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# Integrating Renewable Energy into Inquiry-Based Physics Instruction to Enhance Higher-Order Thinking Skills: A Theoretical Study


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**Abstract**

An This study was motivated by the importance of strengthening students' Higher Order Thinking Skills (HOTS) in physics education relevant to global challenges, particularly the issue of renewable energy. The purpose of this study is to analyze and synthesize research findings related to the integration of inquiry-based physics learning in enhancing students' HOTS, as well as to identify existing research gaps. The method used was a literature review, analyzing 27 relevant articles using a systematic literature review approach. The results indicate that inquiry-based learning, particularly guided inquiry, is effective in enhancing students' HOTS, specifically in the areas of critical thinking, conceptual understanding, and active engagement in learning. However, most studies are still limited to partial measurement of HOTS and have not explicitly integrated the context of renewable energy into learning. Therefore, the development of an inquiry-based physics learning model integrated with the context of renewable energy is needed to strengthen students' HOTS comprehensively and contextually.

[Penelitian ini dilatarbelakangi oleh pentingnya penguatan Higher Order Thinking Skills (HOTS) peserta didik dalam pembelajaran fisika yang relevan dengan tantangan global, khususnya isu energi terbarukan. Tujuan penelitian ini adalah untuk menganalisis dan mensintesis hasil penelitian terkait integrasi pembelajaran fisika berbasis inquiry dalam meningkatkan HOTS peserta didik serta mengidentifikasi kesenjangan penelitian yang ada. Metode yang digunakan adalah studi literatur dengan menganalisis 27 artikel yang relevan menggunakan pendekatan systematic literature review. Hasil penelitian menunjukkan bahwa pembelajaran berbasis inquiry, terutama guided inquiry, efektif dalam meningkatkan HOTS peserta didik, khususnya pada aspek berpikir kritis, pemahaman konsep, dan keterlibatan aktif dalam pembelajaran. Namun demikian, sebagian besar penelitian masih terbatas pada pengukuran HOTS secara parsial dan belum mengintegrasikan konteks energi terbarukan secara eksplisit dalam pembelajaran. Oleh karena itu, diperlukan pengembangan model pembelajaran fisika berbasis inquiry yang terintegrasi dengan konteks energi terbarukan guna memperkuat HOTS peserta didik secara komprehensif dan kontekstual]. © The Authors.





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## 1. Introduction

The global energy transition toward renewable energy sources is one of the strategic priorities in addressing the climate crisis and the sustainability challenges of the 21st century. Energy is a primary necessity in human life. From the moment a person is born until the end of their life, from waking up to going to sleep, humans are constantly engaged in energy transformation processes [1]. Reliance on fossil fuels has significantly contributed to increased greenhouse gas emissions, which impact global warming and climate change. The energy transition is a goal for all nations worldwide, including Indonesia. The Earth's deteriorating condition demands cooperation and synergy among all nations to collectively realize the vision of a sustainable environment [2]. A report from the International Energy Agency emphasizes that accelerating the development of renewable energy sources—such as solar, wind, hydro, and geothermal—is key to reducing the carbon intensity of the energy sector. The concept of renewable energy can be introduced in physics education through teaching materials that link energy transformation to physics concepts, such as a vertical-axis wind turbine lab kit that allows students to observe the conversion of mechanical energy into electrical energy in the context of alternating current [3]. Amid the climate crisis, achieving net-zero emission targets represents a cross-sectoral commitment that demands fundamental transformation—not only in technological aspects but also in strengthening human resources.

Education plays a strategic role in developing human resources with a critical awareness of energy sustainability issues. Formal education in schools also plays a vital role in shaping the mindset of the younger generation regarding social responsibility related to the use of these natural resources [4]. Through formal learning processes in schools, students not only gain conceptual knowledge about energy but are also guided to understand the ecological, economic, and social implications of its use. In the context of the global energy transition, education is required to develop energy literacy that encompasses the impacts of energy use as well as sustainable solutions. Environmental education provided in schools regarding renewable energy and climate management has become crucial [5]. Therefore, the strengthening of energy literacy in education needs to be systematically implemented through physics education to foster higher-order thinking skills and understanding. Furthermore, integrating renewable energy issues into physics education is closely linked to sustainability education, knowledge of climate change, and achieving the Sustainable Development Goals (SDGs), particularly SDG 4 regarding quality education and SDG 7 regarding affordable and clean energy. In this context, physics learning should not only deepen students' conceptual understanding of energy conversion but also equip them with the skills necessary for future employment, such as critical thinking, problem-solving abilities, creativity, scientific reasoning, and evidence-based decision-making to address sustainability challenges.

In theory, inquiry-based physics learning provides students with the opportunity to develop analytical, evaluative, and creative skills through a systematic scientific investigation process. Physics, as one of the branches of science, plays a strategic role in fostering students' critical thinking skills in mastering concepts, problem-solving skills, and the application of knowledge to daily life [6].One approach that fosters critical thinking in students is Inquiry-Based Learning (IBL). The IBL approach is rooted in John Dewey's philosophy that learning begins by sparking a strong sense of curiosity in students [7]. Student-centered physics learning can also be supported through active-learning-based instructional media, such as physics e-modules designed to encourage students' active participation in learning activities [8]. This process aligns with the characteristics of the scientific method in physics, enabling students to build a deeper and more meaningful understanding. Analytical skills develop as students break down physical phenomena into conceptual components. Thus, inquiry-based physics learning is not only oriented toward concept mastery but also significantly contributes to the strengthening of Higher Order Thinking Skills (HOTS).

Although previous studies have widely demonstrated the effectiveness of inquiry-based physics learning, particularly guided inquiry, in improving students' critical thinking skills, conceptual understanding, science process skills, and learning engagement, most of these studies still measure HOTS in a limited manner, mainly focusing on critical thinking rather than comprehensively addressing analytical, evaluative, creative, and reflective thinking skills. In addition, studies related to renewable energy education generally emphasize STEM activities, energy literacy, practical applications, or students' attitudes toward sustainability, but have not systematically integrated renewable energy issues into the stages of inquiry-based physics learning. This indicates a conceptual and pedagogical gap between inquiry-based learning as an approach to strengthen HOTS and renewable energy as an authentic contextual issue in physics education. Therefore, a more explicit theoretical formulation is needed to map renewable energy content into inquiry-based learning stages and align it with HOTS indicators, particularly analysis, evaluation, and creation, so

that physics learning can become more contextual, meaningful, and relevant to sustainability challenges.

The integration of renewable energy into physics education can be achieved by contextualizing key topics related to the concept of energy and its transformations. Topics such as the law of conservation of energy, work and energy, energy conversion, electric circuits, and thermodynamic concepts are directly related to the operating principles of solar energy, wind turbines, hydroelectric power plants, and geothermal energy. Through an inquiry-based approach, students can be guided to investigate how solar energy is converted into electrical energy via solar cells, analyze factors affecting wind turbine efficiency, or develop energy conversion systems in simple hydroelectric power plants. Renewable energy, particularly the use of solar panels as a source of electricity, holds great potential in Indonesia, a tropical country rich in sunlight [9]. This investigative process enables students not only to understand physics concepts theoretically but also to learn them through real-world problems relevant to current issues. Physics learning will be more effective if it enables students to build upon their existing experiences to observe and understand the real world using scientific processes and principles [10]. Thus, the integration of renewable energy into inquiry-based physics learning serves as an authentic context that stimulates students' analytical, evaluative, and creative abilities in a more focused and systematic manner.

Conceptually, the integration of renewable energy into inquiry-based physics learning can be achieved through the integration of content selection, learning syntax stages, and indicators for strengthening higher-order thinking skills. During the problem-orientation stage, students are presented with real-world phenomena related to renewable energy issues to foster curiosity and the ability to identify problems. The hypothesis formulation and investigation design stages encourage students to develop analytical skills regarding variables that influence an energy system. Furthermore, the experimentation and data collection processes allow students to evaluate the alignment of results with the theories they have learned. In the final stage—reflection and conclusion drawing—students are encouraged to formulate solutions or innovative ideas as a manifestation of creative ability. The integration of renewable energy content with inquiry-based learning forms a learning framework that systematically stimulates indicators C4 (analysis), C5 (evaluation), and C6 (creation) in the cognitive taxonomy. Thus, physics learning serves not only as a transfer of concepts but also as a vehicle for building knowledge relevant to the challenges of energy sustainability.

Based on the above discussion, the integration of renewable energy into inquiry-based physics learning is a pedagogical strategy with significant potential for developing students' higher-order thinking skills. However, a more comprehensive analysis is needed to map the conceptual relationships between renewable energy content, inquiry syntax, and indicators of higher-order thinking skills in a structured manner. Therefore, this article aims to theoretically examine the integration of renewable energy into inquiry-based physics learning as an effort to strengthen Higher-Order Thinking Skills. This study is expected to provide a conceptual contribution to the development of physics learning designs that are more contextual, innovative, and relevant to the challenges of the 21st century. The uniqueness of this study lies in the development of an integrative conceptual framework that explicitly links the context of renewable energy, the syntax of inquiry-based learning, and indicators of higher-order thinking skills. Unlike previous studies, which mostly examined inquiry-based physics learning, renewable energy literacy, or the development of HOTS separately, this study positions renewable energy issues as contextual inquiry problems that can be systematically mapped into the stages of inquiry-based learning and linked to analytical, evaluative, and creative thinking skills. Therefore, the contribution of this study is not the development of a new learning model or HOTS assessment instruments, but rather the formulation of a theoretical framework for designing inquiry-based physics instruction that integrates renewable energy issues to strengthen students' HOTS.

## 2. Method

This study employed a theoretical literature review approach to analyze the integration of renewable energy into inquiry-based physics learning for strengthening students' Higher-Order Thinking Skills (HOTS). This approach was used because the study focuses on conceptual synthesis rather than direct empirical data collection. The final sources analyzed consisted of 27 selected publications, comprising 20 journal articles and 7 conference proceedings. No books or official institutional reports were included in the final analysis. These sources were selected based on their relevance to inquiry-based learning, renewable energy education, physics education, energy literacy, and HOTS, as well as publication recency within the last ten years and source credibility.

Data were collected through Google Scholar using keywords such as “Inquiry-Based Physics Learning,” “guided inquiry in physics education,” “renewable energy in physics learning,” “higher-order thinking skills,” “energy literacy,” and “contextual physics learning.” The initial search identified 356 articles. After screening titles, keywords, abstracts, and full-text availability, 30 articles were considered eligible. Furthermore, 3 articles were excluded because they were not directly related to the focus of this study. Thus, 27 articles were included in the final analysis.

Data analysis was conducted through data reduction, literature classification, content analysis, and conceptual synthesis. Data reduction was used to eliminate irrelevant studies, while literature classification grouped the selected articles based on research focus, method, learning model, renewable energy context, and HOTS indicators. Content analysis was used to identify patterns, similarities, differences, strengths, and limitations of previous studies. Finally, conceptual synthesis was conducted to formulate an integrative framework connecting renewable energy content, inquiry-based learning stages, and HOTS indicators, particularly analysis, evaluation, and creation. The flow of the literature selection and analysis process is presented in Figure 1.

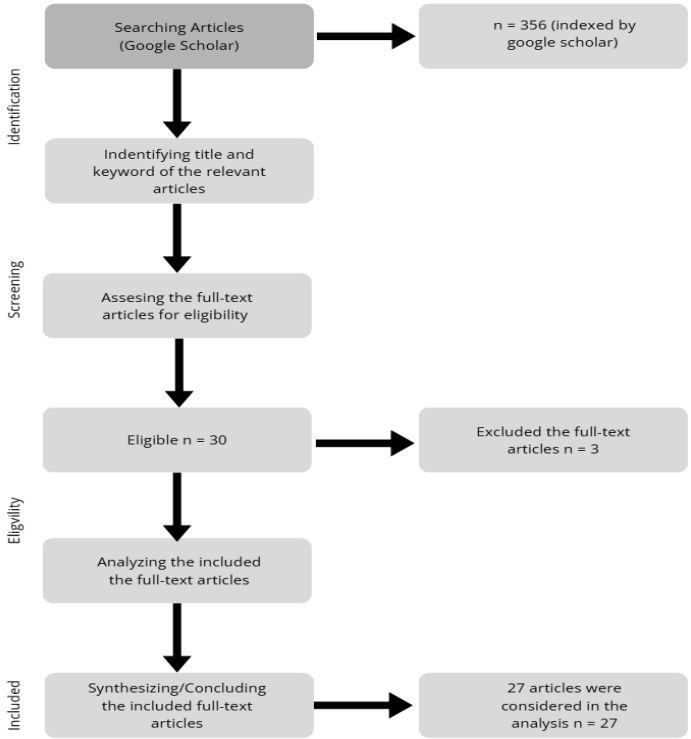


Figure 1. Research Method Flowchart

## 3. Results

To clarify the findings from the analyzed articles, the following is a summary of the research results from 27 articles relevant to this study, presented in Table 1 below.

Table 1. Research Findings

| No | Author and Year | Research Title | Research Findings |
|---|---|---|---|
| 1 | Zain & Jumadi, 2018 | Effectiveness of guided inquiry based on blended learning in physics instruction to improve critical thinking skills of the senior high school student | Guided inquiry instruction using blended learning is more effective in improving students' critical thinking skills than guided inquiry without the support of blended learning |
| 2 | Russo & Persano Adorno, 2018 | An inquiry-based learning path to introduce modern physics in high-school | Inquiry-based learning combined with laboratory work and cooperative learning has been shown to increase students’ motivation, participation, and conceptual understanding |
| 3 | Lämsä et al., 2018 | Visualising the temporal aspects of collaborative inquiry-based learning processes in technology-enhanced physics learning | Visualization in technology-based collaborative inquiry learning is effective in identifying scaffolding needs and enhancing student collaboration and engagement, although it is |

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|---|---|---|---|
| | | | limited by sample size and the generalizability of the results. |
| 4 | Nisa et al., 2018 | Development Of Guided Inquiry-Based Physics Teaching Materials To Increase Critical Thinking Skills Of Highschool Students | Guided inquiry-based physics teaching materials have been proven to be valid, appropriate, and effective in improving students' critical thinking skills, with a moderate level of improvement. |
| 5 | Pratiwi et al., 2019 | The Impact of Guided Inquiry Model Integrated with Peer Instruction towards Science Process Skill and Physics Learning Achievement | There is a significant difference in students' science process skills and learning outcomes, with the guided inquiry model integrated with peer instruction proving more effective than conventional methods. |
| 6 | Husnaini & Chen, 2019 | Effects Of Guided Inquiry Virtual And Physical Laboratories On Conceptual Understanding, Inquiry Performance, Scientific Inquiry Self-Efficacy, And Enjoyment | Guided inquiry using virtual labs and physical labs each has its own advantages in enhancing conceptual understanding and inquiry skills; therefore, a combination of both is recommended for optimal learning outcomes. |
| 7 | Rodriguez et al., 2020 | Designing Inquiry-Based Learning Environments For Quantum Physics Education In Secondary Schools | Digital inquiry-based learning on the photoelectric effect enhances students' conceptual understanding and reasoning skills, although their understanding of the particle nature of light remains limited. |
| 8 | Maknun, 2020 | Implementation of Guided Inquiry Learning Model to Improve Understanding Physics Concepts and Critical Thinking Skill of Vocational High School Students | The use of guided inquiry significantly improves students' understanding of static fluid concepts and their critical thinking skills compared to conventional instruction. |
| 9 | S. R. Putri & Syafriani, 2020 | Analysis Development Of Guided Inquiry Based Physics E-Module To Improve Critical Thinking Ability Of Students High School | The limited availability of learning resources and the suboptimal quality of instructional materials necessitate the development of guided inquiry-based e-modules to enhance students' critical thinking skills |
| 10 | Phonna et al., 2020 | Guided inquiry-based on practicum to improve critical thinking skills on the subject of Newton's law | Practical-based guided inquiry effectively enhances students' critical thinking skills in Newton's laws through experimental activities. |
| 11 | Medriati et al., 2021 | The difference in the guided inquiry model towards critical thinking skills in physics subject at *SMAN 3 Kota Bengkulu* | The guided inquiry model has a significant impact on improving students' critical thinking skills in the subject of work and energy. |
| 12 | Ogegbo & Ramnarain, 2022 | Teaching and learning Physics using interactive simulation: A guided inquiry practice | The use of interactive simulations based on guided inquiry effectively improves students' learning outcomes, thinking skills, and metacognitive abilities in physics. |
| 13 | Hiğde, 2022 | An Interdisciplinary Renewable Energy Education: Investigating the Influence of STEM Activities on Perception, Attitude, and Behavior | Design-based STEM learning in the context of renewable energy shows promise in enhancing critical thinking, perceptions, attitudes, and behaviors regarding energy sustainability issues. |
| 14 | Akpokiniovo, 2022 | Effects of Self-Instruction and Guided Inquiry Teaching Strategies on Secondary School Physics Students' Achievement | Self-directed learning yields the highest academic achievement, followed by guided inquiry, and both are more effective than the lecture method in improving physics learning outcomes. |
| 15 | Septyowaty et al., 2023 | Application of the Guided Inquiry Model to Improve Psychomotor Skills and Interest in Learning Physics | The guided inquiry model enhances students' psychomotor skills and interest in learning through active engagement in the scientific process. |
| 16 | Worachak et al., 2023 | Analysis Of Critical Thinking Skills In Problem-Based Learning And Inquiry Learning Models | Problem-based learning and inquiry-based learning are effective in enhancing students' critical thinking skills, as these learning approaches encourage analysis, problem-solving, and scientific reasoning. |
| 17 | Affilia et al., 2023 | Critical Thinking Skills Improvement of Students Through Guided Inquiry Learning Model with Scientific Approach | The implementation of guided inquiry using a scientific approach significantly improves students' critical thinking skills, with a high level of improvement. |
| 18 | Lathifa & Hufri, 2023 | Comparison of Guided Inquiry Learning Models with Direct Instruction Learning Models on Physics Learning Outcomes | The guided inquiry model yields better learning outcomes than direct instruction when teaching vectors and linear motion. |
| 19 | J. K. Putri et al., 2024 | Implementation of Guided Inquiry to Increase Students' Interest in Learning Physics and Critical Thinking Skills | Guided inquiry-based laboratory activities are effective in moderately improving students' critical thinking skills and interest in learning, with optimal results when supported by effective lesson planning. |
| 20 | Alanazi et al., 2024 | Effect Of Scaffolding Strategies And Guided Discovery On Higher-Order Thinking Skills In Physics Education | Scaffolding and guided discovery strategies are more effective than conventional methods in enhancing students' Higher Order Thinking Skills (HOTS) in physics instruction. |

| | | | |
|---|---|---|---|
| 21 | Dayu et al., 2025 | The Effectiveness of Guided Inquiry Learning Model with Digital Simulations to Enhance Students' Critical Thinking Skills in Physics | The integration of guided inquiry with digital simulations effectively enhances students' critical thinking skills, engagement, and conceptual understanding, although it remains limited to specific samples and contexts. |
| 22 | Maolani et al., 2025 | Application Of Guided Inquiry Model To Improve The Ability And Critical Thinking Disposition Of Senior High School Students In Physics Learning. | The guided inquiry learning model has been shown to significantly improve students' critical thinking skills and dispositions, and demonstrates a positive correlation between the two in physics education. |
| 23 | Majid et al., 2025 | Integrating energy literacy into science education: a comprehensive systematic review | Energy education based on a transdisciplinary approach, experimentation, and active learning effectively enhances students' energy literacy, understanding of sustainability, and readiness to address global energy challenges. |
| 24 | Sriatun et al., 2025 | Strategies for Promoting Energy Literacy in Physics Education: Insights from a Systematic Literature Review | Integrating energy and environmental education through active learning methods such as project-based learning effectively improves students' attitudes and awareness regarding energy issues, and makes the learning process more contextual through the incorporation of local wisdom. |
| 25 | Htet Sandy, 2025 | Enhancing Renewable Energy Education Through Practical Applications in Grade-12 Physics: A Case Study in Myanmar | Experience-based learning using a renewable energy toolkit shows promise in enhancing student engagement and understanding; however, its implementation requires curriculum support, teacher training, and sustainable policies. |
| 26 | Satriawan et al., 2025 | Pre-service physics teachers' readiness and perceptions in implementing renewable energy-focused STEM learning media to support SDG 7 | The pedagogical readiness and energy literacy of prospective physics teachers in STEM-based learning are significantly influenced by their teaching experience; therefore, there is a need to strengthen field practice and technology-based training. |
| 27 | Satriawan et al., 2026 | The landscape of renewable energy awareness: Cognitive, affective, conative, and reflective analysis as a foundation for strengthening sustainable energy literacy | Students' awareness of renewable energy is influenced by gender and grade level; therefore, efforts to strengthen energy literacy should be implemented in a gradual, contextual, and reflective manner within physics instruction. |

Based on Table 1, it can be observed that most studies confirm the effectiveness of inquiry-based physics learning—particularly guided inquiry—in enhancing students' higher-order thinking skills (HOTS), especially in the areas of critical thinking, problem-solving, and scientific reasoning. The implementation of inquiry combined with various approaches, such as blended learning, laboratory work, and digital simulations, has proven capable of increasing students' active engagement in the learning process. This indicates that inquiry serves not only as a learning strategy but also as an approach capable of fostering meaningful, student-centered learning experiences.

The analysis also shows that most studies still focus on improving cognitive abilities without explicitly integrating the context of renewable energy into learning. While some studies have begun to link learning to energy issues, they remain limited to STEM approaches or energy literacy without systematic reinforcement within an inquiry framework. This indicates a research gap, where the integration of inquiry-based learning, renewable energy contexts, and the reinforcement of students' higher-order thinking skills (HOTS) has not been comprehensively examined; thus, the development of more contextual learning models relevant to global energy challenges is needed.

## 4. Discussion

The analysis of 27 articles shows that inquiry-based physics learning significantly supports students' Higher-Order Thinking Skills (HOTS) through investigation, analysis, and problem-solving activities. However, most studies still focus on testing the effectiveness of inquiry models and mainly measure HOTS through critical thinking, without comprehensively addressing analysis, evaluation, creativity, and problem-solving. Moreover, the renewable energy context has not been explicitly integrated into inquiry-based physics learning. This indicates a gap between HOTS development and contextual learning related to global sustainability challenges.

### 4.1. Methodological Trends in Previous Studies

Table 2 below provides a more systematic overview of the distribution of research methods used in this study.

Table 2. Research Methodology

| No | Author and Year | Research Methodology | Frequency |
|---|---|---|---|
| 1 | Zain & Jumadi, 2018; Pratiwi et al., 2019; Husnaini & Chen, 2019; Maknun, 2020; Phonna et al., 2020; Medriati et al., 2021; Akpokiniovo, 2022; Lathifa & Hufri, 2023; Alanazi et al., 2024; Dayu et al., 2025; Maolani et al., 2025 | Quasi-Experimental | 11 |
| 2 | S. R. Putri & Syafriani, 2020; Satriawan et al., 2025; Satriawan et al., 2026 | Quantitative Descriptive / Survey | 3 |
| 3 | Worachak et al., 2023; Sriatun et al., 2025 | Systematic Literature Review (SLR) | 2 |
| 4 | Russo & Persano Adorno, 2018; Rodriguez et al., 2020 | Design-Based Research (DBR) | 2 |
| 5 | Nisa et al., 2018; J. K. Putri et al., 2024 | Research and Development (R&D) | 2 |
| 6 | Hiğde, 2022; Affilia et al., 2023 | Pre-Experimental | 2 |
| 7 | Ogegbo & Ramnarain, 2022; Htet Sandy, 2025 | Mixed Methods | 2 |
| 8 | Majid et al., 2025 | Review Integratif (PRISMA) | 1 |
| 9 | Septyowaty et al., 2023 | Classroom Action Research (CAR/PTK) | 2 |
| 10 | Lämsä et al., 2018 | Technology-Enhanced Collaborative Inquiry Analysis | 1 |

Based on Table 2, the classification results for the 27 articles that met the criteria show that the quasi-experimental method was the most commonly used approach, appearing in 11 articles. This dominance indicates that research in inquiry-based physics learning tends to focus on testing the effectiveness of learning models in improving students' learning outcomes and higher-order thinking skills (HOTS). The quasi-experimental method can be used as an empirical comparison of the impact of implementing learning models in relatively real classroom conditions; this provides strong evidence of the successful implementation of inquiry-based physics learning. The quantitative descriptive/survey method was found in 3 articles and was used to analyze initial conditions, learning needs, and the readiness levels of students and educators in the context of physics learning.

The systematic literature review (SLR) approach used in the two articles played a role in systematically analyzing the findings of previous research. A PRISMA-based integrative review in one article provided a more comprehensive analysis of the development of studies in this field. Design-based research (DBR) and research and development (R&D) methods were used in two articles focused on the development of inquiry-based learning tools and designs. These methods demonstrate an effort not only to test the effectiveness of learning but also to design continuous learning innovations. Pre-experimental and mixed-methods approaches were used in two articles, while classroom action research (CAR/PTK) and other methods found in only one article indicate that such approaches remain rarely employed in inquiry-based physics learning studies.

### 4.2. Inquiry-Based Learning Model

The analysis of the 27 reviewed articles shows that inquiry-based learning, particularly guided inquiry, is the most frequently used model in physics education. This model is considered effective in promoting students' active engagement, conceptual understanding, and HOTS. Its implementation also varies through integration with digital technology, blended learning, virtual simulations, laboratory activities, scientific approaches, STEM, and problem-based learning. These variations indicate that inquiry-based learning is flexible and adaptable to different physics topics, learner characteristics, and technological developments. However, most studies still emphasize procedural implementation and learning outcomes, while the integration of inquiry with contextual issues such as renewable energy remains limited. Thus, the use of inquiry-based learning as a strategy to connect physics instruction with global sustainability challenges still needs further development.

### 4.3. Analysis of Strengths and Challenges

The reviewed studies show that inquiry-based physics learning has several strengths, particularly in improving students' active engagement, conceptual understanding, and critical thinking as part of Higher-Order Thinking Skills. Its integration with blended learning, laboratory activities, digital simulations, and scientific approaches further supports learning effectiveness. However, most studies still focus on procedural implementation and general learning outcomes, while the renewable energy context has not been explicitly integrated into inquiry-based physics instruction. In addition, HOTS assessment is often limited to critical thinking and does not comprehensively address creativity, problem-solving, analysis, and evaluation. This limitation highlights the need for inquiry-

based physics learning that is pedagogically effective, contextually connected to renewable energy issues, and capable of strengthening students' HOTS more comprehensively.

## 5. Conclusion

Based on the results of a review of 27 analyzed articles, it can be concluded that inquiry-based physics learning, particularly guided inquiry, has proven effective in enhancing students' HOTS, especially in terms of critical thinking, conceptual understanding, and active engagement in the learning process. Nevertheless, most studies still show limitations in explicitly integrating the context of renewable energy and have not comprehensively examined HOTS across its various dimensions. This indicates that inquiry-based learning still needs further development so that it not only focuses on pedagogical effectiveness but is also capable of presenting a learning context relevant to global issues. The uniqueness of this study lies in its proposal for a theoretical integration of inquiry-based learning, the context of renewable energy, and HOTS into a single conceptual framework. This framework explains how renewable energy issues can serve as contextual inquiry problems, as well as how each stage of inquiry-based learning can be aligned with HOTS dimensions, particularly analysis, evaluation, and creation. Therefore, this study provides a conceptual foundation for the future development of inquiry-based physics learning designs that are contextual, sustainability-oriented, and driven by HOTS. Overall, the integration of inquiry-based learning models, renewable energy contexts, and the strengthening of HOTS is an urgent necessity to realize physics learning that is more contextual, meaningful, and oriented toward future challenges.

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