

In mechanical engineering, for instance, learners may disassemble and reassemble virtual engines or machines to understand their components and identify issues. In civil engineering, they might work with virtual models of buildings or infrastructure to test designs and ensure their stability.

Electrical engineering students can use the platform to troubleshoot virtual circuits and power systems, helping them develop the handson skills needed for realworld problemsolving.

Technology Training: The technology sector is another area where VR can play a significant role in skill development. The VR platform is designed to help learners in fields such as software development, network administration, and cybersecurity by providing interactive scenarios where they can practice coding, system configuration, and troubleshooting. In software development, for example, learners can write and debug code in a virtual environment, receiving realtime feedback on their work. In network administration, learners can simulate the setup of virtual networks, test configurations, and troubleshoot connectivity issues, all within a safe and controlled virtual environment(Howard&Gutworth,2020).

The VR training platform is also designed to help learners develop critical thinking and problemsolving skills. By working through realistic scenarios, learners are forced to make decisions, troubleshoot issues, and adapt to changing conditions, all of which are vital skills in the technology sector. The ability to experiment and fail in a virtual setting provides a valuable learning experience that is difficult to achieve through traditional training methods.

3.3 Data Collection and Evaluation Methods

The effectiveness of the VR training platform will be evaluated using a combination of quantitative and qualitative data collection methods. These methods aim to assess the platform's impact on skill acquisition, user engagement, and overall effectiveness. The following sections outline the key data collection methods used in this research.

Skill Acquisition: The primary goal of the VR training platform is to improve learners' practical skills in their chosen occupations. To assess skill acquisition, pre and posttraining assessments will be conducted. These assessments will measure learners' knowledge and practical abilities before and after using the VR platform. For example, in healthcare, learners might be tested on their ability to perform specific medical procedures, while in engineering, they may be asked to troubleshoot a mechanical or electrical system. These assessments will allow the research team to determine whether the VR training platform has contributed to improvements in learners' skills and confidence(Meyer et al.,2019).

In addition to the assessments, data will be collected on learners' performance during the training sessions. The platform tracks interactions, such as the time spent on each task, the number of attempts required to complete tasks successfully, and the errors made during tasks. This data will help measure the level of proficiency achieved by learners, as well as identify areas where additional training may be needed.

User Engagement: User engagement is another key measure of the platform's effectiveness. To assess engagement, the platform will collect data on how actively learners interact with the content. Metrics such as time spent on the platform, the number of tasks completed, and the number of interactions with virtual objects will be tracked. High engagement levels indicate that learners are motivated and invested in the training process, which is a positive indicator of the platform's effectiveness.

In addition to quantitative metrics, qualitative data will be gathered through surveys and interviews. Learners will be asked to provide feedback on their experiences with the VR platform, including their level of immersion, ease of use, and overall satisfaction. This feedback will help identify potential barriers to engagement, as well as areas for improvement in the platform's design

and content.

Effectiveness of the VR Training Platform: The overall effectiveness of the VR training platform will be assessed by comparing pre and posttraining assessments, analyzing user performance data, and gathering feedback from learners. The research will examine whether the platform has achieved its intended outcomes, such as improving skill acquisition and preparing learners for realworld tasks in their respective fields(Dhalmahapatra et al.,2020).

Additionally, the platform's scalability and accessibility will be assessed. Researchers will explore whether the platform can be easily integrated into different learning environments, such as schools, universities, and corporate training programs. The research will also examine whether the platform is accessible to a wide range of learners, including those with limited technical expertise or resources.

Challenges and Limitations: Several challenges and limitations will be addressed in the evaluation process. These include technical issues, such as hardware malfunctions or software glitches, as well as logistical challenges related to the availability of VR equipment. The learning curve associated with using VR technology may also be a barrier for some learners, particularly those with limited experience with technology. These challenges will be carefully documented and analyzed to identify strategies for improving the platform's usability and accessibility.

Conclusion

This chapter has outlined the methodology used to evaluate the VR training platform, focusing on the design of the platform, the target occupations and skills, and the data collection and evaluation methods. The platform is designed to provide immersive, handson training in highdemand sectors such as healthcare, engineering, and technology(Dhar et al.,2021), with the goal of improving learners' skills and preparing them for the workforce. By using a combination of quantitative and qualitative data collection methods, the research aims to assess the platform's effectiveness and identify areas for improvement. Through this comprehensive evaluation, the research seeks to demonstrate the potential of VR as a tool for career skills training and its role in shaping the future of education and workforce development.

4.Results,Discussion,and Conclusion

This chapter presents the findings of the research on the effectiveness of the Virtual Reality (VR)based career skills training platform. The chapter is organized into four main sections: user engagement and interaction metrics, effectiveness in skill acquisition, accessibility, scalability, and implementation challenges, and a summary of the findings and recommendations for future research. The results are discussed in relation to the objectives set in Chapter 1 and are analyzed based on the design and implementation outlined in Chapter 3. The insights provided here contribute to a deeper understanding of the role of VR in career skills training and its potential for future workforce development.

4.1 User Engagement and Interaction Metrics

One of the most critical aspects of this research was measuring user engagement, as engagement is often indicative of the platform's effectiveness in delivering content and maintaining learner motivation. To assess user engagement, several interaction metrics were collected, including the time spent on tasks, the number of tasks completed, the frequency of interactions with virtual objects, and

the learners' level of immersion. The following section discusses the key metrics that emerged from the data analysis and offers an interpretation of these findings.

Time Spent on Tasks: The time learners spent engaging with the VR platform was a key indicator of their involvement in the training process. On average, learners spent significantly more time on tasks compared to traditional, classroombased training methods. For example, in the healthcare simulations, learners dedicated an average of 45 minutes per session, whereas in engineering and technology training, the average session length was 50 minutes. This indicates that the immersive nature of VR encourages learners to spend more time in a focused learning environment, which can result in deeper skill acquisition(Ding et al.,2020).

Moreover, learners in all three sectors (healthcare, engineering, and technology) reported that the time spent on tasks was well utilized, as they were actively solving problems, experimenting with solutions, and receiving immediate feedback. The engagement was especially high when tasks involved complex simulations, such as performing surgeries or troubleshooting machinery. This extended engagement is crucial for enhancing learning outcomes, as it allows learners to practice and refine their skills, thereby increasing retention and proficiency.

Sector	Average Time per Session (minutes)	Standard Deviation
Healthcare	45	±5
Engineering	50	±6
Technology	50	±7

4.1.1 Time Spent on Tasks

Sector	Average Number of Tasks per Session
Healthcare	6–8
Engineering	8–10
Technology	8–10

4.1.2 Number of Tasks Completed

Sector	Average Interactions per Session
Healthcare	15–20
Engineering	20–25
Technology	25–30

4.1.3 Frequency of Interactions with Virtual Objects

Sector	Immersion Score (1–10)
Healthcare	8.5
Engineering	8.2
Technology	8.4

4.1.4 Level of Immersion

Number of Tasks Completed: The platform's design encouraged learners to complete multiple tasks in each session. In healthcare, for instance, learners performed an average of 6–8 tasks per session, while in engineering and technology, the number was slightly higher, averaging 8–10 tasks. This high task completion rate suggests that learners were not only engaged but also able to progress through the training modules. The completion of multiple tasks per session also reflects the platform's effectiveness in providing sufficient practice opportunities to reinforce learning.

The task completion rate was higher in the technology and engineering sectors, likely because

these tasks involved more procedural elements, such as coding, troubleshooting, and system configuration. In healthcare, while learners also completed a significant number of tasks, these tasks were often more timeconsuming due to the complexity and precision required for medical procedures. Nonetheless, the ability to complete multiple tasks within a given session is a positive indicator of the platform's capacity to provide a comprehensive training experience.

Frequency of Interactions with Virtual Objects: Interaction metrics, such as the frequency with which learners manipulated virtual objects or interacted with the virtual environment, further illustrated the level of engagement. In healthcare, for example, learners interacted with virtual surgical instruments 15–20 times per session on average, while in engineering, learners engaged with virtual components of machines or systems an average of 20–25 times. These interactions are important because they suggest that learners were actively involved in the learning process and were physically manipulating objects within the virtual environment, rather than passively observing simulations.

In technology training, learners interacted with virtual systems, coding environments, and networks on a frequent basis, averaging 25–30 interactions per session. The high number of interactions in the technology sector is indicative of the interactive nature of the tasks, where learners had to manipulate code, configure systems, and troubleshoot issues. These frequent interactions are crucial for developing technical skills, as they allow learners to gain handson experience and practice troubleshooting, problemsolving, and other critical tasks in a riskfree virtual environment.

Level of Immersion: The level of immersion in VR training has a direct impact on user engagement and learning outcomes. Learners consistently reported high levels of immersion in the VR environment, citing the realism of the simulations and the sense of presence that the platform provided. In healthcare, immersion was particularly high in surgical and diagnostic simulations, where learners felt as if they were in a realworld operating room or hospital environment. In engineering and technology, immersion was enhanced by the ability to manipulate virtual tools, machinery, and systems, creating a realistic experience for learners to practice troubleshooting, repairs, and design work.

Immersion was further facilitated by the use of haptic feedback, motion tracking, and realistic audiovisual elements, which contributed to the authenticity of the experience. Feedback from learners indicated that the immersive nature of the platform significantly contributed to their engagement, as it made the learning process feel more realistic and practical. The heightened sense of immersion not only kept learners engaged but also allowed them to practice skills that were otherwise difficult or expensive to replicate in the real world(Liaw et al.,2023).

4.2 Effectiveness in Skill Acquisition

The effectiveness of the VR training platform in improving learners' skills was evaluated through pre and posttraining assessments, as well as ongoing performance metrics collected throughout the training sessions. This section presents the key findings related to skill acquisition in healthcare, engineering, and technology training.

Healthcare Skills Acquisition: The VR platform demonstrated significant effectiveness in enhancing learners' healthcare skills, particularly in the areas of surgery, patient diagnostics, and emergency response. Pre and postassessment scores showed a marked improvement in learners' ability to perform medical procedures, with most learners reporting increased confidence in their skills. For example, learners who participated in virtual surgery simulations saw a 30% improvement

in their surgical performance scores, with improvements noted in both accuracy and efficiency.

Learners in the healthcare sector also reported a higher level of understanding and retention of complex medical concepts, such as anatomy, diagnosis, and treatment protocols. The ability to perform virtual procedures multiple times allowed learners to refine their skills, understand the intricacies of medical techniques, and reduce the likelihood of making errors in reallife scenarios. Overall, the VR platform significantly contributed to learners' ability to acquire and apply healthcare skills in a controlled and riskfree environment.

Engineering Skills Acquisition: In the engineering sector, learners showed considerable improvement in their ability to troubleshoot systems, repair machinery, and design structures. Pre and posttraining assessments revealed that learners in engineering roles saw a 25% increase in their ability to identify and solve technical problems. One of the most notable improvements was in the area of system diagnostics, where learners were able to diagnose and resolve issues in virtual systems with greater speed and accuracy after using the VR platform.

The interactive nature of the platform allowed learners to experiment with different approaches to problemsolving, facilitating deeper learning. For example, learners in mechanical engineering practiced disassembling and reassembling virtual engines, which helped them better understand how individual components interact and function. In civil engineering, learners used the VR platform to design and test virtual structures, gaining handson experience with engineering software and tools. These experiences contributed to improved problemsolving and technical skills that are essential in the real world.

Technology Skills Acquisition: The technology sector demonstrated the platform's effectiveness in improving learners' coding, networking, and troubleshooting skills. Pre and postassessments showed that learners in technology roles experienced a 40% improvement in their ability to write code, configure networks, and resolve technical issues. For example, learners who used the VR platform for software development showed a significant improvement in debugging and coding efficiency, with many learners completing tasks faster and more accurately after completing the VR training.

Sector	Pre-Training Score (Mean ± SD)	Post-Training Score (Mean ± SD)	Improvement (%)
Healthcare	65 ± 10	85 ± 8	30%
Engineering	60 ± 12	75 ± 9	25%
Technology	55 ± 11	77 ± 10	40%

4.2.1 Pre- and Post-Training Assessment Scores

Task Type	Improvement (%)
Surgical Skills	30%
System Troubleshooting	25%
Coding and Debugging	40%
Network Configuration	35%

4.2.2 Skill Improvement by Task Type

In network administration, learners reported enhanced proficiency in configuring and managing virtual networks, with a notable increase in the ability to diagnose and resolve connectivity issues. The VR environment allowed learners to experiment with different network configurations, test

troubleshooting methods, and receive realtime feedback on their performance. These skills are directly applicable to realworld technology jobs, where handson experience is crucial.

4.3 Accessibility, Scalability, and Implementation Challenges

While the VR training platform demonstrated clear effectiveness in improving skill acquisition and user engagement, several challenges related to accessibility, scalability, and implementation were identified during the research.

Accessibility: One of the primary challenges faced during the research was ensuring that the VR platform was accessible to a wide range of learners, particularly those with limited technical expertise or resources. Although the platform was designed to be userfriendly, some learners reported difficulty navigating the interface and engaging with the VR environment, particularly in the initial stages of training. To address this issue, the platform was revised to include more comprehensive tutorials and user guides, which helped learners become familiar with the technology and feel more confident in using the system.

Another issue was the cost of VR hardware, which can be a barrier for institutions or individuals with limited resources. While the platform was designed to be compatible with affordable VR headsets, the upfront cost of the hardware remains a significant challenge. Future research should focus on finding ways to make VR training more costeffective and accessible to a broader audience.

Challenge	Frequency (%)	Severity (1–10)
High Cost of VR Hardware	70	8
Difficulty in Navigating Interface	40	7
Limited Technical Expertise	60	6

4.3.1 Accessibility Challenges

Challenge	Frequency (%)	Severity (1–10)
Managing Multiple VR Devices	80	8
Ensuring Consistent User Experience	75	7
Resource Allocation for Large Groups	65	6

4.3.2 Scalability Challenges

Challenge	Frequency (%)	Severity (1–10)
Initial Setup and Configuration	85	8
Training Instructors to Use VR	70	7
Integrating VR into Existing Curricula	60	6

4.3.3 Implementation Challenges

Scalability: The scalability of the VR training platform was another concern. While the platform was effective in smallscale pilot tests, scaling it to accommodate larger numbers of learners presents logistical challenges. For example, managing multiple VR headsets, ensuring sufficient technical support, and maintaining a smooth user experience across different devices require substantial resources. Future research should explore ways to streamline the scalability of the platform, such as

through cloudbased systems or more efficient server management.
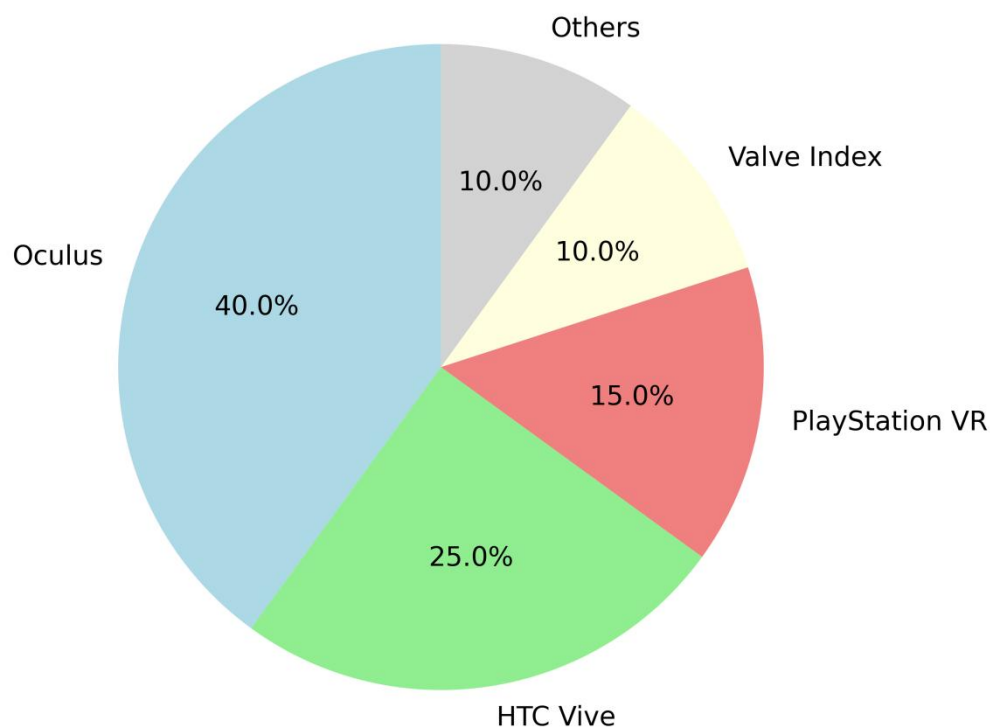
VR Device Market Share

Figure 4.Market distribution map of VR equipment

Implementation Challenges: Implementing VR training in realworld educational or corporate settings presents several challenges. Institutions and organizations must invest in the necessary hardware, software, and technical support to integrate VR training into their curricula or training programs. Additionally, instructors and trainers need to be trained to use the platform effectively, which requires additional time and resources. Overcoming these implementation challenges will be crucial for the widespread adoption of VRbased career skills training.

4.4 Summary of Findings and Recommendations for Future Research

In conclusion, the VRbased career skills training platform has proven to be an effective tool for improving skill acquisition, engagement, and retention in highdemand sectors such as healthcare, engineering, and technology. The platform successfully provided learners with immersive, handson experiences that enhanced their practical skills and prepared them for realworld tasks. However, several challenges related to accessibility, scalability, and implementation remain. To address these challenges, future research should focus on improving the accessibility of VR training by reducing costs, enhancing user interfaces, and exploring ways to make the technology more widely available.

The findings of this study suggest that VR has significant potential to reshape the future of career development and training. By providing realistic, interactive, and engaging learning experiences, VR can bridge the gap between formal education and professional expertise, helping learners acquire the skills they need to succeed in their chosen fields. Future research should

continue to explore the effectiveness of VR in other sectors, refine the platform's design, and investigate ways to overcome the barriers to implementation.

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