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# Introduction of Mining Virtual Reality (mining VR) to Geology and Mining Students of Vocational School Muhammadiyah Jambi City

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## Abstract

The employment of vocational high school graduates in the mining sector remains relatively low compared to other educational levels. With the continued expansion of the mining industry in Indonesia, particularly in Jambi Province, the establishment of vocational high schools with Mining Geology majors in Jambi City is anticipated to contribute to the supply of workers. The scarcity of teachers, particularly those with a mining education background, can be a significant factor in the decline in the quantity and quality of these vocational high school graduates. This program aims to introduce Mining Virtual Reality (Mining VR) as a contemporary learning approach for the mining industry. Utilizing this simulation program, students can engage directly with various mining activities within the classroom without incurring substantial financial and time expenditures. Furthermore, they gain access to restricted areas, such as underground mines and blasting zones. The intended outcomes of this program encompass: (1) augmenting student knowledge and comprehension of several mining learning modules, (2) fostering students' practical skills in the utilization of digital technology through Virtual Reality Simulators, and (3) disseminating activities in the form of articles on social media platforms and comprehensive reports. This program is expected to enhance the quality of graduates of Muhammadiyah Vocational High Schools specializing in Mining Geology.

**Keywords:** mining virtual reality; learning digitalisation; Vocational High Schools; Mining Geology; digital technology

## Cite This Article

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## INTRODUCTION

In the even academic year of 2024/2025, there were 14,456 vocational high schools (SMK) in Indonesia [1]. Of these, only 106 vocational high schools had a Mining Geology major [2]. Vocational high school graduates, especially in the fields of geology and mining, are expected to be ready-to-use workers, especially as operators and surveyors. In 2022, vocational high school graduates only contributed to 7.4% of those working in the mining sector [3] (Figure 1). This condition is influenced by the decline in the quantity and quality of graduates, due to the lack of vocational high school teachers with a Mining Engineering educational background and minimal field practice.

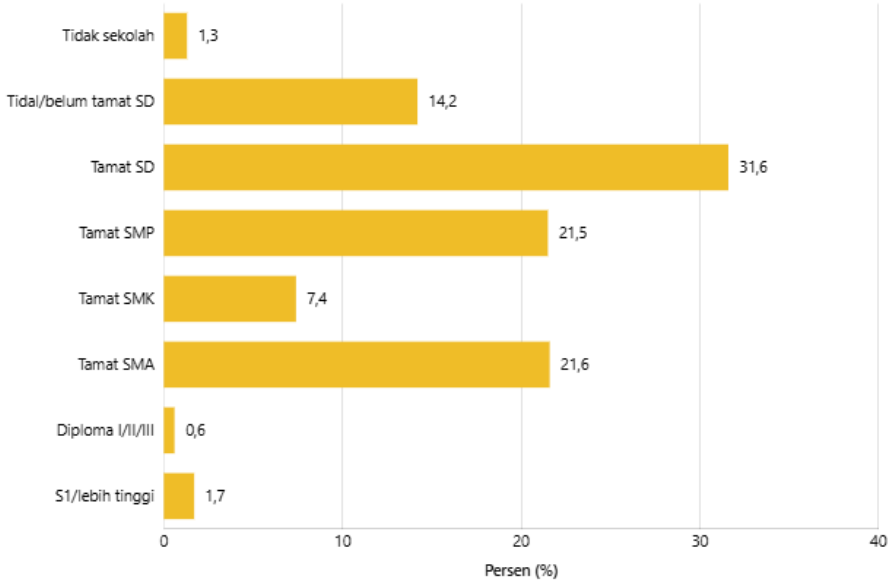


**Figure 1.** *Distribution of mining industry workers based on educational background [3]*

With the rapid advancement of technology, educators have a significant opportunity to improve the quality of the learning process while equipping students with skills and knowledge relevant to today's industry needs [4]. One technology that can be utilized for this purpose while providing an immersive digital learning experience is virtual reality (VR). Integrating VR technology into the learning process can bridge the gap between the concepts taught and their application in real-world contexts [5]. Through the realistic virtual experiences provided by VR, students can explore material and concepts while solving various problems. This approach encourages students to directly apply theory, resulting in a deeper understanding of the material. Another benefit is its ability to create a more efficient learning ecosystem in terms of cost and time [6,7].

Mining Virtual Reality Simulator is a device with an application designed to simulate various mining activities and current operational standards in the mining industry, including both surface and underground mining. The application is operated using a VR headset (Oculus Quest 2) equipped with a controller for navigation and interaction within the simulation (Figure 2).

Gambar 2. Modul-modul yang tersedia pada Mining VR Simulator

**Figure 2.** *Mining Virtual Reality headset, controllers, and available software*

Muhammadiyah Vocational High School Jambi is the only vocational school in Jambi City that has a Geology-Mining expertise program. Based on the discussions with the school principal and teachers, the main issues were the limited number of teaching staff, especially those with educational backgrounds or professional experience in the mining sector, as well as the still minimal laboratory facilities. This has an impact on the low level of student engagement in learning and the lack of readiness of graduates to follow industry competency standards. Based on these problems, the community service team consisting of Mining Engineering lecturers from Universitas Jambi visited the school to introduce the Mining VR Simulator and measure the level of knowledge and understanding of students from mining modules before and after using Mining VR. It is expected that with the implementation of VR technology in learning, students can interact virtually without having to allocate costs and time to visit mining sites, especially locations with minimal access such as underground mines.

## METHODS

Community service (PkM) activities were carried out on September 19, 2025, at Muhammadiyah Geology-Mining Vocational School, Jambi City. This PkM activity was given to 1 class group, namely class XIII. The PkM activity method was divided into 4 stages: planning and coordination stages, formulation of material modules, introduction to Mining VR, and finally the evaluation stage to measure the level of knowledge and understanding of students.

## RESULTS AND DISCUSSION

The positive response from students was evident in the pre-test (before using the VR mining device) and post-test (after using it) evaluation stages. There was an increase in knowledge and understanding, from 69.37 to 78.12 (Figure 3). This is because the learning presented mining conditions in a 3D and interactive manner, making the concepts easier to remember and understand (Shen et al., 2023).

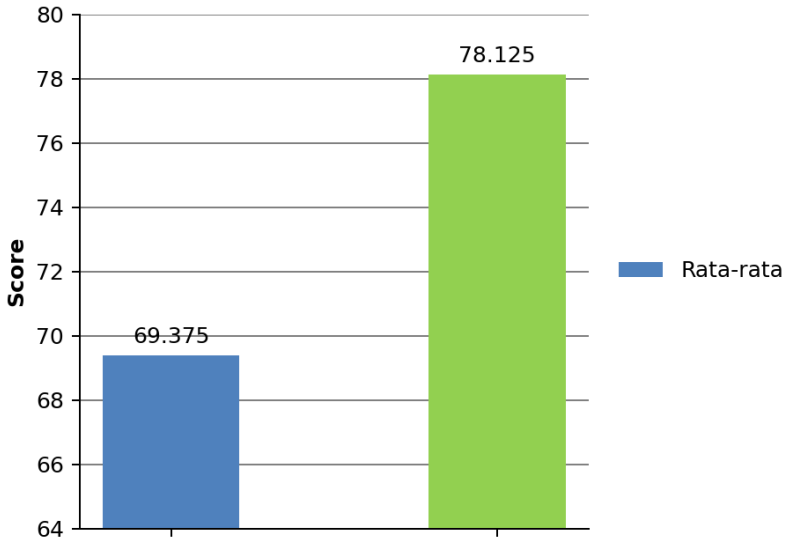


**Figure 3.** *Average pre and post test score*

During the learning process using the Mining Virtual (VR) Simulator, the majority of students were very enthusiastic and motivated to participate, as they felt like they were playing a game. In the open pit module, students can directly interact with the open pit mining environment. They can observe the coal layering and determine the geometry of the benches themselves: berms, benches, and crests. They can also interact with various types of mechanical equipment found in open pit mining.

In the underground mining module, they can observe the facilities in an underground mine, such as the appearance of ore material, tunnel shapes, support, and ventilation systems. Students are also provided with modules on bench blasting, exploration drilling, core storage management, mine water management, and safety inspection.

Mining VR also provides features related to potential hazards that can arise during each mining activity, such as falling debris, hazardous gases, risks on heavy equipment routes, and so on. This can train students' responsiveness, increasing early safety and health awareness, identifying potential hazards quickly and accurately, and minimizing errors when they enter the field.

Student scores improved after using Mining VR, as VR enhances their ability to understand even difficult, abstract concepts. Students whose learning model utilized VR simulations demonstrated a deeper conceptual understanding compared to the control group using conventional methods [8]. VR implementation allows students to understand scientific processes in greater detail through experimental simulations that are difficult to conduct even on a laboratory scale [9]. Students who learn using VR not only demonstrate improved conceptual understanding but also develop critical thinking skills [10].

Therefore, VR technology is highly recommended for implementation in Mining Geology Vocational High Schools (SMKs). Students will gain a comprehensive understanding and skills in the mining sector, thereby improving the quality of vocational high school graduates and making them better prepared to enter the mining industry.

## CONCLUSIONS

The implementation of a Mining Virtual Reality (VR) Simulator as a supplement to the learning model at Muhammadyah Geology-Mining Vocational School (SMK Geologi-Pertambangan Muhammadyah) has shown a positive response, with an increase in the average knowledge and understanding score before using Mining VR from 69.57 to 78.12 after using the device. VR technology is able to create a fun, immersive learning experience. Students are able to interact directly with difficult-to-understand mining concepts. Therefore, VR has great potential to enrich the hybrid learning model, improving the quality of learning and education at Mining Geology-based vocational schools throughout Indonesia.

The implementation of Virtual Mining (VR) into learning models is not a stand-alone process; it still requires educators with educational backgrounds and professional experience in the mining sector. Muhammadyah Jambi Geology and Mining Vocational School should consider procuring a Mining Virtual Reality (VR) Simulator for its learning process in the future.

## ACKNOWLEDGMENT

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