

Literature Review: Analysis of the Application of Guided Inquiry in Physics Learning to Improve Student Competence

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Abstract: Penelitian ini bertujuan menganalisis penerapan model guided inquiry dalam pembelajaran fisika serta pengaruhnya terhadap peningkatan kompetensi peserta didik. Penelitian menggunakan metode studi literatur dengan menganalisis 12 artikel jurnal nasional terbitan 2021–2026 yang membahas penerapan guided inquiry pada pembelajaran fisika. Data dianalisis berdasarkan kompetensi yang dikembangkan, desain penelitian, hasil peningkatan, serta faktor pendukung penerapan model. Hasil kajian menunjukkan bahwa guided inquiry memiliki kecenderungan positif terhadap kemampuan berpikir kritis, pemahaman konsep, keterampilan proses sains, dan literasi sains. Efektivitasnya dipengaruhi karakteristik materi, kualitas bimbingan, perangkat pembelajaran, dan media pendukung.

Abstract: This study aims to analyze the implementation of the guided inquiry model in physics learning and its effects on improving students' competencies. This study employed a literature review method by analyzing 12 national journal articles published from 2021 to 2026 that examined the implementation of guided inquiry in physics learning. The data were analyzed based on the competencies developed, research designs, learning improvement outcomes, and supporting factors. The findings indicate that guided inquiry tends to have a positive effect on students' critical thinking skills, conceptual understanding, science process skills, and scientific literacy. Its effectiveness is influenced by the characteristics of the learning material, quality of guidance, instructional materials, and supporting media.

Introduction

Physics is a branch of natural science that studies natural phenomena through observation, experimentation, and scientific reasoning. The essence of physics encompasses physics as a product, in the form of facts, concepts, principles, laws, and theories, as well as physics as a scientific process based

on the skills of observation, hypothesis formulation, and experimentation (Murdani, 2020). This essence demonstrates that physics cannot be understood simply as a collection of mathematical formulas.

Physics learning is not only oriented towards mastering facts, concepts, and mathematical equations, but also on students' abilities to observe phenomena, conduct investigations, process information, use evidence, and draw conclusions based on scientific processes. Therefore, physics learning needs to provide opportunities for students to actively engage in the process of acquiring and constructing knowledge. Learning approaches that provide space for students to conduct investigations are important because understanding of physics cannot be built solely through passive reception of information. Research on physics learning also shows that inquiry-based learning models can influence physics learning outcomes and students' conceptual understanding (Yudatika & Jauhariyah, 2021; Shidik et al., 2021).

These demands are increasingly relevant to the need for learning that develops students' competencies more comprehensively. Competence in physics learning is not only reflected in cognitive learning outcomes but also encompasses critical thinking skills, conceptual understanding, science process skills, and scientific literacy. These skills are closely related to scientific activities because students need to identify problems, propose hypotheses, conduct observations or experiments, analyze data, and use evidence to explain phenomena. Recent research shows that guided inquiry learning can be used to develop science process skills and physics learning outcomes through student engagement in the investigation process (Fitriyana et al., 2025). The application of guided inquiry has also been reported to support increased scientific literacy when the investigation process is combined with activities that enable students to connect concepts with physical phenomena (Utami et al., 2025).

One learning model that aligns with these characteristics is guided inquiry. This model positions students as the primary actors in the investigation process, while still providing teacher guidance to ensure that learning activities proceed in a directed manner. This guidance can be provided through problems, guiding questions, investigation prompts, and feedback as students collect and analyze data. Thus, guided inquiry strikes a balance between student independence and teacher support. Research and development experiments in physics learning have shown that the application of this model can support conceptual understanding, critical thinking skills, and science process skills. For example, the application of guided inquiry assisted by PhET simulations has been reported to have an impact on students' conceptual understanding, while PhET-assisted guided inquiry learning tools have also been developed to improve science process skills (Salim & Fianti, 2024; Ulfa et al., 2022). The use of supporting media such as PhET simulations also allows students to observe and explore physical phenomena that are difficult to observe directly.

Although numerous studies have been conducted on guided inquiry in physics learning, the results are still scattered based on the competencies measured, physics material, educational level, research design, and learning media used. Some studies focus on conceptual understanding, while others examine critical thinking skills, science process skills, or science literacy. The results also do not always show the same level of improvement. For example, research on guided inquiry tools assisted by PhET simulations showed an improvement in science process skills, but its effectiveness was still moderate (Ulfa et al., 2022). Conversely, other studies showed an increase in conceptual understanding and critical thinking skills with a higher level of effectiveness (Calesta et al., 2021; Giawa et al., 2024). These differences indicate the need to synthesize various research findings to obtain a more comprehensive picture of the application of guided inquiry in physics learning.

Previous studies have provided evidence of the effectiveness of inquiry in physics learning. Yudatika and Jauhariyah (2021), for example, found through a meta-analysis of 23 articles that inquiry learning influences physics learning. A more recent study also analyzed the role of guided inquiry in improving critical thinking skills in physics learning in Indonesia (Yaumie et al., 2025). However, this

study focused on critical thinking skills, while a synthesis that integrates several forms of student competencies in physics learning is still needed. Therefore, this article focuses on four competencies: critical thinking skills, conceptual understanding, science process skills, and science literacy, taking into account variations in research designs, materials, and supporting media used in the implementation of guided inquiry.

Based on the description, the problem formulation in this study is how the application of the guided inquiry model in physics learning contributes to improving student competency and what factors are related to the success of its implementation. The study is limited to national journal articles that discuss the implementation or development of guided inquiry-based physics learning and contain results related to student competency. The purpose of this study is to analyze the application of the guided inquiry model in physics learning towards improving student competency based on the results of published research, as well as to identify trends in the results and supporting factors for its implementation.

Research methods

This study uses a literature review approach to analyze the trend of guided inquiry model implementation in physics learning and its relationship to improving student competency. The study procedure refers to the literature review stages proposed by Snyder (2019), including study design, literature collection and selection, analysis of findings, and synthesis. This approach was used because the study did not collect data directly from students, but utilized previous research findings as secondary data sources to obtain an overview of the implementation patterns of guided inquiry in physics learning.

The research data sources were scientific journal articles discussing the implementation or development of guided inquiry-based physics learning. Literature searches were conducted through databases and scientific journal pages that provide articles online. The literature considered met the following criteria: (1) discussing the guided inquiry model in physics learning; (2) involving students at elementary or secondary education levels, with a primary focus on secondary school physics learning; (3) reporting competencies or learning outcomes related to student abilities; (4) published in the 2021–2026 period; and (5) available in the form of scientific articles that can be accessed for analysis purposes. Articles that did not focus on physics learning, did not use guided inquiry, or did not present information relevant to the focus of the study were not included in the synthesis.

Based on these criteria, twelve articles were selected for in-depth analysis. Article selection was based on topic suitability, year of publication, research characteristics, measured competencies, and the availability of information regarding the results of guided inquiry implementation. The twelve articles included experimental research, developmental research, and meta-analyses. A variety of research designs was maintained because this study did not aim to calculate a single combined effect size, but rather to identify trends in findings across relevant research.

Data collection was conducted using documentation techniques. Information from each article was recorded in an analysis matrix that included the author's identity and year of publication, research objectives, research level or subject, physics material, research design, form of guided inquiry implementation, media or supporting devices used, competencies measured, measurement instruments or indicators, and research results. Quantitative data such as N-Gain values, effect sizes, score differences, and significance test results were recorded if available in the article. Meanwhile, qualitative findings regarding the feasibility, practicality, student responses, as well as supporting and inhibiting factors for the implementation of guided inquiry were used as complementary information in the interpretation process.

Data analysis was conducted using a descriptive-comparative approach. In the first stage, each article was analyzed based on the research characteristics and the competencies being measured. In the

second stage, findings were grouped based on student competencies, namely critical thinking skills, conceptual understanding, science process skills, and science literacy. In the third stage, results across publications were compared, taking into account physics material, subject characteristics, research design, media or technology use, and the type of learning tools applied. Next, results with similar patterns were synthesized to identify general trends, while different findings were used to explain variations in the effectiveness of guided inquiry implementation.

The synthesis was not conducted by combining all research results into a single statistical value because the characteristics, variables, instruments, designs, and outcome measures across the twelve articles were not completely homogeneous. Therefore, this study employed a narrative synthesis by comparing the direction and strength of the findings reported by each study. This approach allows the results of experimental research, development research, and meta-analyses to be read contextually without ignoring the differences in methodological characteristics of each source.

The twelve articles that served as the main data sources in this study are presented in Table 1.

Table 1. List of journal articles analyzed in the literature study

No	Article Title	Author (Year)	Summary
1	The Effectiveness of Physics Learning with the Guided Inquiry Model Assisted by PhET Interactive Simulations to Improve Students' Ability Critical Thinking of High School Students	Mardiyanti & Jatmiko (2022)	Implementing guided inquiry assisted by PhET Interactive Simulations on high school students with a one-group pretest-posttest design. Critical thinking skills increased significantly, with a high average N-Gain (0.77 and 0.72 in the two classes).
2	The Influence of the Guided Inquiry Learning Model Assisted by PhET Simulation on Students' Conceptual Understanding and Attitudes Optical Instrument Material	Salim & Fianti (2024)	Testing guided inquiry assisted by PhET simulation on optical instrument material with a true experimental posttest only control design. The conceptual understanding value of the experimental class (74.63) was higher than the control class (67.23), with sig. 0.029.
3	Meta-Analysis of the Influence of Guided Inquiry Learning Model on Understanding of Physics Concepts Student	Mulyana et al. (2021)	Meta-analysis of 13 national and international articles. Guided inquiry has a high influence on understanding of physics concepts in grade X (effect size 1.22), but only a moderate influence on fluid material (effect size 0.40).
4	Development of a Guided Inquiry Practicum E-Module Based on Liveworksheets Assisted by Tracker Software Analysis on Module Material Elasticity of Material	Novarensa (2024)	Developing a guided inquiry practicum e-module based on Liveworksheet and Tracker analysis on the elastic modulus of materials. This e-module effectively improves critical thinking skills with high effectiveness.
5	Development of Guided Inquiry-Based Student Worksheets Assisted by E-Learning to Improve Understanding Concepts in Grade X High School Students	Calesta et al. (2021)	Developing a guided inquiry worksheet assisted by e-learning. Very good validity (material 88.66%, language 86%, design 90.76%) and N-Gain conceptual understanding of 0.87 (high) in grade X students.

No	Article Title	Author (Year)	Summary
6	Development of Guided Inquiry Model Learning Tools to Improve Students' Physics Learning Outcomes	Mulyana et al. (2022)	Developing a guided inquiry learning tool validated using a Likert scale. The tool is categorized as good to excellent (score 3.05–3.70), making it suitable for supporting student competency improvement.
7	Implementation of the Phyphox-Assisted Guided Inquiry Learning Model on Student Learning Outcomes in the Material Doppler Effect	Jannah et al. (2026)	Implementing guided inquiry assisted by Phyphox on the Doppler effect material. Student competency achievement increased by 36 points and was significant based on the Paired Sample t-Test ($p = 0.000$).
8	Development of E-LKPD Physics Based on Guided Inquiry on Straight Motion Material for Students Educate Grade X High School	Aksari et al. (2021)	Developing a guided inquiry electronic student worksheet (LKPD) on linear motion. The E-LKPD was categorized as highly feasible and received a positive response from students as a means of strengthening conceptual understanding.
9	The Influence of Guided Inquiry Learning Model on Skill Improvement Student Science Process on Dynamic Fluid Material	Safna et al. (2025)	Quasi-experimental nonequivalent control group design. The science process skills of the experimental group (76) were significantly higher than the control (56), with a moderate N-Gain (0.59) and effect size 1.36.
10	Development of Guided Inquiry-Based Physics Teaching Materials to Improve Critical Thinking Skills Student	Giawa et al. (2024)	Developing physics teaching materials based on guided inquiry. Feasibility, practicality, and effectiveness were all categorized as excellent (above 88%) in improving critical thinking skills.
11	Development of a Guided Inquiry Model Learning Tool Assisted by PhET Simulation to Improve Skills Student Science Process	Ulfa et al. (2022)	Developing a guided inquiry tool assisted by PhET simulations on work and energy topics. The tool is valid and practical, but the N-Gain of science process skills (50.61%) is classified as moderate with relatively low effectiveness.
12	<i>Guided Inquiry Worksheets with Teaching Aids: Improving Students' Scientific Literacy</i>	Utami et al. (2025)	Developing guided inquiry worksheets with teaching aids on spring force material. Scientific literacy increased with an N-Gain of 0.51 (moderate), practicality good, and around 80% of students considered learning more active and enjoyable.

Results and Discussion

Characteristics of the Research Reviewed

Based on the twelve articles analyzed, the application of guided inquiry in physics learning was studied through experimental designs and development research. Experimental research included one-group pretest-posttest designs, quasi-experimental nonequivalent control group designs, and true experimental posttest-only control designs. These designs were used to determine changes in student competency after participating in guided inquiry learning and to compare the results with those in a control group. Mardiyanti and Jatmiko (2022) and Jannah et al. (2026), for example, used one-group pretest-posttest designs, while Safna et al. (2025) used a quasi-experimental nonequivalent control group, and Salim and Fianti (2024) used a true experimental posttest-only control design.

In addition to experimental research, some articles utilize developmental research to produce learning tools that support the implementation of guided inquiry. The products developed include e-practicum modules, student worksheets (LKS), e-LKPD (Worksheets for Students), teaching materials, learning tools, and LKPD. Some of these products are integrated with digital technologies, such as e-learning, PhET Interactive Simulations, Liveworksheets, and Tracker (Aksari et al., 2021; Calesta et al., 2021; Novarensa, 2024; Ulfa et al., 2022). Mulyana et al. (2021) used a meta-analysis approach to examine the effect of guided inquiry based on previous research, while Mulyana et al. (2022) developed a learning tool based on the same model.

This diversity of designs demonstrates that guided inquiry research is not only aimed at examining changes in student competency but also at providing tools to help teachers implement inquiry stages in a more structured manner. This is relevant to the characteristics of guided inquiry, which positions students as the investigators, yet still receives assistance and direction throughout the learning process. Furtak et al. (2012) demonstrated that inquiry-based learning is linked to learning outcomes when inquiry activities are accompanied by appropriate guidance. Therefore, the presence of learning tools in development research is not merely complementary but can also serve as a means of providing scaffolding during the inquiry process.

Improving Critical Thinking Competence

Three articles in this study specifically measured critical thinking skills through the application of guided inquiry. Mardiyanti and Jatmiko (2022) reported an increase in critical thinking skills after implementing guided inquiry using PhET Interactive Simulations, with average N-Gain of 0.77 and 0.72 in two classes. Novarensa (2024) also reported that a guided inquiry-based practical e-module equipped with Liveworksheets and Tracker analysis was highly effective in improving critical thinking skills. Meanwhile, Giawa et al. (2024) demonstrated that guided inquiry-based teaching materials had excellent levels of feasibility, practicality, and effectiveness in supporting the improvement of critical thinking skills.

This tendency can be understood from the characteristics of guided inquiry activities. Students not only receive explanations of physics concepts, but are also directed to observe phenomena, identify problems, collect information or data, analyze evidence, and draw conclusions. This series of activities provides opportunities for students to use analytical and evaluation skills when determining the relationship between the evidence obtained and the concepts being studied. These results align with a study by Yaumie et al. (2025) who analyzed guided inquiry research in physics learning in Indonesia and found that the model is widely used to develop critical thinking, especially in activities that require data analysis and comparison of experimental results with theoretical foundations.

The use of technology in all three studies also demonstrated functions beyond simply enhancing the learning experience. PhET can provide visual representations of phenomena that are difficult to observe directly, while Tracker allows students to analyze motion phenomena based on video data. Wieman et al. (2008) explain that interactive simulations can help students explore relationships between concepts and obtain feedback during the learning process. Therefore, technology can enhance guided inquiry when used as part of the investigation process, not simply as a medium for delivering material.

However, improving critical thinking is not solely determined by media use. Teacher guidance, question quality, opportunities for inquiry, and the form of assessment also determine the competency development. A study by Yaumie et al. (2025) showed that the self-regulation aspect of critical thinking remains relatively under-recognized compared to other indicators. These findings suggest that the implementation of guided inquiry needs to be designed so that students are not limited to collecting and analyzing data but are also given the opportunity to reflect on the investigation process and results.

Improved Conceptual Understanding

Conceptual understanding is one of the competencies that is quite dominant in the articles reviewed. Salim and Fianti (2024) found that the application of guided inquiry assisted by PhET simulations on optical instrument material resulted in an average conceptual understanding of 74.63 in the experimental class, higher than the control class at 67.23, with a significance value of 0.029. These results indicate that learning that provides opportunities for students to explore phenomena through investigation can help them build connections between representations or observations with physics concepts.

These findings were reinforced by Mulyana et al. (2021) through a meta-analysis of 13 articles. The analysis results showed that the influence of guided inquiry on conceptual understanding in 10th-grade students was high, with an effect size of 1.22. However, this effect was not the same for each material. For temperature and heat, and dynamic electricity, the effect sizes were high, at 1.82 and 1.76, respectively. Meanwhile, for fluids, the effect size was 0.40, which is in the medium category. This difference indicates that the effectiveness of the learning model cannot be separated from the characteristics of the material being studied.

This distinction is important because physics has materials with different conceptual and mathematical characteristics. Materials that present phenomena that are easily observed or manipulated through experiments can provide greater space for students to build concepts through investigation. Conversely, materials that require abstract representations or more complex mathematical relationships may require more intensive guidance and scaffolding. The findings of Lazonder and Harmsen (2016) support this understanding, as their meta-analysis of 72 studies showed that providing guidance has a positive influence on learning activities, performance success, and learning outcomes in inquiry learning.

The results of development research also show a consistent pattern. Calesta et al. (2021) obtained an N-Gain of 0.87 for conceptual understanding through guided inquiry-based worksheets (LKS) assisted by e-learning. Aksari et al. (2021) produced a guided inquiry-based e-LKPD on linear motion that achieved a high feasibility rate and positive student responses. These findings indicate that learning tools can help translate guided inquiry stages into more structured activities. Thus, improving conceptual understanding is not only related to the abstract learning model but also to how the model is translated into worksheets, inquiry questions, observation activities, and the conclusion-drawing process.

In a study by Jannah et al. (2026), the application of guided inquiry assisted by Phyphox on the Doppler effect also resulted in a 36-point increase in achievement with a significant Paired Sample t-Test result ($p = 0.000$). The use of Phyphox provides students with the opportunity to utilize available devices as part of the measurement process. These results demonstrate that the integration of measurement technology can expand the experimental experience in physics learning. However, these results still need to be understood in the context of the research design used so that they are not directly equated with the magnitude of the effect in research with a control group.

Improving Science Process Skills

Science process skills are competencies directly related to investigative activities. In a study by Safna et al. (2025), the application of guided inquiry to fluid dynamics resulted in an average posttest score of 76 for the experimental group and 56 for the control group. The study also obtained an N-Gain of 0.59 and an effect size of 1.36. These results indicate an increase in science process skills as well as a significant difference between the guided inquiry group and the control group.

This improvement can be explained through learning activities that require students to be directly involved in the scientific process. When students are guided to observe, identify problems, conduct measurements, process data, and draw conclusions, science process skills are not only explained theoretically but also practiced during the learning process. Thus, guided inquiry aligns with the

development of science process skills because both place investigative activities as a crucial part of acquiring knowledge.

However, the results of Ulfa et al. (2022) show that this relationship does not always result in significant improvements. The PhET-assisted guided inquiry learning device developed for work and energy was declared valid and practical, but the N-Gain for science process skills of 50.61% was only in the moderate category and its effectiveness was relatively low. The difference between the results of Safna et al. (2025) and Ulfa et al. (2022) shows that the feasibility of the device does not automatically guarantee significant competency improvements.

These differences can be attributed to the quality of implementation and the characteristics of the activities provided to students. A valid tool indicates that the content and format of the tool meet development criteria, while student skill improvement remains dependent on the tool's use in the learning process. Students need sufficient opportunities to conduct measurements, process data, interpret results, and receive guidance when they encounter difficulties. This aligns with the results of Lazonder and Harmsen's (2016) meta-analysis, which demonstrated the importance of guidance in inquiry learning.

Improving Scientific Literacy

Scientific literacy is a competency that is relatively less studied than critical thinking, conceptual understanding, and science process skills in the twelve articles analyzed. Utami et al. (2025) developed a guided inquiry student worksheet (LKPD) with teaching aids on spring force and obtained a scientific literacy N-Gain of 0.51, which is in the moderate category. Furthermore, the LKPD has a good level of practicality, and approximately 80% of students assessed that learning became more active and enjoyable.

These results indicate that guided inquiry can provide a platform for developing scientific literacy through activities that connect concepts to phenomena and investigative activities. Scientific literacy is not only related to the ability to memorize concepts, but also the ability to use knowledge to understand phenomena and make decisions based on evidence. Therefore, the use of visual aids in student worksheets (LKPD) is important if the activities direct students to observe phenomena, interpret data, and connect the results of investigations to relevant issues.

However, the moderate N-Gain value indicates that the implementation of guided inquiry does not automatically result in significant improvements in scientific literacy. Learning activities need to be designed so that students not only conduct experiments but also interpret information, explain phenomena scientifically, and use evidence to support conclusions. Therefore, developing scientific literacy requires integration between inquiry activities and assessments that truly measure these literacy skills.

Synthesis of Findings and Supporting Factors for the Success of Guided Inquiry

Overall, the twelve articles showed a positive trend for the application of guided inquiry on various student competencies, but the level of improvement was not uniform. Relatively strong findings were seen for critical thinking skills and conceptual understanding, while science process skills and scientific literacy showed moderate to high variation depending on the study. Therefore, the findings of this study are more appropriately interpreted as a positive trend with varying effectiveness, rather than as evidence that guided inquiry always results in significant competency gains.

This positive trend aligns with broader meta-analysis research. Furtak et al. (2012) showed that inquiry-based science learning can yield better results when the cognitive characteristics of the activity and the level of guidance are appropriately considered. Lazonder and Harmsen (2016) also found that providing guidance in inquiry learning positively impacts learning activities, performance success, and learning outcomes. Thus, the term "guided" in guided inquiry is crucial to the model's effectiveness because students are not left to conduct investigations without direction.

The next factor is the use of media and technology. Several studies in this study utilized PhET, Phyphox, Tracker, Liveworksheet, e-learning, and teaching aids. These technologies provide different functions according to learning needs. PhET supports virtual visualization and manipulation of phenomena, Phyphox can be used to assist with device-based measurements, and Tracker supports video data analysis. Thus, technology is not a factor that automatically increases the effectiveness of guided inquiry, but it can expand students' opportunities to observe, measure, analyze, and test during investigations.

Another factor evident in the study is the quality of learning tools. Student worksheets (LKS), e-LKPD (e-LKPD), e-modules, teaching materials, and learning devices can serve as scaffolding that guide students through the inquiry stages. However, the results of Ulfa et al. (2022) show that valid and practical tools do not necessarily result in significant competency gains. This means that product quality must be considered alongside the quality of its implementation. Teachers still have a role in asking guiding questions, explaining concepts when needed, providing feedback, and adjusting the level of support to students' abilities.

Variation based on material is also a significant finding. A meta-analysis by Mulyana et al. (2021) showed that the effect of guided inquiry on conceptual understanding differed across several physics materials. This suggests that the model's implementation needs to be tailored to the material's characteristics, learning objectives, the level of conceptual abstraction, and the types of investigative activities students are likely to engage in. Thus, the effectiveness of guided inquiry is a result of the interaction between the model, materials, tools, technology, teacher guidance, and student characteristics.

The findings of this study also need to be placed within the development of more recent literature research. Yaumie et al. (2025) have specifically examined the role of guided inquiry on critical thinking skills in physics education in Indonesia through 27 articles, while Koli et al. (2026) examined the implementation of guided inquiry in physics learning at the secondary school level through 15 studies. Therefore, the contribution of this study lies not in claiming that previous research on guided inquiry has never been synthesized, but rather in mapping the findings from articles selected based on the focus of student competencies that include critical thinking, conceptual understanding, science process skills, and science literacy. This synthesis shows that guided inquiry has the potential to develop diverse competencies, but the results of its application remain dependent on the quality of guidance, material characteristics, learning tools, supporting technology, and the implementation process in the classroom.

Conclusion

Based on a literature review of twelve national scientific journal articles, the application of the guided inquiry model in physics learning shows a positive trend towards improving student competencies, including critical thinking skills, conceptual understanding, science process skills, and scientific literacy. This improvement is demonstrated through the N-Gain results, effect size, differences in learning outcomes, and significance tests reported in the analyzed studies. However, the level of improvement is not uniform across studies. These differences indicate that the effectiveness of guided inquiry is related to the characteristics of the material, the form of guidance, learning tools, supporting media, and student characteristics.

The use of technologies such as PhET simulations, Phyphox, Tracker, and e-learning can support the inquiry process when directly integrated with observation, measurement, data analysis, and conclusion-drawing activities. Similarly, tools such as student worksheets (LKS), e-LKPD (e-LKPD), e-modules, teaching materials, and LKPD can function as scaffolding that helps students follow the guided inquiry stages in a more focused manner. Therefore, the implementation of this model needs to be tailored to learning objectives, material characteristics, student readiness, and teacher ability to provide guidance

during the inquiry process. Future research can expand the study to more diverse levels, materials, and physics competencies and use research designs that allow for stronger comparisons of effectiveness across contexts.

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