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Research Article

The Effectiveness of the Contextual Virlab Practical Module on Energy Material on the Psychomotor Skills of Grade IV Students of Banyuripan Elementary School

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Abstract

The advancement of technology in education demands teachers to innovate learning processes, particularly to improve students' psychomotor skills. However, science learning for grade IV students still faces challenges such as limited innovation, minimal use of technology-based media, and unmeasured psychomotor skills. This study investigates the effectiveness of using a contextual *Virtual Laboratory* (*VirLab*) practicum module supported by *PhET simulation* in teaching energy material to fourth-grade students at Banyuripan Elementary School. Employing a quantitative pre-experimental design with a one-shot case study approach, this research involved 18 students who were observed during practicum activities focusing on imitation and manipulation stages of psychomotor skills. Data were analyzed using the normalized gain formula to measure skill improvement. Results revealed an average gain value of 0.8056, categorized as "high," confirming that the *VirLab* practicum module effectively enhances students' psychomotor skills, particularly in imitation and manipulation. This study demonstrates that integrating contextual virtual labs in science education positively influences active learning and skill development at the elementary level.

Introduction

Education is a fundamental human need that plays a vital role in developing individual potential to adapt to the dynamic changes of life (Sari & Syamsi, 2015). In the context of formal education, structured learning and a conducive learning environment are essential for optimizing the development of spiritual, cognitive, affective, and psychomotor aspects of students (Ujud et al., 2023). One of the critical elements in education is the curriculum, which serves as the foundation for planning and implementing the learning process. In Indonesia, the curriculum has undergone significant transformations, and currently, the *Merdeka Curriculum* has been implemented as a response to the learning challenges during the Covid-19 pandemic (Cholilah et al., 2023).

The *Merdeka Curriculum* requires educators to master the concept of *Merdeka Belajar* (Freedom to Learn) and develop skills in utilizing various learning materials, resources, and media, including digital platforms that support interactive learning (Wicaksana & Rachman, 2018). The rapid advancement of digitalization in the 21st century has brought significant changes to the field of education, particularly through the use of digital technologies that enhance the quality of interaction between teachers and students (Apryanto, 2022). Technology allows teachers to deliver learning materials in a more engaging, interactive, and developmentally appropriate manner (Ariyani, 2024). In line with these demands, teachers are expected to develop 21st-century skills such as critical thinking, communication, collaboration, and creativity (Suryandari et al., 2022).

The utilization of technology as a learning medium is an effective strategy for optimizing student learning processes, making learning more meaningful and improving students' practical skills (Agustian & Salsabila, 2021). In this regard, the selection of appropriate methods and learning media is crucial to ensure that national educational objectives are achieved optimally. One of the significant transformations in the *Merdeka Curriculum* is the integration of Natural Sciences (IPA) and Social Sciences (IPS) into a new subject called IPAS (Ilmu Pengetahuan Alam dan Sosial) (Septiana, 2023).

Science education, particularly on energy-related topics, emphasizes experimental activities as a vital part of achieving learning objectives (Hikmah et al., 2017). However, in practice, many schools face challenges in implementing experiments due to limited facilities and a lack of awareness among teachers regarding the importance of psychomotor skills (Setiadi & Muflika, 2015). Psychomotor skills, which encompass movement, manipulation, communication, and creation, are essential components of the learning process, as they relate to students' ability to perform actions following learning experiences (Hikmawati et al., 2020). Effective assessment of psychomotor aspects should ideally be structured and conducted in laboratory settings (Saputri et al., 2018). However, limitations in infrastructure often hinder optimal implementation of hands-on experiments in schools.

As an innovative solution, the use of Virtual Laboratory (VirLab)–based learning media has been widely proposed and implemented to overcome these challenges. VirLab is an interactive simulation platform that aligns with students' needs and the current curriculum (Suryandari et al., 2022). This media allows students to perform virtual experiments closely resembling real-world practices, thereby enhancing scientific process skills and digital literacy (Suryandari et al., 2023).

Based on preliminary interviews conducted at SD N Banyuripan, it was found that fourth-grade science learning already uses contextual approaches with various media. However, student engagement remains uneven, and the assessment of psychomotor skills is still conducted subjectively. Therefore, an innovative approach is needed to

address the demand for experiential learning, particularly in the topic of energy. VirLab, as a virtual laboratory, enables students to conduct experiments digitally and may serve as a solution to the lack of practical facilities in schools. Previous studies have shown that the use of VirLab can enhance scientific process skills (Yulasti et al., 2018), improve students' digital literacy (Suryandari et al., 2023), and receive positive responses from both teachers and students (Astuti, 2024).

However, limited research has specifically examined the effectiveness of contextual VirLab-based practicum modules on the development of psychomotor skills in elementary school students, particularly in the topic of energy. Based on this research gap, this study aims to investigate the effectiveness of a contextual VirLab-based practicum module on the psychomotor skills of fourth-grade elementary school students. This research is expected to contribute to the development of technology-based learning media that strengthen students' psychomotor skills and serve as a reference for future educational research and practice.

Methodology

This study employed a quantitative approach with an experimental method (Normalia Arlianty, 2021), to determine the effect of a contextual-based VirLab practicum module on the psychomotor skills of fourth- grade elementary school students (Rahmi Pertiwi et al., 2023). The research design used was pre-experimental with a One-Shot Case Study model, where a single group received treatment and was observed afterward without a control group or pre-test (Nahadi et al., 2016). The research paradigm is illustrated as follows:

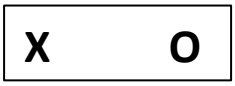

Figure 1. Research Design Model

Explanation:
X = treatment given (contextual-based VirLab practicum module)
O = observation of students' psychomotor skills

The data collection techniques used in this research were interviews and observations. The interview was conducted to explore the teacher's perspective regarding students' psychomotor skills, while the observation aimed to assess students' psychomotor performance during the practicum activities. The research instrument used was an observation sheet consisting of 25 indicators of psychomotor skills, measured using a Likert scale ranging from 1 to 5.

The formula used to calculate the student's score is as follows:

$$\text{Score} = \frac{\text{Observed Score}}{\text{Maximum Score}} \times 100\%$$

The data analysis method involved calculating the gain score and normalized gain (N-Gain) using SPSS software. Since the number of samples was fewer than 50 students, a normality test using the Shapiro-Wilk test was first conducted as a prerequisite before performing the gain analysis. The gain and N-Gain scores were then analyzed to determine whether the use of the contextual-based VirLab practicum module had a significant effect in enhancing students' psychomotor skills.

Result

The study was conducted in Class IV at SD Negeri Banyuripan during the even semester of the 2024/2025 academic year, involving 18 students as participants. Data were collected through observations following the implementation of a contextual-based Virtual Laboratory (VirLab) practicum module. The observation instrument underwent validation by experts and was deemed highly feasible. **Table 1** presents the results of the instrument validation:

Table 1. Validation Results of Psychomotor Observation Instrument

No	Assessed Aspect	Total Score	Average Score (%)	Category
1	Content Feasibility	22	88	Very Feasible
2	Language Feasibility	13	86	Very Feasible
3	Presentation Aspect	12	80	Very Feasible
4	Imitation Aspect	12	80	Very Feasible
5	Manipulation Aspect	17	85	Very Feasible
6	Display and Interactivity Aspect	19	76	Feasible
	Total Score	95		
	Average Score (%)		83	Very Feasible

The construct validity test indicated that all items hadan r-count greater than the r-table value (0.468), signifyinga very high level of validity. Additionally, the reliability testusing Cronbach's Alpha yielded a value of 0.982, demonstrating excellent reliability.

Post-implementation of the contextual-based VirLab module, students' psychomotor skills were observed and analysed. The normality test using the Shapiro-Wilk method showed a significance value of 0.623, indicating thatthe data were normally distributed and met theprerequisites for further analysis. The average gainscore of students' psychomotor skills is detailed in Table 2:

Table 2. Gain Score of Students' Psychomotor Skills

Group	N-Gain	Percentage (%)	Category
Experiment	0.8056	80.56	High

The normalised gain score of 0.8056, or 80.56%, falls into the "High" category, indicating that the use of the contextual-based VirLab practicum module was effective in enhancing students' psychomotor skills. These findings align with previous studies by Yulasti et al., (2018) and Suryandari et al., (2023), which reported that virtual laboratory media can improve science process skills and students' digital literacy. Furthermore, the contextual-based module has proven to increase students' active participation and support the development of 21st-century skills, particularly in manipulation and imitation aspects. Therefore, it can be concluded that the contextual- based VirLab practicum module on the topic of energy significantly contributes to the improvement of psychomotor skills among fourth-grade elementary students. This module serves as an effective

alternative solution to the limitations of practical facilities commonly found in elementary schools.

Discussion

This study aims to examine the effectiveness of using a contextual-based VirLab practicum module on the topic of energy in improving the psychomotor skills of fourth-grade students at SD Negeri Banyuripan. The research subjects consisted of 18 students in the even semester of the 2024/2025 academic year. Data collection was carried out through observations using validated instruments focused on the psychomotor domain, particularly the aspects of imitation and manipulation.

Before being used, the instrument was validated by experts based on six aspects: content feasibility, language, presentation, imitation, manipulation, as well as visual display and interactivity. The average validation score was 86%, which is categorized as "very feasible" according to the conversion of quantitative to qualitative data. The lowest score was in the visual and interactivity aspect, which scored 75%, but was still categorized as "feasible." This finding is consistent with research by Himmah & Sulaikho, (2022), which shows that students' low digital literacy can lead to difficulties in adapting to animated media. Both students and observers required additional time to understand the interactive features within the PhET simulation. Similarly, Adien Adien Inayah et al., (2024)emphasized that students' limited digital competence affects their optimal use of media.

Construct validity testing indicated that all indicators had r-count values greater than the r-table value (0.468), indicating high validity. Reliability testing using Cronbach's Alpha yielded a value of 0.982, signifying that the instrument is highly reliable and consistent. The normality test using the Shapiro-Wilk method showed a significance value of 0.623, indicating that the data were normally distributed ($p > 0.05$).

The effectiveness of the VirLab module was further supported by the normalized gain (N-Gain) analysis. Students' psychomotor skill scores increased from an average pre-test score of 56.00 to a post-test average of 91.00, resulting in an N-Gain score of 0.8056 or 80.56%, which falls into the "high" effectiveness category. These results confirm a substantial improvement in students' ability to perform, imitate, and manipulate virtual practicum procedures.

These findings answer the research questions and indicate that the contextual-based VirLab practicum module is effective in enhancing elementary students' psychomotor skills. This is particularly evident in the imitation and manipulation aspects, where students were able to independently follow instructions in the PhET simulation and operate variables effectively. This is in line with the psychomotor taxonomy proposed by Rachman (2018), which includes imitation, manipulation, precision, articulation, and naturalization. In this study, the dominant aspects observed were imitation and manipulation.

These findings reinforce the theory proposed by Samsu et al., (2020), who stated that practicum modules are essential for guiding students to learn actively and independently. Uzani et al., (2023) and Sari et al., (2020) also noted that practicum modules help students better understand and retain concepts through systematic practice. VirLab, which integrates animation and simulation, improves motor coordination and provides a realistic experimental experience (Baruno, 2021); (Saputra et al., 2020). This aligns with (Arnita Sari, 2019), who asserted that practicum activities support intellectual, manual, and social development among students.

The study is also supported by prior research. (Azhar et al., 2023) reported that virtual practicum- based learning is more effective than conventional methods. Aini et al., (2021) found that using virtual laboratories like VirLab can enhance students' science process skills. Roosyanti et al., (2022) stated that PhET simulations effectively improve students' psychomotor abilities by simplifying laboratory procedures. Marta et al., (2020) added that contextual modules encourage students to relate science concepts to real-life contexts, thereby increasing motivation and participation.

Therefore, the VirLab module is effective in supporting the development of students' psychomotor skills, particularly in guided virtual practice. It strengthens conceptual understanding of energy and reinforces both theoretical and practical functions in science learning at the elementary level. The module is also relevant to the characteristics of digital-era learning and can serve as an alternative interactive learning medium that promotes active and meaningful learning.

Conclusion and Recommendation

The use of the contextual-based VirLab practicum module on the topic of energy has been proven effective in enhancing the psychomotor skills of fourth- grade elementary students. This effectiveness is reflected in the increased active participation of students during practicum activities, from the imitation stage to manipulation. Statistically, prerequisite tests show that the data were normally distributed (Sig. = 0.623), and the normalized gain score averaged 0.8056, categorized as "High." These findings demonstrate that the VirLab practicum module not only significantly improves psychomotor skills but also provides a more interactive and meaningful learning experience, tailored to the needs of elementary science education.

This study contributes new insights into the application of virtual lab modules in primary education, highlighting their potential to support active and independent learning in the digital era. It is recommended that future research explores the long- term effects of VirLab modules on students' scientific inquiry skills and investigates their applicability across different science topics.

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