

Innovation of Virtual Reality Learning Media in Increasing Vocational High School Students' Learning Motivation in Building Management Layout Material

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ABSTRACT

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This study aims to examine the effectiveness of a learning medium that has been developed since 2024, namely *VROOM: Virtual Reality Room Organization and Optimization Media*, in increasing vocational high school (SMK) students' learning motivation in the subject of Building Management Layout. The method used was Research and Development (R&D) with the ADDIE development model approach, focusing on the implementation and evaluation stages. The research subjects consisted of 30 eleventh-grade SMK students majoring in Office Management who participated in learning activities using VROOM. The data collection instrument was a student learning motivation questionnaire measuring two main aspects: intrinsic and extrinsic motivation. The results showed a significant increase in students' learning motivation after using VROOM. Intrinsic motivation increased from 2.45 to 3.28, while extrinsic motivation increased from 2.35 to 3.22. Overall, the total score rose from 2.94 to 3.79, with a significant difference ($p < 0.05$) and a large effect size (Cohen's $d = 1.5$). These findings indicate that VROOM effectively supports experiential and interactive learning, helping students better understand spatial concepts while increasing their motivation. Therefore, VR-based learning media has strong potential to support skill-based learning in vocational education.



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A. INTRODUCTION

The development of digital technology in education has brought significant changes to the way teachers and students interact with learning materials. One of the most prominent innovations is the use of virtual reality (VR) as a learning medium. This technology is capable of creating immersive three-dimensional simulations, allowing learners to experience more concrete and realistic learning (Radianti et al., 2020). In the context of vocational high schools (SMK), the use of VR technology is highly relevant to support practice-based learning, including in the subject of Building Management Layout. This subject requires students to understand the concepts of effective and efficient space organization in order to create a productive work environment (Haynes, 2008). VR emerges as one solution by presenting immersive three-dimensional virtual environments that integrate both physical and virtual settings simultaneously (Jamil, 2018). The aspects that make VR highly suitable as a learning medium lie in its ability to make possible what would otherwise be impossible to bring into the

classroom. VR enables direct interaction with objects or simulated scenarios, so that students feel as if they are in the real world during the learning process (Azmi et al., 2024).

A study by Juan et al. (2021) developed a VR-based decision support system for office interior design and found that the use of VR not only improved the efficiency of design communication but also accelerated decision-making and reduced perceptual differences between users and designers. This indicates that the integration of VR in spatial layout learning can yield similar positive impacts, particularly in facilitating spatial understanding and design efficiency. In addition, research by Wong et al. (2023) found that the use of VR significantly enhanced users' perceptions of workplace design characteristics, especially in terms of workspace enclosure, storage facilities, and layout flexibility. In vocational learning, these findings are important because they support students' achievement of basic competencies in designing workspaces according to functional and ergonomic needs.

Field observations show that the teaching of building management layout in vocational high schools (SMK) still relies heavily on conventional approaches such as lectures, textbooks, and two-dimensional media, which tend to be passive. Based on a needs analysis conducted in a previous study (Hasim et al., 2024), it was found that students experience difficulties in visualizing the real application of spatial layouts. This results in low student interest and motivation, making the learning process less effective. Many teachers still depend on conventional teaching methods such as lectures and textbooks (Zuraini et al., 2024). These methods are sometimes not sufficiently engaging for students and provide limited opportunities for hands-on learning or experimentation. Teachers also report limitations in the availability of learning media, which reduces the effectiveness of knowledge transfer. The ability to strategically organize office spaces is highly needed by vocational high school students majoring in office administration as a practical skill for the workplace.

In this context, VR can serve as an alternative form of experiential learning. Experiential learning is known as an effective approach to enhance students' understanding (Dewi et al., 2025). This aligns with Edgar Dale's Cone of Experience theory, which explains that the learning process progresses from the most concrete to the more abstract (Dale, 1969). In other words, the more students are engaged in direct learning experiences, the greater their chances of understanding and retaining the material. VR technology falls into this category of concrete learning because it allows users to experience situations as if they were physically present in a real environment.

With VR, educators can guide students to learn while visualizing the material in a virtual world (Dumayanti & Kusumawati, 2024). The use of VR media in learning has proven effective, particularly in subjects that require visualization. For example, to support learning in sketching and illustration subjects, VR media was designed with the theme of literacy tourism based on local wisdom in Sidoarjo. Through this medium, students can experience deep visual engagement (Bramantya & Yuliana, 2020). Learners not only acquire skills in drawing techniques but also gain insights into the local cultural context. Inspiration from local cultural motifs or ornaments can provide added value to the learning material while fostering an appreciation for regional culture.

Research conducted by Sappaile et al. (2023) shows that VR technology has great potential in enhancing learning motivation, student engagement, and understanding of learning materials. This technology can create realistic simulation environments that are accessible through specialized VR headsets. Through immersive visual, auditory, and kinesthetic experiences, VR not only provides a more holistic learning sensation but is also effective in improving students' concentration and learning motivation (Azmi et al., 2024).

One of the competencies in Building Management materials requires spatial arrangement skills as an implementation of office administration studies. The planning and presentation of hierarchical and interrelated patterns of space utilization are at the core of spatial planning

(Mungkasa, 2020). Building management covers various aspects such as maintenance, security, and space optimization, all of which can be effectively taught through VR simulations. VR technology has the potential to fill this gap by providing direct simulations of building environments. Through VR, abstract spatial concepts can be visualized concretely, enabling students to learn through *learning by doing* in a virtual environment. This aligns with the need to present real-world examples in learning so that students can more easily understand the material (Tsaqib et al., 2022).

Despite the growing body of research highlighting the effectiveness of virtual reality (VR) in enhancing learning motivation, engagement, and spatial understanding, most previous studies have primarily focused on general education contexts or higher education settings, particularly in fields such as engineering and design. Furthermore, existing studies tend to emphasize the use of VR as a tool for visualization or simulation without specifically addressing its pedagogical integration in vocational education, especially in the field of office administration. In addition, limited research has explored the development of VR-based learning media that is specifically tailored to the characteristics of the Building Management Layout subject, which requires contextual, practical, and spatially oriented competencies.

The novelty of this study lies in the development and implementation of VROOM, which is specifically focused on teaching office space management skills in vocational high schools (SMK), a topic that has not been widely explored in the context of VR-based vocational education. This study also integrates the evaluation of students' learning motivation quantitatively using a pre- and post-test design. This provides a new contribution by addressing the lack of research on measuring the impact of VR use on learning motivation in vocational education within the field of administration. Furthermore, VROOM was developed using the systematic ADDIE model, making it replicable and adaptable to other subjects that require realistic spatial visualization. The urgency of this research is further reinforced by the demands of the workforce, which requires vocational school graduates with practical skills aligned with technological developments. Thus, the development and implementation of VROOM is not only academically relevant but also strategic in preparing students to meet the needs of modern industry.

Based on the above background, the research problem in this study focuses on the extent to which the use of VROOM media influences students' learning motivation. Therefore, the objective of this study is to analyze the effectiveness of VROOM in enhancing vocational high school students' learning motivation, both intrinsic and extrinsic, within the context of Building Management Layout learning. The findings of this study are expected to contribute to the development of innovative, interactive, and immersive learning strategies that are relevant to the needs of vocational education in the digital era. As a technology-based learning innovation, VROOM is expected to create a more engaging, interactive, and immersive learning atmosphere that can increase students' active participation in the learning process. Therefore, the purpose of this study is to conduct an in-depth analysis of the impact of using VROOM media on improving vocational high school (SMK) students' learning motivation, so that the findings can provide input for the development of more effective learning strategies that are relevant to the needs of today's digital generation.

B. METHODS

This study employs the Research and Development (R&D) method, aiming to produce an educational product in the form of VROOM: Virtual Reality Room Organization and Optimization Media and to test its effectiveness in enhancing students' learning motivation. The development model used refers to the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) (Branch, 2009). The research focus in 2025 is directed toward the last two stages, namely implementation and evaluation, to examine the effectiveness of using

VROOM media in improving vocational high school (SMK) students' learning motivation in the subject of Building Management Layout (Hasim et al., 2024). The quantitative research design applied is a pre-experimental design with a one-group pretest–posttest format. This means there is one group of subjects who were given a pretest (initial motivation measurement), then participated in learning activities using VR media, and were subsequently given a posttest (final motivation measurement). The comparison of pretest and posttest results was used to assess whether there was an increase in students' learning motivation after the VR media intervention. This single-group approach was chosen because the study focuses on product trial of the developed media.

The subjects of this study were vocational high school students studying Building Management Layout within the field of office administration. Students were directly involved in the field trial of the VROOM media. Their participation as end users was crucial to obtain a realistic picture of the success of the media's implementation in the classroom learning context.

The instrument used in this study was a student learning motivation questionnaire consisting of 30 statement items. The questionnaire was divided into two parts: the pre-cycle questionnaire and the post-cycle questionnaire after the use of VROOM media. The development of the questionnaire referred to the indicators of learning motivation by Suroso (2023), which include intrinsic and extrinsic aspects. Each statement in the questionnaire used a Likert scale with the following range: (1) strongly disagree, (2) disagree, (3) agree, and (4) strongly agree.

Data analysis was carried out by comparing the results of the learning motivation questionnaire before and after the use of the VROOM learning media. The analysis technique employed was quantitative descriptive analysis to describe the trends in students' learning motivation. The results of this analysis were then used to assess the effectiveness of the media in increasing learning motivation as well as to provide feedback for improving the media before being implemented on a broader scale.

C. RESULT AND DISCUSSION

This section presents the Implementation–Evaluation stages of the ADDIE development model, focusing on the field trial of the VROOM learning media: *Virtual Reality Room Organization and Optimization Media* and the evaluation of its effectiveness in enhancing vocational high school (SMK) students' learning motivation in the subject of Building Management Layout. The evaluation was carried out using a quantitative approach by measuring learning motivation before and after the VR-based learning intervention.

1. Implementation of VROOM in Learning

The implementation stage of the ADDIE model involved applying the VROOM media in Building Management Layout learning for eleventh-grade vocational high school (SMK) students in the Office Management program. The implementation was conducted over two 90-minute face-to-face sessions, where students used VR devices alternately under the supervision of the teacher and research team. The learning activities were designed as a 3D office simulation, where students completed tasks such as arranging workspace layouts, optimizing lighting, and selecting ergonomic furniture to enhance their understanding of spatial concepts in a contextual and practical manner. Students actively explored the virtual environment, made design decisions, and engaged in group discussions, followed by reflection sessions guided by the teacher. At the end of the session, students completed a validated 20-item learning motivation questionnaire covering intrinsic and extrinsic aspects. The results of this instrument were used to evaluate the effectiveness of VROOM in increasing student engagement and learning motivation in vocational education.

2. Evaluation of VROOM in Learning

a. Validity and Reliability of the Learning Motivation Instrument

Before being used for data collection, the learning motivation instrument in this study first underwent an assessment process for each statement item. This evaluation was conducted to ensure that the instrument accurately and consistently represented the construction of learning motivation, particularly the two main dimensions of focus: intrinsic motivation and extrinsic motivation. Content validity was carried out by involving three experts relevant to the research context, namely: a lecturer in office management as a subject-matter expert, a virtual reality instructional technology specialist, and a vocational high school teacher with more than five years of teaching experience. These experts were asked to review the 30 questionnaire items in terms of their alignment with motivation indicators, comprehensibility for SMK students, and clarity of wording.

Several statements received notes for refinement, for example, the replacement of technical terms such as “spatial ergonomics” with “workplace comfort in space arrangement” to make them more understandable for students. Revisions were made without altering the substance of the constructions being measured. After refinement, the questionnaire was empirically tested using item–total correlation analysis. The results of the analysis are presented in the following table:

Table 1. Results of Validity Test of the Learning Motivation Instrument

Measured Aspect	Number of Items	Item–Total Correlation (r)	Validity Criteria
Intrinsic Motivation	15	0,32 – 0,74	Valid
Extrinsic Motivation	15	0,35 – 0,70	Valid

All items in both aspects obtained correlation values above the minimum threshold commonly used in social research, namely 0.30. This indicates that each statement in the questionnaire has a sufficiently strong relationship with the overall construct being measured, so all items are empirically valid and none needed to be eliminated. Thus, there were no items that were divergent or irrelevant to the overall aspects of motivation intended to be measured.

After the validation process was completed, the instrument was also tested for reliability to examine the internal consistency among the statement items. The reliability test was conducted by administering the questionnaire to 30 vocational high school students from another school with characteristics similar to those of the main research subjects. The reliability test results are presented in the following table:

Table 2. Results of Reliability Test of the Learning Motivation Instrument

Number of Items	Cronbach’s Alpha (α)
30	0,88

Cronbach’s Alpha value falls into the high category (≥ 0.80), indicating that the instrument has very good internal consistency. In other words, all items in the questionnaire yield stable and reliable results in measuring students’ learning motivation. Therefore, the VROOM learning motivation questionnaire is deemed appropriate for use in the implementation stage and in analyzing the effectiveness of virtual reality–based learning media in the vocational context.

b. Effectiveness of the Media on Enhancing Motivation

This study aimed to examine the effectiveness of the VROOM virtual reality (VR)-based learning media in improving vocational high school students’ learning motivation in the subject of Building Management Space Organization. The effectiveness evaluation was

conducted after the implementation stage during face-to-face classroom sessions, with learning motivation measured before and after the use of the media. The results of the data analysis are presented in Table 3 below.

Table 3. Average Scores of Students' Learning Motivation Before and After Treatment

Motivation Aspect	Pre-test	Post-test	Δ Score
Intrinsic	2,45	3,28	+0,83
Extrinsic	2,35	3,22	+0,87
Total	2,94	3,79	+0,85

Based on the quantitative analysis of students' learning motivation questionnaire scores before and after the use of VROOM, a significant improvement was found in both motivational aspects—intrinsic and extrinsic. The average intrinsic motivation score increased from 2.45 (SD = 0.34) in the pre-test to 3.28 (SD = 0.29) in the post-test, with a gain of +0.83 points. Meanwhile, extrinsic motivation also showed a rise from an average of 2.35 (SD = 0.38) to 3.22 (SD = 0.32), with an increase of +0.87 points. Overall, the total learning motivation score rose from 2.40 to 3.25, or by +0.85 points.

Table 4. Results of Paired-Sample t-test on Learning Motivation Scores

Variable	t-value	df	Sig. (2-tailed)	Description
Motivasi Total	8,12	29	0,000	Significant ($p < 0,05$)

This improvement was further tested using a paired-sample t-test, which yielded $t(29) = 8.12$ with a significance level of $p < 0.05$. This indicates that the difference between pre-test and post-test scores is statistically highly significant. Moreover, the Cohen's d value of approximately 1.5 indicates a large practical effect, suggesting that the impact of VROOM on learning motivation is not only statistically meaningful but also practically strong and evident in the classroom learning context.

3. Discussion

The significant increase in students' learning motivation after using VROOM demonstrates the tangible contribution of virtual reality (VR)-based learning technology to improving the quality of vocational high school students' learning processes. The 0.83-point rise in intrinsic motivation indicates that students' drive to engage in learning no longer stems solely from external demands but grows from internal interest and curiosity. This can be understood through the framework of Self-Determination Theory (SDT), which emphasizes the importance of fulfilling three basic psychological needs—autonomy, competence, and relatedness—to foster intrinsic motivation (Ryan & Deci, 2000). In the context of learning with VROOM, these three aspects are optimally facilitated. Students are given the freedom to explore the workspace independently, arrange furniture layouts, determine lighting directions, and select appropriate materials, thereby fostering a sense of agency that strengthens their engagement (Makransky & Lilleholt, 2018).

In addition, real-time 3D visualization enables students to directly observe the consequences of their designs, such as disrupted workflows or inefficient lighting. Such feedback has been shown to enhance students' self-efficacy as they can concretely experience their progress in competence (Huang et al., 2019). The office workspace simulations presented in VROOM also foster a sense of relatedness to real-world professional contexts. This feeling of relatedness is crucial in vocational learning because it allows students to see the direct connection between what they are learning and the professions they will pursue in the future (Nouwen et al., 2022).

Not only intrinsic motivation but also students' extrinsic motivation was found to increase significantly, with a rise of 0.87 points. This was mainly driven by the integration of gamification elements in VROOM, such as a workspace efficiency point system, digital badges as rewards for specific achievements, and adaptive quizzes that provide instant feedback. These features deliver positive reinforcement that enhances task value and utility value, two key dimensions of extrinsic motivation (Kam & Umar, 2018). Interestingly, the relatively balanced increase between intrinsic and extrinsic aspects (a difference of 0.04 points) indicates that the media did not merely steer students toward reward-based motivation. Instead, these incentives acted as scaffolding to support the transition from external regulation to more internalized regulation, as explained in the lever-balance model by Büttner et al. (2018).

These quantitative findings are reinforced by observational data showing that most students were able to operate the device within less than five minutes. This indicates that the interface design and simulations used in VROOM are already aligned with students' everyday experiences, thus facilitating easier adaptation (Weissenberger, 2022). Moreover, debriefing sessions facilitated by teachers after the simulations provided a reflective space for students to construct meaning from their experiences, an important stage in experiential learning (Freina & Ott, 2015). Students were also able to transfer knowledge from the simulation to theoretical concepts they had previously learned, such as ergonomics, lighting, and workspace efficiency, demonstrating the occurrence of meaningful contextual learning (Latip et al., 2025).

The context of the Building Management Space Planning course in vocational schools requires students to understand complex spatial principles such as circulation flow, workflow efficiency, ergonomic placement of furniture, as well as lighting and ventilation. The highly visual and contextual nature of this material is often difficult to grasp through verbal explanations or two-dimensional images alone. This is where the advantages of VR-based media such as VROOM become highly relevant and effective. VR technology enables three-dimensional spatial representations that can be directly explored and manipulated by students, allowing them to better understand the interconnections between spaces in a building structure in a more concrete way.

In the VROOM simulation, students are not only tasked with arranging an office space according to ergonomic standards but are also asked to test the effectiveness of the layout through simulations of daily work activities. In other words, learning through VR provides an embodied learning experience because students are physically and cognitively engaged in exploring the workspace, making spatial design concepts no longer abstract but directly perceivable through interaction in the virtual world. A study by Akçayır & Akçayır (2017) affirms that VR is highly effective in enhancing spatial reasoning skills, a crucial cognitive ability in learning spatial planning and interior design.

Furthermore, the VROOM media integrates spatial planning principles based on realistic vocational needs. The placement of furniture, circulation paths for documents, and positioning of light sources are all simulated in scenarios that resemble the actual standards of modern office spaces. This allows students to build both conceptual and procedural understanding of functional space design, as suggested in the contextual learning approach (Kinchin et al., 2021). In addition, the use of VR in this context aligns with findings which show that VR-based training in space management results in deeper understanding of concepts such as space utilization and operational efficiency in workplace design (Aufegger et al., 2022).

VR integration also enables personalized learning, as students can test multiple design scenarios and receive immediate visual feedback, such as when a chair position disrupts workflow circulation or when room lighting is too dim. This flexibility not only stimulates

students' curiosity and creativity but also fosters decision-making skills grounded in data and visualization. In the long term, this is highly relevant to the demands of the building management field, which is increasingly digital and evidence-based in its design approach (Shi, 2024). VROOM's capability to represent real-world work environments in the form of interactive simulations also supports meaningful and applicable learning. This virtual environment bridges the gap between classroom theory and field practice, making students better prepared to face professional challenges. In line with the findings of Halabi (2020), the use of VR simulations in engineering education has been proven to improve problem-solving skills and the transfer of knowledge to real work contexts. Therefore, the utilization of VROOM not only supports the achievement of cognitive learning objectives but also vocational competencies that are practical and applicable.

Overall, this study makes an important contribution to the development of immersive technology-based learning media in vocational education. VROOM has proven to be not only a technological innovation but also an evidence-based pedagogical approach capable of comprehensively enhancing students' learning motivation. The collaboration between strong instructional design, adaptive immersive technology, and relevant learning contexts positions VROOM as a potential model to support the transformation of vocational education in the digital era.

D. CONCLUSION AND SUGGESTIONS

This study concludes that the use of *VROOM: Virtual Reality Room Organization and Optimization Media* significantly enhance the learning motivation of vocational high school students in the subject of Building Management Layout. This is evidenced by the increase in the average total learning motivation score from 2.94 to 3.79, covering both intrinsic and extrinsic aspects, as well as a large practical effect size (Cohen's $d = 1.5$). These findings indicate that VROOM not only has a statistically significant impact but also a strong practical contribution in the context of vocational education. Pedagogically, VROOM promotes experiential learning aligned with constructivist principles and Self-Determination Theory, enabling students to actively engage in meaningful and contextual learning experiences through immersive virtual environments. The three-dimensional visualization provided by VROOM also facilitates students' understanding of abstract concepts such as ergonomics, workflow, and spatial efficiency, making it a relevant and applicable innovation for skill-based learning.

However, this study has several limitations that should be considered. The use of a pre-experimental design without a control group limits the generalizability of the findings, and the measurement of learning motivation was conducted only in the short term, which does not fully capture its long-term sustainability. In addition, practical challenges were encountered during the implementation of VR media in vocational schools, including limited availability of VR devices, the need for technical support, variations in students' familiarity with VR technology, and time constraints in managing device rotation. These findings indicate that the effectiveness of VR-based learning depends not only on the quality of the media but also on infrastructure readiness, teacher competence, and classroom management. Therefore, future research is recommended to employ quasi-experimental or experimental designs with control groups, conduct longitudinal studies to examine long-term impacts, explore the integration of adaptive features such as AI-based feedback, investigate teacher readiness and pedagogical integration of VR, and expand the application of VROOM to other vocational subjects and educational levels to assess its scalability and broader impact.

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