Psychology, Evaluation, and Technology in Educational Research
7 (2), 2025, 258-268

Available Online: http://petier.org/index.php/PETIER

The effect of PhET (Physics Education Technology)-assisted guided inquiry learning on grade VI learning interest and critical thinking skills

Mukarramah [1 a] *, Dewa Bagus Sanjaya [b], I Wayan Suastra [c]

Universitas Pendidikan Ganesha, Udayana St. No.11, Singaraja, Bali, 81116, Indonesia
[a] mukarramah.journal1@gmail.com ; [b] bagus.sanjaya@undiksha.ac.id; [c] iwsuastra@undiksha.ac.id
*Corresponding Author

Received: 2 December 2025; Revised: 19 December 2025; Accepted: 21 December 2025

Abstract: This study investigates the impact of the guided inquiry learning model, augmented by PhET (Physics Education Technology) media, on the critical thinking skills and learning interest of sixth-grade students in Science subjects at Islamic elementary school, Jembrana, Indonesia. The research was prompted by the observed deficiency in both aspects, attributed to conventional, passive, and non-interactive pedagogical methods. Utilizing a quantitative approach with a quasi-experimental design, the study divided subjects into two groups: an experimental class implementing PhET-assisted guided inquiry and a control class utilizing conventional methods. Data collection involved essay tests to measure critical thinking skills and Likert-scale questionnaires to assess learning interest. Multivariate Analysis of Variance (MANOVA) results indicated that the integration of guided inquiry and PhET media significantly influenced students' critical thinking skills and learning interest. The experimental group demonstrated higher mean scores. PhET media effectively visualized abstract scientific concepts, making them more tangible and comprehensible, while the guided inquiry model stimulated analytical reasoning and active student participation. This combined approach proved effective in enhancing student outcomes in science education.

Keywords: Guided Inquiry; PhET; Critical Thinking Skills; Learning Interest; Science Education

How to Cite: Mukarramah, M., Sanjaya, D. B. & Suastra, I. W. (2025). The effect of PhET (Physics Education Technology)-assisted guided inquiry learning on grade VI learning interest and critical thinking skills. *Psychology, Evaluation, and Technology in Educational Research*, *7*(2), 258–268. https://doi.org/10.33292/petier.v7i2.301

INTRODUCTION

Natural Science instruction at the elementary school level holds a crucial function in developing students' critical thinking abilities, promoting active knowledge exploration, and nurturing an early enthusiasm for science. Science learning serves as an effective means to strengthen problem-solving skills and stimulate curiosity, which is a fundamental driver of meaningful learning. Ideally, science education should be structured to encourage analytical thinking, support students' independence in constructing knowledge, and foster a strong interest in science from a young age (Vannilia et al., 2023). In addition, science education helps learners understand natural phenomena while enhancing cognitive abilities and scientific attitudes that are vital for their long-term personal growth.

Nevertheless, these expected outcomes have not yet been optimally achieved in practice. Field observations and several preliminary studies indicate that elementary science education,

10.33292/petier.v7i2.301

particularly at the sixth-grade level, still encounters considerable obstacles. Instructional practices remain largely teacher-centered, relying heavily on conventional lectures and lacking interactive learning media that can effectively represent abstract scientific concepts. Research conducted by Sari (2020) in multiple elementary schools found that more than 70% of science lessons were dominated by teacher explanations, with minimal opportunities for students to actively engage in exploration and knowledge construction. As a result, students' critical thinking skills remain underdeveloped, as reflected in their limited ability to analyze problems and formulate scientific conclusions. In line with this, Nurjanah's (2021) survey on learning interest revealed that over half of the students considered science to be a dull and uninteresting subject. These findings highlight the urgent need for innovative, interactive, and contextually relevant science teaching approaches that align with elementary learners' characteristics to enhance conceptual understanding and critical thinking skills.

Critical thinking is recognized as a fundamental competence required in the 21st century and has become a central emphasis in contemporary education (Firdaus et al., 2020; Hadi, 2015). Students today are expected not merely to absorb information but also to critically analyze it, assess evidence, and draw reasoned conclusions. According to Facione (2011), critical thinking involves a range of interconnected skills, such as interpreting information, analyzing problems, evaluating arguments, making inferences, explaining concepts, and exercising self-regulation in the thinking process. These competencies are particularly essential in science learning, where students are required to understand natural phenomena logically and systematically. By developing critical thinking skills, students are better equipped to apply scientific concepts to real-life situations and achieve a deeper, more meaningful understanding of science.

Beyond critical thinking, learning interest represents an essential internal factor that strongly influences students' engagement and achievement in the learning process (Slameto, 2011). Interest serves as a motivational force that enhances concentration, active participation, and perseverance in exploring learning materials. In contrast, low levels of learning interest may result in reduced enthusiasm, quick feelings of boredom, and difficulties in understanding instructional content, even when the material is inherently meaningful and closely related to everyday experiences (Majid, 2014; Utami & Wiratma, 2023). Therefore, this study argues that the existing limitations in students' critical thinking abilities and learning interest, particularly in Science learning, constitute a critical issue that requires immediate attention through instructional innovation.

In response to the need to improve students' critical thinking skills and interest in science, the development of innovative learning models becomes indispensable. One instructional approach with considerable potential is the guided inquiry model. This model provides a meaningful learning experience by actively involving students in authentic scientific activities (Fitriyani & Cahyaningsih, 2023; Lestari et al., 2022). Through structured processes of observation, experimentation, and reasoning, students are encouraged to process information and construct knowledge independently with appropriate teacher guidance and scaffolding (Yasa & Rachmawati, 2023). Unlike traditional teacher-centered instruction, guided inquiry promotes questioning, investigation, and analytical thinking, allowing students to learn science in a manner similar to practicing scientists.

Nevertheless, to maximize the effectiveness of the guided inquiry approach, the integration of supportive interactive learning media is essential. PhET (Physics Education Technology) interactive simulations present a highly effective solution (Hamdani & Yulianti, 2020; Kurniasih & Sari, 2021; Ramdani & Anggraeni, 2021). PhET consists of computer-based science simulations designed to make abstract scientific concepts more accessible, concrete, and

engaging for learners. Through interactive and dynamic visual representations, PhET enables students to manipulate variables, observe immediate outcomes, and develop an intuitive understanding of complex scientific concepts (Eka & Pratiwi, 2024).

The combination of guided inquiry, which emphasizes active learning and exploration, with PhET media, which effectively visualizes abstract concepts, forms a strong and relevant instructional strategy to address students' low critical thinking skills and limited learning interest in science. Accordingly, this study is highly relevant. Based on the identified educational challenges, the urgency for improvement, and the potential advantages of these instructional innovations, this research aims to examine in depth the impact of the PhET-assisted guided inquiry model on sixth-grade students' critical thinking skills and learning interest in science learning. The findings of this study are expected to contribute empirical evidence regarding the effectiveness of integrating guided inquiry and PhET media in creating engaging, interactive science learning experiences that support the development of higher order thinking skills at the elementary level.

METHODS

The research methodology comprises the research design, techniques for data collection, and procedures for data analysis. The design emphasizes the establishment of experimental and control groups. Data were gathered through observations, achievement tests, and questionnaires, while data analysis was carried out using Multivariate Analysis of Variance (MANOVA).

Research Design and Procedure

This study adopts a quantitative approach employing a quasi-experimental method, as the researcher was unable to exercise complete control over external variables that could potentially affect the intervention. The research design applied is the Posttest-Only Control Group Design, which involves two groups an experimental group and a control group without random assignment. The research population includes all sixth-grade students enrolled in the 2025/2026 academic year. Sampling was conducted using a finite population technique, resulting in a total sample of 65 students, distributed into Class VI-A as the experimental group (n = 32) and Class VI-B as the control group (n = 33).

The experimental group was taught using the guided inquiry learning model supported by PhET media, whereas the control group received instruction through conventional teaching methods, including lectures and question-and-answer activities. The learning process was implemented over four instructional sessions within a two-week period, focusing on the topic of "Force and Motion." The research instruments employed in this study consist of two categories:

At the critical thinking skills test, an essay-type test comprising five questions, developed in accordance with Facione's (2011) essential components of thinking, namely interpretation, analysis, evaluation, inference, and explanation. The instrument was subjected to expert judgment for content validity and tested for reliability using Cronbach's Alpha coefficient.

At the learning interest questionnaire, a questionnaire consisting of ten statements, including both positively and negatively worded items, was measured using a four-point Likert scale. This instrument was constructed based on learning interest indicators proposed by Slameto (2011), which include enjoyment, attention, involvement, and motivation to learn.

Data Collection Techniques

The data collection procedures in this study were carefully designed to correspond with each research variable: PhET-assisted guided inquiry learning as the independent variable, critical thinking skills as the first dependent variable, and learning interest as the second dependent variable. These procedures aimed to obtain accurate and dependable data to support valid research conclusions. The data were collected using the following methods:

Observation

Observation was conducted to examine the extent to which the PhET-assisted guided inquiry learning model was implemented as intended. This method employed observation sheets developed according to the stages of the inquiry process, including stimulation, problem formulation, hypothesis development, experimentation using PhET simulations, data interpretation, and conclusion formulation (Sugiyono, 2020). The observations were carried out by the researcher or appointed observers throughout the teaching and learning activities.

Test

A test was administered to assess students' critical thinking skills after the instructional intervention. The assessment instrument consisted of essay-type questions designed based on Facione's (2011) critical thinking framework, encompassing skills such as analysis, evaluation, inference, and the ability to present logical reasoning. The test was given after the completion of the learning activities, and the results were analyzed to determine the effect of the instructional model on students' critical thinking performance.

Questionnaire

A questionnaire was used to measure students' learning interest in Science following the implementation of the PhET-assisted guided inquiry model. The questionnaire employed a four-point Likert scale and included statements representing various indicators of learning interest, such as enjoyment, attraction to the learning media, attention, active involvement, and motivation to continue learning.

Data Analysis Techniques

Data analysis procedures were applied to process the research results and to generate valid and objective conclusions consistent with the research questions and aims. In this study, quantitative data obtained from critical thinking skills tests, learning interest questionnaires, and observation instruments were analyzed using statistical methods. Before conducting the main analysis, prerequisite testing was carried out, including normality testing using the Shapiro–Wilk procedure and homogeneity testing through Box's M Test. These preliminary analyses represent a crucial step to ensure the validity and reliability of the findings and to confirm the suitability of the selected statistical techniques for the data distribution and characteristics.

The main analytical method used in this study was Multivariate Analysis of Variance (MANOVA), which was employed to examine both the combined and individual effects of the instructional treatment on the two dependent variables. Data analysis was performed using the most recent version of SPSS software. To determine the statistical significance of the treatment's effect on the dependent variables simultaneously, the Wilks' Lambda (Λ) statistic was utilized. Wilks' Lambda reflects the proportion of variance not explained by differences

between groups; a value closer to zero indicates greater group differences, while a value near one suggests that no significant differences exist.

RESULTS AND DISCUSSION

Results

This research involved two groups: an experimental class that was instructed using the PhET-assisted guided inquiry approach and a control class that received conventional instruction. Data were collected through three instruments: (1) a learning interest questionnaire, (2) a critical thinking skills assessment, and (3) an observation sheet to monitor the implementation of the learning process. In the experimental class, guided inquiry learning was supported by PhET (Physics Education Technology) simulations, which were used in small-group settings to investigate electrical energy concepts. Students worked individually or in pairs while completing structured tasks provided in student worksheets. The PhET electrical energy simulation model, which includes virtual electric circuit representations, is illustrated in the figure below.

Figure 1. Website Phet Homepage

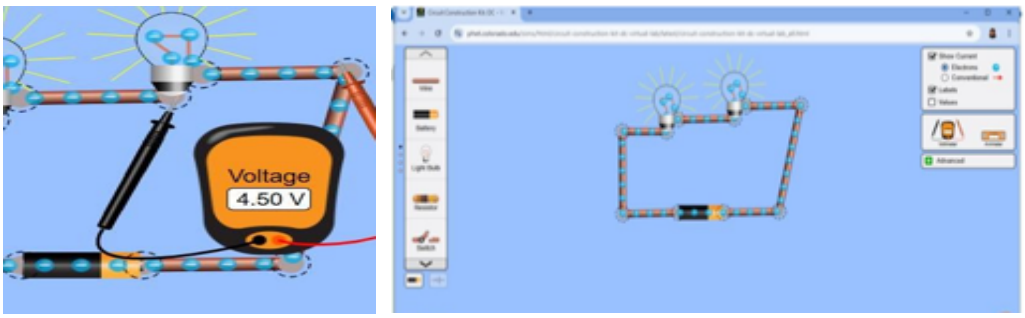

Figure 2. Voltmeter and Electron Flow in PhET Electrical Circuits

The teaching and learning activities using the PhET-assisted guided inquiry model began with introductory stages. During this phase, the teacher engaged students by relating the topic to their prior experiences with electricity and presenting a video related to electrical energy. The teacher then introduced the PhET simulation, explained its functions, and demonstrated its initial use (Figure 3). Afterward, students were organized into small groups to carry out inquiry-based investigations (Figure 4). Each group was provided with worksheets containing

exploratory tasks that required students to construct series and parallel electrical circuits using PhET simulations in the computer laboratory (Figure 5). Throughout the activity, the teacher facilitated group discussions as students interacted with the simulations. The learning process continued with group presentations and question-and-answer sessions aimed at analyzing and evaluating the problem-solving strategies employed (Figure 6). The lesson concluded with reflective activities conducted by both the teacher and students, followed by a post-test to assess students' conceptual understanding.

Figure 3. PhET Media Demonstration

Figure 4. Exploration of Electrical Circuits

Figure 5. PhET-Based Guided Inquiry Worksheet

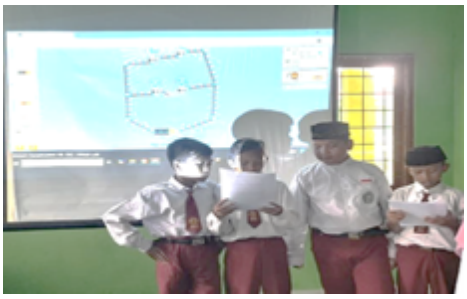

Figure 6. Presentation and Q&A Session

The study's results, when compared with those of the control class, demonstrated superior outcomes for the experimental group. In terms of learning interest, the experimental group achieved an average score of 84.6, whereas the control group obtained a mean score of 74.8. Similarly, the experimental group attained a higher average score in critical thinking skills (82.4) compared to the control group (72.1). Observational data further indicated that the PhET-assisted guided inquiry learning process promoted active and participatory student engagement. Detailed comparisons of competency scores for both groups are presented in Table 1 and Figure 7.

Table 1. Data descriptions

Group	Learning Interest (Average)	Critical Thinking Skills (Average)
Experiment	85.6	82.4
Control	76.4	73.2

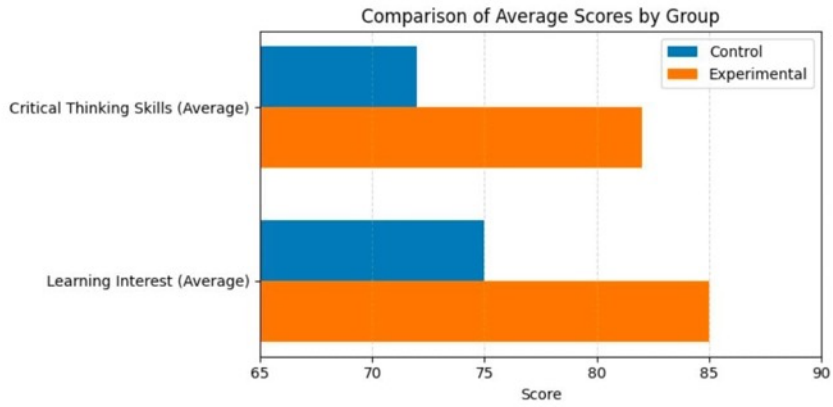

Figure 7. Comparison of Learning Interest and Critical Thinking Skills Scores

Before conducting the main analysis using Multivariate Analysis of Variance (MANOVA), a set of prerequisite tests was administered to ensure the accuracy and validity of the statistical results. These preliminary tests are necessary to confirm that the data meet the underlying assumptions required for MANOVA, thereby guaranteeing that the conclusions drawn from the analysis are dependable. Initially, a normality test was carried out to assess whether the data distributions for both the experimental and control groups conformed to a normal distribution. The Shapiro–Wilk test was applied, and the results showed that the significance values (p-values) for all variables in both groups exceeded 0.05. This outcome indicates that the data related to students' critical thinking skills and learning interest were normally distributed, satisfying one of the essential assumptions for parametric testing. In addition, a homogeneity of covariance test was performed using Box's M Test to evaluate whether the variance–covariance matrices of the dependent variables were equivalent across groups. The test produced a significance value greater than 0.05, demonstrating that the assumption of homogeneity of covariance was met and that the variability between groups did not differ significantly. This result further supports the appropriateness of applying MANOVA.

The successful fulfillment of these prerequisite tests confirms that the research data satisfy the statistical requirements for conducting MANOVA. As a result, a strong methodological foundation was established for subsequent analyses, allowing the researcher to draw valid and accurate conclusions regarding the effect of the PhET-assisted guided inquiry learning model on students' critical thinking skills and learning interest. Ensuring multivariate normality and homogeneity of variance–covariance matrices is a critical step in multivariate analysis, as emphasized by methodological authorities such as Tabachnick and Fidell (2013). With these assumptions adequately met, the use of MANOVA to simultaneously examine the influence of the instructional model on the two dependent variables is statistically justified.

The MANOVA analysis was then performed to test the primary research hypothesis, namely, whether the implementation of the PhET-assisted guided inquiry model significantly affects students' critical thinking skills and learning interest. The results revealed a highly significant effect. The analysis produced a Wilks' Lambda (Λ) value of 0.431, with an associated F statistic of $F(2, 47) = 13.02$ and a p-value less than 0.001. A p-value well below the 0.05 threshold indicates that the observed differences between the experimental and control groups are statistically significant and unlikely to have occurred by chance. To determine the magnitude of the instructional effect, Partial Eta Squared (Partial η^2) was calculated. The obtained value of 0.357 suggests that approximately 35.7% of the variance in the combined dependent variables critical thinking skills and learning interest—can be attributed to the PhET-assisted guided

inquiry model. This value represents a large effect size, confirming that the instructional intervention had a substantial and meaningful impact.

Table 2. Results of the univariate test (partial ANOVA) for each variable

Variable	F Table	Sig. (p)	(Sig.)
Learning Interest	12.89	0.001	Significant
Critical Thinking	15.73	0.000	Significant

This improvement can be explained by the fundamental features of the guided inquiry learning model, which encourages students to actively investigate, observe phenomena, and develop hypotheses independently. When combined with PhET simulations, students are provided with a meaningful and interactive learning environment (Nuryani & Zubaidah, 2018; Ramanda et al., 2024). For example, in learning topics such as "Force and Motion," students are able to manipulate virtual simulations involving pushing and pulling forces and directly observe the resulting changes in an object's motion. These hands-on activities prompt students to ask questions, participate in discussions, and apply critical thinking to understand the observed phenomena.

In addition, students' learning interest is enhanced through the use of PhET media, which offers visually appealing and easy-to-use interactive features. Such characteristics help increase students' engagement and intrinsic motivation throughout the learning process. This finding is consistent with Slameto's (2011) view that learning interest develops when students experience enjoyment, encounter meaningful challenges, and perceive the learning material as relevant to their everyday lives.

Discussion

The findings of this study indicate that the guided inquiry learning model supported by PhET simulations has a significant effect on students' critical thinking abilities and learning interest. Students in the experimental group demonstrated greater improvements in both critical thinking test scores and learning interest questionnaire results compared to those in the control group. From a theoretical standpoint, these results support Vygotsky's social constructivist theory, which emphasizes that knowledge is constructed through interactive and contextual learning experiences facilitated by instructional scaffolding provided by the teacher (Permana & Hariri, 2019). The guided inquiry approach encourages learners to actively investigate problems, evaluate information, and formulate conclusions independently under structured teacher guidance, thereby promoting the development of higher-order cognitive skills (Rusman, 2017).

In terms of instructional media, PhET simulations offer dynamic and interactive representations of abstract scientific concepts, including force and motion. These simulations enable students to engage in virtual experimentation in a safe and flexible environment, free from the limitations of physical laboratory equipment. Previous research by Wieman and Perkins (2010) highlights the effectiveness of PhET in supporting science learning, a conclusion further supported by studies conducted by Putri et al. (2020) and Arini and Dwiningsih (2021), which reported increased student comprehension and engagement following the integration of interactive simulation-based media.

Overall, the results of this study extend existing research by contributing empirical evidence to the development of technology-enhanced instructional practices that foster critical thinking skills and enhance students' learning interest in the digital age. Moreover, the findings reaffirm

the effectiveness of combining the guided inquiry learning model with PhET simulations as a strategy for improving the quality of science education at the elementary school level.

CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that the PhET-assisted guided inquiry learning approach has a significant effect on improving students' critical thinking skills and learning interest in Science education. Students who participated in learning activities using this approach demonstrated statistically higher outcomes compared to those who experienced conventional instruction. The guided inquiry learning model provides students with opportunities to actively explore concepts, ask questions, and construct knowledge independently through structured teacher guidance. The use of PhET media further enhances the learning process by offering interactive simulations that transform abstract scientific concepts into concrete and engaging visual representations. The integration of guided inquiry and PhET simulations creates a meaningful and enjoyable learning environment that effectively promotes active student participation. This study contributes novel insights to the development of digital-based instructional strategies at the elementary school level, particularly in *madrasah ibtidaiyah*, where the integration of inquiry-based learning and simulation technology remains relatively underexplored. Therefore, this instructional approach can be recommended as an innovative alternative for improving the quality of science learning at the primary education level.

ACKNOWLEDGMENTS

The author would like to express sincere gratitude to the school principal of the school where this research was conducted for granting permission and providing support throughout the implementation of this research. Appreciation is also extended to all sixth-grade teachers and students who actively participated in the learning process and data collection.

REFERENCES

Arini, D., & Dwiningsih, K. (2021). Pengaruh media PhET terhadap pemahaman konsep dan motivasi belajar siswa pada materi listrik dinamis. *Jurnal Pendidikan Fisika Indonesia*, *17*(2), 145–154. https://doi.org/10.15294/jpfi.v17i2.52112

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.

Facione, P. A. (2011). *Critical thinking: What it is and why it counts* (6th ed.). Insight Assessment. https://www.insightassessment.com

Firdaus, A., Wahyuni, S., & Pratiwi, S. (2020). Penerapan pembelajaran inkuiri terbimbing untuk meningkatkan hasil belajar siswa sekolah dasar. *Jurnal Pendidikan Dasar Nusantara*, *6*(2), 84–92. https://doi.org/10.29407/jpdn.v6i2.14578

Fitriyani, A. P., & Cahyaningsih, U. (2023). Penggunaan media Physics Education Technology (PhET) pada pembelajaran IPA di sekolah dasar. *Journal of Innovation in Primary Education*, *2*(1), 30–37. https://www.ejournal.unma.ac.id/index.php/jipe/article/view/7336

Hadi, S. (2015). Pengaruh model pembelajaran inkuiri terbimbing terhadap hasil belajar IPA siswa kelas V SD. *Jurnal Pendidikan*, *16*(1), 25–32.

Hamdani, A., & Yulianti, S. (2020). Pengaruh penggunaan media PhET terhadap hasil belajar siswa pada materi listrik dinamis. *Jurnal Pendidikan Fisika dan Teknologi*, *6*(1), 37–43. https://doi.org/10.29303/jpft.v6i1.1589

Keller, J. M. (2010). *Motivational design for learning and performance: The ARCS model approach*. Springer.

Kurniasih, D., & Sari, D. A. P. (2021). Peningkatan minat belajar dan hasil belajar IPA melalui pembelajaran inkuiri terbimbing. *Jurnal Ilmiah Pendidikan Dasar*, *8*(2), 110–119. https://doi.org/10.22236/jipd.v8i2.6225

Lestari, N. P., Suhartini, T., & Rahayu, S. (2022). Implementasi pembelajaran inkuiri terbimbing untuk meningkatkan keterampilan berpikir kritis dan hasil belajar IPA siswa SD. *Jurnal Cakrawala Pendidikan*, *41*(2), 345–358. https://doi.org/10.21831/cp.v41i2.46126

Majid, A. (2014). *Strategi pembelajaran*. Remaja Rosdakarya.

Nuryani, S., & Zubaidah, S. (2018). Efektivitas pembelajaran berbasis inkuiri untuk meningkatkan keterampilan berpikir kritis dan hasil belajar siswa. *Jurnal Pendidikan Biologi Indonesia*, *4*(1), 45–52. https://doi.org/10.22219/jpbi.v4i1.5515

Permana, A. D., & Hariri, H. (2019). Hubungan antara minat belajar dan hasil belajar siswa. *Jurnal Ilmiah Sekolah Dasar*, *3*(2), 145–152. https://doi.org/10.23887/jisd.v3i2.18007

Putri, A. R., Mulyani, S., & Kurniawan, H. (2020). Efektivitas penggunaan simulasi PhET dalam meningkatkan pemahaman konsep siswa pada materi suhu dan kalor. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *9*(1), 73–84. https://doi.org/10.24042/jipfalbiruni.v9i1.5520

Eka, P. S., & Pratiwi, V. (2024). Determinasi model pembelajaran inkuiri terbimbing berbantuan media interaktif PhET terhadap kemampuan literasi sains SISWA SD. *Jurnal Pendidikan Dasar Indonesia*, *9*(2), 67–71. http://repository.unars.ac.id/id/eprint/3387

Ramanda, N., Rahmad, M., & Islami, N. (2024). Pengaruh model pembelajaran inkuiri terbimbing berbantuan simulasi phet terhadap kemampuan berpikir kritis siswa pada materi fluida dinamis. *Silampari Jurnal Pendidikan Ilmu Fisika*, *6*(2), 223–239. https://doi.org/10.31540/sjpif.v6i2.2900

Ramdani, R., & Anggraeni, R. D. (2021). Peningkatan berpikir kritis siswa melalui pendekatan inkuiri terbimbing. *Jurnal Pendidikan Sains Indonesia*, *9*(3), 368–376. https://doi.org/10.24815/jpsi.v9i3.20800

Rusman. (2017). *Model-model pembelajaran*. Rajawali Pers.

Sari, D. M., & Maulidina, R. (2019). Penerapan media PhET terhadap peningkatan minat dan hasil belajar siswa pada materi gaya. *Jurnal Pendidikan Fisika Indonesia*, *15*(1), 60–67. https://doi.org/10.15294/jpfi.v15i1.17985

Slameto. (2011). *Belajar dan faktor-faktor yang mempengaruhinya*. Rineka Cipta.

Sugiyono. (2020). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (6th ed.). Pearson.

Trianto. (2013). *Mendesain model pembelajaran inovatif-progresif*. Kencana Prenadamedia Group.

Utami, N. W., & Wiratma, I. G. A. (2023). Pengaruh model inkuiri terbimbing terhadap kemampuan berpikir kritis dan hasil belajar IPA siswa sekolah dasar. *Jurnal Ilmiah Sekolah Dasar*, *7*(1), 23–30. https://doi.org/10.23887/jisd.v7i1.49621

Vannilia, V., Fanani, A., & Rosidah, C. T. (2023). Model inquiry learning berbantuan media PhET Sebagai virtual laboratory terhadap keterampilan proses sains siswa SD. *Progressive of Cognitive and Ability*, *2*(4), 338–348. https://doi.org/10.56855/jpr.v1i4.666

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wieman, C. E., & Perkins, K. K. (2010). Transforming physics education. *Physics Today*, *58*(11), 36–41. https://doi.org/10.1063/1.2155756

Yasa, P., & Rachmawati, D. O. (2023). Pengaruh model pembelajaran inkuiri terbimbing

berbantuan Phet terhadap kemampuan berpikir kritis peserta didik. *Jurnal Pendidikan dan Pembelajaran IPA Indonesia, 13*(3), 94–100. https://doi.org/10.23887/jppii.v13i3.74038