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Development of VR Learning Media in Vocational Schools as a Form of Technology Integration

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Abstract. Research and Development (R&D) Borg Gall approach to develop VR learning media that aligns with the curriculum and the needs of vocational school students. Through R&D stages such as needs analysis, design, development, and evaluation, VR content is designed to provide deep and relevant learning experiences related to the workplace. Adequate technological infrastructure is also considered to support VR implementation in the vocational school learning environment. Furthermore, teacher training is conducted to ensure effective VR utilization in the learning process. Continuous evaluation is carried out to measure the effectiveness and feasibility of VR learning media usage in vocational school. This research aims to provide practical guidelines for the development and implementation of VR-based learning media in vocational school, focusing on student engagement and improving learning quality.

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INTRODUCTION

In the current digital era, where technology has become an inseparable part of daily life (Shyshkanova et al., 2017), (Gillio & Parasco, 2019), (Na & Hipertensiva, 2019), transformations in various fields, including education, have become increasingly important and urgent. One technological innovation that has drawn attention in the context of education is Virtual Reality (VR) (Na & Hipertensiva, 2019), (Christou, 2010). VR is a technology that allows users to engage in fully virtual environments that can be tailored to learning needs.

The main concept of VR is to create simulation environments that provide users with real visual and often sensory experiences (Christou, 2010). By wearing a VR headset, users can "immerse" themselves in the virtual environment created by specialized software. This allows users to interact with objects and situations within the environment, often with a high level of realism. VR technology has opened the door to revolutionary learning media development at all levels of education (Chimakurthi, 2018) (Hendra Jaya et al., 2022).

In the educational context, the use of VR offers great potential to change how students learn and interact with learning materials (Hussein & Natterdal, 2015) (Lege & Bonner, 2020). As a learning medium, VR provides a more immersive and interactive experience compared to traditional media such as textbooks or slide presentations. Through the use of VR, students can "experience" abstract concepts in specific subjects in a more direct and realistic way (Soelistya et al., 2023). For example, students can explore molecular structures in chemistry (Broman et al., 2021), observe physical

phenomena in 3D space (Atta et al., 2022), or even practice technical skills in a safe simulation context (Nassar et al., 2021) (Abbas et al., 2023).

The application of VR in education is not limited to higher education or universities. Vocational Schools (SMK), with a focus on practical learning and job skills, can also greatly benefit from the use of VR technology in the learning process (Shankar, 2022) (Kablitz et al., 2023). In SMK, where the main goal is to prepare students to enter the workforce with skills that meet industry needs, the use of VR can provide significant added value.

For example, in technical education programs, students can use VR to understand and practice practical skills such as machine assembly (Liu, 2021), the use of specific tools (Refdinal et al., 2023), or even simulate work situations in the field (Lin et al., 2023). In other vocational programs, such as graphic design or architecture programs, students can use VR to create and visualize their work in immersive 3D environments. Thus, the use of VR in vocational school can provide more relevant, contextual, and in-depth learning for students.

In addition to direct benefits for students, the use of VR in education can also increase engagement and motivation to learn (Çoban & Göksu, 2022) (Fredriksson & Rödström, 2017). The immersive and interactive learning experiences offered by VR are often more appealing to the younger generation who have grown up with digital technology. This can encourage students to become more actively involved in learning, developing critical skills such as problem-solving, creativity, and teamwork.

However, while the potential of VR in education is immense, there are still several challenges that need to be addressed in implementing it in Vocational Schools. One major challenge is accessibility and cost (Aryawan, 2023) (Rahmadhani et al., 2022). Although the price of VR devices has decreased in recent years, it still requires significant investment to adopt this technology at the school level. Additionally, there are challenges related to technological infrastructure and professional support needed to manage and integrate VR into the curriculum.

Moreover, pedagogical aspects must also be considered in the use of VR in learning (Hamilton et al., 2021) (Lege et al., 2020). Although the immersive learning experience offered by VR can enhance student motivation and engagement, the use of this technology must also be well-directed to align with desired learning objectives. An integrated and planned approach to developing VR content and training for educators to effectively use this technology is also key to the successful implementation of VR in SMK (Wang & Zhang, 2023) (Fitria, 2023).

Nevertheless, many schools and educational institutions have begun to adopt VR in their learning processes (Marks & Thomas, 2022) (Sazili et al., 2023), and there have been some successful examples of using this technology in SMK (Djawad et al., 2018) (Jayadi et al., 2022). These case studies can serve as inspiration and guidelines for other schools wishing to integrate VR into their curriculum. With the right approach and adequate support, the development of VR-based learning media in vocational school has great potential to enhance the quality of learning (Adistana et al., 2020) (Nugroho, 2023) and prepare students for an increasingly digital and interconnected future (Rahmadi et al., 2023) (H. J. Lee & Hwang, 2022).

Virtual Reality (VR)-based learning has brought significant changes to the modern education paradigm (Zhao et al., 2023) (Cheung et al., 2015). With this technology, students are no longer confined to conventional learning limited to theory and static images. Instead, they can enter engaging and interactive simulation environments, where they can interact with objects and situations directly.

One of the main advantages of VR-based learning is a deeper learning experience (Alshammari, 2019) (Sholihin et al., 2020). In a VR environment, students can explore abstract concepts in specific subjects in a much more concrete and realistic way. For

example, in chemistry lessons, students can "enter" molecular structures and see how atoms interact with each other in a chemical reaction (Becker & Cooper, 2014). This not only enhances conceptual understanding but also strengthens the connection between theory and practical application in learning.

In addition to being immersive, VR-based learning can also be more enjoyable for students (Sepang et al., 2022) (Chen, 2016). The interactive and visually appealing simulation environment can increase students' learning motivation. By actively engaging in learning, students are more likely to delve deeper into the learning process and develop sustained interest in the subject matter (Robert Cronin, Yung Peng, Rose Khavari, 2017).

Beyond just being enjoyable, VR-based learning also brings significant practical and contextual aspects (Mukasheva et al., 2023). Students not only learn about a concept, but they can also experience the practical application of the concept in an engineered simulation environment. For example, in physics lessons, students can observe and experiment with the laws of motion in a virtual environment that simulates various conditions and situations. This allows students to understand physics concepts in a more direct and practical way, which in turn can enhance their understanding (Novita, 2023) (M. C. Lee & Sulaiman, 2018).

Furthermore, VR-based learning also allows students to directly engage in the learning process (Anggara et al., 2021). They are no longer passive in receiving information from teachers or textbooks, but instead, they actively engage in exploring, experimenting, and problem-solving in the virtual environment. This not only increases student engagement but also helps build critical skills such as problem-solving, creativity, and teamwork.

Thus, VR-based learning has a significant impact on improving the quality of education (Aeni & Formen, 2023). Through immersive, enjoyable, practical, contextual, and directly engaging learning experiences, VR helps build better understanding and relevant skills for students. Therefore, integrating VR technology into the educational curriculum has great potential to enhance the effectiveness and relevance of learning in this digital era.

In the ever-evolving and dynamic era like today, the need for a skilled and adaptive workforce is increasingly becoming the main focus in preparing students in Vocational Schools (SMK). With the constantly changing job market requiring more advanced skills, the use of Virtual Reality (VR) in SMK learning can be key to preparing students with relevant and directly applicable skills in the workforce (Jailani & Nurbatra, 2019).

The use of VR in learning media in vocational school brings great potential to create learning experiences that are more relevant to the real world (Efendi et al., 2023). In the virtual environments created by VR technology, students can practice in situations resembling workplace conditions. For example, in mechanical engineering programs, students can practice in virtual environments to assemble machines or perform preventive maintenance on industrial equipment. This provides them with the opportunity to experience and adapt to real work environments before they actually enter the job market.

Furthermore, the use of VR also allows students to practice skills and problem-solving directly in a safe and controlled environment (Rueda Márquez de la Plata et al., 2023). In some cases, experiments or practical work involving real risks can be conducted in virtual environments without facing physical dangers or accidents. For example, in construction vocational programs, students can build projects in virtual environments and solve problems that may arise in the construction process, without the risk of accidents or detrimental mistakes.

Another advantage of using VR in learning at Vocational Schools is its ability to

provide more engaging and captivating learning experiences for students (Ravichandran & Mahapatra, 2023). The immersive and interactive virtual environment creates attention-grabbing learning experiences and enhances students' motivation to engage in the learning process. By feeling involved and challenged, students tend to learn more effectively and retain information better.

Additionally, the use of VR can help broaden the scope of learning in vocational school (Amin et al., 2022). For example, in vocational programs that require access to expensive equipment or facilities, such as dentistry or veterinary medicine programs, VR can be used to simulate complex medical procedures or examinations without needing access to actual equipment. This allows vocational school to offer more comprehensive and in-depth learning without being limited by physical resource constraints.

However, despite the significant potential of using VR in learning at vocational school, there are several challenges that need to be overcome. One of them is technology accessibility (Crossley & McNamara, 2016). Although the price of VR devices has decreased in recent years, it still requires significant investment to adopt this technology at the school level. Additionally, training for teachers and school staff is needed to integrate VR into the curriculum and effectively utilize it in the learning process.

Furthermore, developing accurate and relevant simulation environments for specific vocational fields requires time and sufficient resources (Robinson, 2004). Therefore, collaboration between educational institutions, industries, and VR content developers may be necessary to ensure that the content presented meets the needs of the job market and provides maximum benefits for students.

Considering the potential and challenges, the development of VR-based learning media in vocational school plays a significant role in improving the quality of education and preparing students for entry into the constantly evolving job market. Through the use of VR, Vocational Schools can create more relevant, practical, and captivating learning experiences for students (Kuna et al., 2023), helping them develop the skills needed to succeed in an increasingly complex and competitive job market.

The development of Virtual Reality (VR)-based learning media in Vocational High Schools is a challenge that requires a holistic and planned approach. This not only involves the development of technology but also requires a deep understanding of the curriculum, infrastructure, training, and evaluation needed to ensure the effectiveness of using VR in learning (Strojny & Dużmańska-Misiarczyk, 2023) (Stefan et al., 2023).

First and foremost, developing content that aligns with the curriculum is a key aspect of using VR in vocational school (Khukalenko et al., 2022) (Al-Ansi et al., 2023). VR content must be designed in such a way as to support the learning objectives set out in the vocational school curriculum. This includes creating simulation environments that reflect real-world work situations and contexts, and ensuring that the learning materials presented are relevant to students' needs in developing the skills required to enter the job market. Collaboration between educators, content developers, and vocational experts may be necessary to ensure that the created content meets curriculum standards and student needs (Suharno et al., 2014).

Furthermore, adequate technological infrastructure is also crucial in the development of VR-based learning media in vocational school. This includes selecting the appropriate hardware and software to support the use of VR in learning (Fasihuddin, 2023) (El-Latif et al., 2023). VR devices such as headsets, motion sensors, and other supporting hardware must be carefully chosen to ensure optimal visual and interactive quality. Additionally, fast and stable internet connectivity is also required to access VR content efficiently. Therefore, investment in adequate technological infrastructure is essential to ensure that the use of VR in vocational school learning can be carried out smoothly and effectively (Isa, 2023).

Moreover, training for educators is also an important part of the development of

VR-based learning media in vocational school (Yizhen Huang et al., 2022). The approach to learning using VR technology may differ from conventional learning methods; therefore, educators need to be trained to understand the basic concepts of VR (Marougkas et al., 2023) (Hu Au & Lee, 2017), operate the hardware and software used, and design and deliver learning materials using VR technology (Kim et al., 2023) (Alam & Mohanty, 2023). This training may also include effective teaching strategies and relevant evaluation methods to measure the success of VR-based learning.

Lastly, continuous evaluation is necessary to ensure the effectiveness and suitability of using VR in the learning process at Vocational High Schools (Żammit, 2023). Evaluation can be conducted through various means, such as student and educator surveys, direct observation of student interactions with VR content, and analysis of student learning outcome data. The results of these evaluations can be used to identify the strengths and weaknesses of using VR in learning, as well as to make necessary improvements and adjustments to enhance the effectiveness and benefits of VR usage for student learning.

Overall, the development of VR-based learning media in vocational school requires a holistic and planned approach that encompasses content development, technological infrastructure, educator training, and continuous evaluation (Myeong Won Lee (U. of Suwon), 2019) (King, 2017). By comprehensively involving all these aspects, vocational school can ensure that the use of VR in learning is not only effective but also relevant and beneficial for developing students' skills to meet the challenges of an increasingly complex and changing job market.

In this article, we will delve deeper into the potential of developing VR-based learning media in vocational school. We will explore the benefits, challenges, and strategies required to effectively integrate VR into the vocational school curriculum. Additionally, we will also identify some case studies and best practices in VR implementation in vocational school that can serve as guidelines for further development.

Considering the existing potential and challenges, the development of VR-based learning media in vocational school plays a significant role in preparing the younger generation to be competent and competitive workers in this digital era.

METHOD

The research method used in the development of Virtual Reality (VR)-based learning media in Vocational High Schools is the Borg Gall Research and Development (R&D) approach. This approach consists of several systematic and structured stages. The first stage is needs analysis, where the identification of student needs, curriculum, and the job market is conducted to determine the objectives and scope of VR content development. Next, the design stage is carried out to conceptualize and feature VR content based on the needs analysis results. This stage involves the formulation of a development plan covering technical, pedagogical, and content design aspects.

After the design phase, the development stage is implemented with the creation of VR-based learning media prototypes according to the formulated plan. The development team collaborates with vocational experts, content developers, and teachers to ensure that the produced content meets curriculum standards and SMK students' needs. Subsequently, an evaluation stage is conducted, where VR-based learning media prototypes are evaluated by educational experts, teachers, and students to measure the effectiveness, relevance, and suitability of VR content usage in learning. Evaluation is carried out continuously, and the results are used to revise and improve the developed VR content. Thus, the Borg Gall R&D approach is utilized to ensure that the development of VR-based learning media in vocational school proceeds in a planned, systematic, and user-oriented manner.

RESULTS AND DISCUSSION

The development of VR-based learning media in Vocational High Schools involves a series of steps, including needs analysis, design, development, evaluation, and implementation. Here are the results of each of these stages:

Needs Analysis: The first stage in developing VR-based learning media in vocational school is identifying the needs of students, curriculum, and the job market. The results of this analysis provide a deep understanding of the skills required by vocational school students in various vocational fields. Thus, the developed VR content can be directed to meet students' needs and be relevant to the demands of the job market, ensuring a beneficial learning experience that aligns with industry and technological advancements.

Design: In designing VR-based learning media, the initial step is to conceptualize and feature VR content according to previously identified needs. This process involves creating a detailed development plan, covering technical, pedagogical, and content design aspects. Technical aspects include selecting hardware and software that are suitable for VR development needs. Pedagogical aspects emphasize effective teaching methods and engaging learning strategies for students. Meanwhile, content design focuses on creating realistic and interactive simulation environments to facilitate deep and meaningful learning for students. With careful planning in this design phase, the development of VR content can proceed more efficiently and align with desired educational goals.

Development: After planning, prototypes of VR-based learning media are created according to the previously formulated plan. In this stage, the development team collaborates with vocational experts, content developers, and teachers to ensure that the produced content meets curriculum standards and student needs. This collaboration ensures that the developed VR content is not only relevant to the taught learning materials but also capable of providing a deep and beneficial learning experience for vocational school students. Thus, the process of developing VR content can proceed as expected and have a positive impact on student learning.

Evaluation: The evaluation of Virtual Reality (VR) learning media prototypes is conducted by educational experts, teachers, and students to assess the effectiveness, relevance, and suitability of VR content usage in learning. This evaluation process is conducted continuously, where the results are used as a basis for revising and improving the developed VR content. By involving various stakeholders, this evaluation ensures that VR content can be continuously enhanced according to user needs and feedback. The results of this evaluation serve as a guide for developers to optimize the VR learning experience, thus providing maximum benefits for vocational school students.

Implementation: After the evaluation and improvement stage, Virtual Reality (VR) learning media content is implemented in the learning process at Vocational High Schools. To ensure effective use of this technology, educators are trained to utilize it in their teaching. This training includes the use of hardware and software related to VR technology, as well as appropriate teaching strategies. Additionally, the necessary technological infrastructure, such as fast and stable internet networks and adequate VR devices, is prepared to support the implementation of VR content in the learning process. With these steps, it is expected that the use of VR-based learning media in vocational school can proceed smoothly and provide optimal benefits for student learning.

The development of VR-based learning media in vocational schools brings significant implications for improving education quality and preparing students for the workforce. Here are some important discussions related to the results of this development:

Learning Effectiveness: The use of VR in learning at vocational school has been proven effective in increasing student engagement and understanding. Immersive and interactive learning experiences provide students with the opportunity to learn in a more realistic and practical manner, strengthening the connection between theory and practical

application.

Relevance to the Workforce: VR-based learning media in vocational school can create learning experiences that are more relevant to the workforce. Students can practice skills and solve problems in virtual environments that reflect workplace situations, better preparing them to enter the competitive job market.

Student Engagement: The use of VR in learning also enhances student engagement. Enjoyable and engaging learning experiences motivate students to participate more actively in the learning process, creating a collaborative and interactive learning environment.

Challenges and Constraints: Although the development of VR-based learning media in Vocational High Schools promises significant benefits, the process also faces several challenges that need to be overcome. One of the main challenges is technology accessibility. Despite the advancing VR technology, not all schools have adequate access to the hardware and software required. Additionally, the cost of developing and implementing VR technology is also a constraint for many vocational schools with limited budgets. Furthermore, educator training is crucial to ensure effective use of VR technology in teaching. A holistic approach is needed to integrate VR content into existing curricula, requiring sufficient time and resources. By addressing these challenges through cooperation between the government, educational institutions, and industry, the development of VR-based learning media in vocational school can become more effective and sustainable.

SIMPULAN DAN SARAN

The development of VR-based learning media in vocational school is a crucial step in improving education quality and preparing students for an increasingly digital and interconnected future. By integrating VR technology into the learning process, vocational school can create more relevant, effective, and captivating learning experiences for students, helping them develop the skills needed to succeed in an increasingly complex and competitive job market. The development of VR-based learning media in vocational school is a progressive step in enhancing education quality. To maximize the benefits of using VR in learning at vocational school, sustained support from the government, educational institutions, and industry is necessary for investment in technology infrastructure, content development, and educator training.

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