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Guided Inquiry Based Physics E-Module to Enhance Students' Conceptual Understanding and Learning Attitudes: A Literature Review

Literature Review

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Abstract

This study aims to review the quality of guided inquiry-based learning module development and its contribution to students' scientific literacy, academic language use, and discourse-based conceptual understanding in Physics learning. The method employed was a literature review examining 50 articles on guided inquiry-based learning material development published between 2018 and 2025. From these, 10 of the most relevant articles were selected using the PRISMA procedure for in-depth analysis through content analysis techniques. The results indicate that various learning products, including modules, e-modules, worksheets, digital comics, and interactive learning media, achieved very valid and very practical categories based on evaluations by experts, teachers, and students. Furthermore, guided inquiry-based learning consistently supports the development of students' conceptual understanding as reflected in their ability to interpret scientific texts, construct explanations, use scientific terminology appropriately, and engage in argumentation, as well as fostering positive learning attitudes manifested through increased engagement, collaborative communication, and reflective discourse during learning activities. In conclusion, guided inquiry-based learning modules are feasible for implementation and demonstrate strong potential in enhancing the quality of Physics learning, particularly in promoting students' scientific literacy and language-mediated learning processes across various educational levels.

Keywords: Conceptual Understanding, E-Module, Guided Inquiry, Learning Attitude.

1. Introduction

Critical thinking skills, conceptual understanding, learning independence, and problem-solving skills are essential competencies in 21st-century education. In the context of science education, these competencies are closely related not only to cognitive processes but also to students' academic language development and scientific literacy, as learning science requires interpreting texts, constructing explanations, engaging in argumentation, and communicating evidence-based reasoning. However, various studies indicate that learning processes in schools and universities remain dominated by conventional, teacher-centered approaches that provide limited opportunities for students to actively construct knowledge through inquiry and scientific discourse. This condition contributes to low learning outcomes, minimal inquiry-based activities, and underdeveloped higher-order thinking and language-mediated reasoning skills (Damayanti & Panggabean, 2025).

Previous studies across disciplines such as Physics, Chemistry, Biology, Mathematics, and Islamic Religious Education report that students experience difficulties in understanding abstract concepts, engaging in learning activities, and maintaining learning motivation (Indayani & Danial, 2022). From a literacy perspective, these difficulties are often associated with students' limited ability to comprehend scientific texts, use discipline-specific

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terminology, and articulate reasoning processes verbally and in writing. Furthermore, many teaching materials currently used by teachers are non-interactive, weakly grounded in scientific processes, and lack structured activities that support scientific communication, argumentation, and critical reading, which are core components of academic literacy in science education (Safitri et al., 2021).

Inquiry-based learning has been widely recommended as an effective approach to address these challenges. This approach positions students as active participants in learning through stages of observing, questioning, formulating hypotheses, collecting and analyzing data, and drawing conclusions. From a language and literacy perspective, inquiry-based learning promotes meaningful use of scientific language, encourages students to negotiate meaning through discussion, and supports the development of written and oral scientific explanations. Research in science education highlights that inquiry activities foster scientific literacy by integrating conceptual understanding with language practices such as explanation, argumentation, and evidence-based communication (Ariyaldi et al., 2020; Nugroho et al., 2018; Rais et al., 2021).

A review of 50 studies reveals consistent patterns in inquiry-based teaching material development. Most studies employ the ADDIE or 4D development models, involve expert validation, practicality testing by teachers and students, and effectiveness evaluation using pretest-posttest designs. Nearly all developed products including e-modules, worksheets, printed modules, Android-based media, and interactive multimedia which achieve very valid and very practical categories and demonstrate effectiveness in improving students' learning outcomes across educational levels, from elementary school to higher education (Gumay & Syabawaihi, 2024). Importantly, several studies also report improvements in students' ability to communicate scientific ideas, interpret representations, and engage in reflective learning discourse.

Based on these conditions, this literature review aims to map research trends in inquiry-based teaching material development, analyze the methodological quality of existing studies, and examine the contribution of inquiry-based approaches to improving student competencies, particularly scientific literacy and academic language use in science learning. This study is expected to provide a comprehensive overview of the effectiveness of inquiry-based learning materials and to inform future research directions that integrate inquiry, content mastery, and language development in science education.

2. Methods

This study employs a literature review as a form of library research aimed at synthesizing findings from 50 articles related to the development of inquiry-based teaching materials. A literature review was selected because it allows for a comprehensive examination of research trends, development models, product quality, and the effectiveness of inquiry-based materials in improving student learning outcomes, including language-mediated learning processes in science education (Damayanti & Panggabean, 2025).

Articles were retrieved from five scientific databases: Google Scholar, SINTA, DOAJ, ERIC, and ScienceDirect. The use of multiple databases was intended to broaden the scope of the search and ensure diversity of sources. The initial corpus consisted of 50 articles published between 2018 and 2025. The selection process followed the PRISMA procedure, with additional linguistic-based inclusion criteria, namely that the articles explicitly report learning activities involving scientific communication, explanation, argumentation, interpretation of scientific texts or representations, or the use of academic/scientific language within inquiry-

based learning materials. Through this process, 10 articles were identified as the most relevant for in-depth analysis, ensuring both methodological rigor and relevance to academic literacy in science education (Safitri et al., 2021).

The research objects are scholarly articles on the development of inquiry-based teaching materials, including modules, e-modules, worksheets (LKS/LKM), handouts, Android-based media, and interactive multimedia. Article selection was guided by the following inclusion criteria: (1) the study is development research; (2) the teaching materials employ an inquiry-based approach; (3) the study reports validity and/or practicality data; (4) the study includes learning activities that involve language use such as reading scientific texts, constructing written or oral explanations, discussion, or argumentation; and (5) the article is published in peer-reviewed journals or conference proceedings (Indayani & Danial, 2022).

The research procedure consisted of several stages. First, articles were screened based on titles, abstracts, and thematic relevance, including the presence of inquiry processes and academic language elements. Second, a full-text review was conducted to assess methodological quality, particularly the development models used (e.g., ADDIE and 4D), as well as the integration of inquiry stages with communicative and literacy-oriented learning activities (Ariyaldi et al., 2020; Rais et al., 2021). Third, data extraction was carried out to collect information on research objectives, types of teaching materials developed, participants, validation procedures, practicality testing by teachers and students, effectiveness results, and reported language-related learning outcomes such as explanation skills, use of scientific terminology, and student discourse participation (Gumay & Syabawaihi, 2024).

The primary instrument used in this study was a data extraction sheet designed to systematically map similarities and differences across articles. In addition to general development indicators, the instrument included specific indicators for academic language and scientific literacy, such as the presence of text-based inquiry tasks, guided questioning, argumentation activities, reflective writing, and opportunities for oral scientific communication. The extracted data were analyzed using thematic analysis, grouping findings into key themes including development models, validity, practicality, effectiveness, and the role of inquiry-based materials in supporting academic language use and scientific discourse (Nugroho et al., 2018).

Data analysis was conducted using a descriptive-comparative approach by comparing findings across studies to identify general patterns and research trends. Particular attention was given to how inquiry-based teaching materials facilitate not only cognitive outcomes such as critical thinking, science process skills, and conceptual understanding, but also language-mediated outcomes, including students' ability to interpret scientific information, articulate reasoning, and engage in collaborative learning discourse (Safitri et al., 2021). Through this approach, the research method provides a comprehensive overview of both the methodological quality and the linguistic contributions of inquiry-based teaching material development across subjects and educational levels.

3. Results and Discussion

3.1. Research Results

The results of this study were synthesized from ten selected articles obtained through the PRISMA procedure. The analysis focused not only on the quality of guided inquiry-based teaching material development, but also on how these materials facilitate scientific discourse practices and academic language use during learning activities. All reviewed studies

implemented guided inquiry in various formats of teaching materials, including e-modules, printed modules, worksheets (LKS/LKM), interactive multimedia, and thematic handouts.

Overall, the findings indicate a consistent trend of high validity and practicality of inquiry-based teaching materials. Beyond improvements in learning outcomes, the reviewed studies reveal that guided inquiry materials systematically embed language-mediated inquiry processes, such as problem formulation, hypothesis articulation, interpretation of representations, explanation construction, and conclusion writing. These processes support students in developing scientific discourse competencies, including the ability to use scientific terminology, construct coherent explanations, and engage in reflective and collaborative discussions.

Although the primary indicators reported in most studies are conceptual understanding and learning attitudes, further synthesis shows that these outcomes are closely linked to students' engagement with multimodal learning resources, including text, diagrams, animations, simulations, symbols, and interactive tasks. The diversity of media formats enables students to negotiate meaning through multiple semiotic modes, thereby strengthening conceptual understanding alongside academic language development. The article selection process was conducted systematically using the PRISMA framework, as presented in Table 1, to ensure the relevance and quality of the included studies. To provide a structured overview of these characteristics, the findings of each study are summarized in Table 2, highlighting variations in teaching materials, inquiry activities, and learning indicators.

Table 1. Article Selection Flow Using PRISMA

PRISMA Stage	Selection Process	Number of Articles (n)	Notes
Identification	Articles found through searches on five databases (Google Scholar, SINTA, DOAJ, ERIC, ScienceDirect)	250	Search using keywords: *inkuiri terbimbing*, guided inquiry, *pengembangan modul, e-modul inkuiri*, etc.
	Article duplications removed	-130	Articles appearing repeatedly across several databases were eliminated
Screening	Articles screened based on title and abstract	120	Irrelevant articles were excluded
Eligibility	Articles eliminated at screening stage	-70	Not suitable topic, not R&D, or not relevant to guided inquiry
	Full-text articles assessed for eligibility	50	Checked for development model suitability, validity data, practicality, effectiveness
Included	Final articles analyzed in depth	10	Most relevant and quality articles according to study focus

Table 2. Research Summary Related to E-Modules, Guided Inquiry, Conceptual Understanding, and Learning Attitudes

Code	Research Title	Research Results
A1	*Pengembangan E-Modul Pembelajaran Fisika Berbasis Inkuiri Terbimbing pada Materi Suhu dan Kalor Kelas XI SMA* (Damayanti & Panggabean, 2025)	The e-module was declared very valid by material and media experts. Practicality testing showed very good responses from teachers and students. The e-module improved students' conceptual understanding with N-Gain 0.70 (high category). Inquiry activities such as formulating problems, testing hypotheses, and drawing conclusions proved to make students more active, directed, and easily

Code	Research Title	Research Results
		understand abstract concepts of temperature and heat.
A2	*Pengembangan E-Modul Asam Basa Berbasis Inkuiri Terbimbing Berbantuan Flip PDF Professional* (Indayani & Danial, 2022)	The e-module obtained high validity scores (>85%) from material, media, and language experts. Very high practicality was shown by positive teacher and student responses. The e-module significantly improved learning outcomes with 86.5% completion, and helped students master acid-base concepts through digital simulation, pH visualization, and structured inquiry activities.
A3	*Pengembangan Media Pembelajaran Interaktif Berbasis Adobe Flash CS6 untuk Meningkatkan Motivasi dan Hasil Belajar pada Materi Kesetimbangan Kimia* (Harahap & Siregar, 2020)	Interactive media was declared valid, practical, and effective. The use of animated visuals helped students understand equilibrium factors (Le Chatelier). Besides improving learning completion, this media also increased motivation, curiosity, and critical thinking skills, because students were involved in inquiry-based virtual experiments.
A4	*Pengembangan Modul Pembelajaran Matematika dengan Metode Inkuiri pada Materi Segi Empat dan Segitiga* (Safitri et al., 2021)	The module obtained high validity and was easy to use. Implementation of inquiry improved critical thinking skills, especially in identifying plane figure properties and solving problem-solving questions. Students became more independent and active during observing, questioning, and problem-solving phases.
A5	*Kelayakan Teoretis E-Modul berbasis Inkuiri Materi Perubahan Lingkungan untuk Melatihkan Keterampilan Berpikir Kritis Siswa Kelas X* (Azizah & Rachmadiarti, 2023)	The e-module was assessed as very feasible theoretically, based on validation by material, media, and learning experts. The e-module structure guides students to observe environmental phenomena, analyze cause and effect, and draw conclusions. This e-module has strong potential to improve critical thinking skills, environmental awareness, and understanding of ecosystem change concepts.
A6	*Pengembangan Modul Elastisitas Berbasis Inkuiri Terbimbing untuk Mengembangkan Disiplin Belajar dan Kreativitas Siswa SMK* (Nugroho et al., 2018)	The module was very feasible to use and improved understanding of elasticity concepts. The use of inquiry approach made students more disciplined in experiments and increased creativity and scientific attitudes. This module also reduced misconceptions that often appear in elasticity material.
A7	*Pengembangan Modul Pembelajaran Dinamika Gerak Berbasis Inkuiri Terbimbing Untuk Siswa Kelas X SMA/MA* (Setianingsih et al., 2018)	The module was declared very valid and effective in improving understanding of motion dynamics concepts. Pretest-posttest testing showed significant reduction in misconceptions and increased scientific thinking skills. Students more easily understood force, acceleration, and the F=ma relationship through inquiry experiments.
A8	*Pengembangan Multimedia Interaktif Kimia Berbasis Inkuiri Terbimbing Untuk Pembelajaran Materi Pokok Hidrokarbon dan Minyak Bumi Kelas XI MIA* (Nugraheni et al., 2019)	Interactive multimedia obtained high validity scores (>3.3). Presented animations of hydrocarbon structures, chemical reactions, and visual modeling that facilitated conceptual understanding. Effective in improving learning outcomes, motivation, and ability to predict reaction patterns. Liked by students because it was more attractive than lecture methods.
A9	*Pengembangan Lembar Kerja Mahasiswa (LKM) Berbasis Inkuiri pada Materi Interaksi Molekuler* (Bare & Sari, 2021)	LKM was declared very valid and easy for students to use. LKM improved students' ability to analyze intermolecular forces, understand particle interactions, and construct scientific explanations.

Code	Research Title	Research Results
		Provided positive impact on learning independence and engagement during learning.
A10	*Pengembangan Handout Tematik Berbasis Model Inkuiri di Sekolah Dasar* (Yulandari & Mustika, 2021)	Handout obtained 88-95% validity and 96-97% practicality. Very helpful for elementary students in understanding thematic material through simple inquiry steps such as observing, grouping, and concluding. Handout also increased activeness, curiosity, and positive learning attitudes.

3.2. Discussion

The synthesis of 50 reviewed articles demonstrates a strong tendency in educational research toward the development of inquiry-based learning media, modules, and instructional tools designed to meet the demands of 21st-century learning. While most studies report improvements in learning outcomes, a deeper analysis reveals that guided inquiry-based teaching materials also play a significant role in fostering scientific discourse and academic language practices. Through inquiry stages such as questioning, hypothesizing, data interpretation, and conclusion drawing, students are required to articulate ideas, justify reasoning, and communicate findings using discipline-specific language.

For instance, Damayanti & Panggabean (2025) show that inquiry-based e-modules in Physics not only improve students' understanding of temperature and heat concepts, but also guide learners to formulate problems, interpret data tables and graphs, and express conclusions in structured written form. Similarly, Azizah & Rachmadiarti (2023) highlight that inquiry-based e-modules on environmental change encourage students to analyze phenomena, explain causal relationships, and communicate findings through reflective tasks, which are central components of scientific literacy.

In the field of Chemistry, studies by Nugraheni et al. (2019) emphasize the importance of multimodality in inquiry-based learning media. Interactive multimedia combining text, animation, symbolic representations, and simulations support students in understanding abstract chemical concepts such as hydrocarbon structures and chemical equilibrium. These multimodal elements function not only as visual aids but also as semiotic resources that help students construct meaning, interpret representations, and verbalize scientific explanations more accurately.

The integration of inquiry and multimodal media is also evident in Mathematics education. Safitri et al. (2021) report that inquiry-based mathematics modules encourage students to describe geometric properties, explain problem-solving steps, and justify answers using appropriate mathematical language. This finding indicates that inquiry-based approaches contribute to the development of discipline-specific discourse, extending beyond procedural understanding.

At the vocational and higher education levels, studies by Nugroho et al. (2018) and Bare & Sari (2021) further demonstrate that guided inquiry-based modules and worksheets support students in engaging with experimental reports, analytical discussions, and scientific explanations. Students are trained to communicate experimental results, reduce misconceptions through evidence-based reasoning, and participate actively in collaborative inquiry discourse. These practices strengthen both conceptual mastery and academic communication skills.

At the elementary level, thematic inquiry-based handouts developed by Yulandari (2021) show that even simple inquiry stages such as observing, classifying, and concluding can foster early forms of scientific language development. Students are encouraged to describe observations verbally, use basic scientific vocabulary, and express conclusions in their own

words, indicating the foundational role of inquiry in developing academic literacy from an early age.

Overall, the reviewed studies indicate that inquiry-based teaching materials are not only effective in improving learning achievement, but also in supporting scientific discourse development through multimodal learning environments. The combination of inquiry processes with text, visuals, animations, and interactive tasks enables students to engage in meaning-making activities that integrate cognition and language. Therefore, guided inquiry-based learning materials have strong potential to enhance science education by simultaneously promoting conceptual understanding, scientific communication, and academic language development across educational levels.

4. Conclusion

Based on the synthesis of ten articles selected through the PRISMA procedure due to their relevance to the study focus, it can be concluded that the development of guided inquiry-based teaching materials such as e-modules, printed modules, worksheets (LKS/LKM), interactive multimedia, and thematic handouts demonstrates very high quality in terms of validity, practicality, and effectiveness. All analyzed teaching materials achieved very valid categories based on evaluations by material, media, and learning experts, and were consistently rated as very practical by teachers and students.

Beyond cognitive learning outcomes, the findings indicate that structured inquiry-based approaches contribute significantly to the development of scientific literacy and academic language skills. The inquiry stages of observing, problem formulation, hypothesis construction, investigation, data analysis, and conclusion drawing require students to engage in language-mediated learning processes, such as interpreting scientific texts and representations, using discipline-specific terminology, constructing written and oral explanations, and participating in inquiry-based discussions. These activities support the development of scientific discourse alongside conceptual understanding.

Further, the integration of digital teaching materials particularly e-modules and interactive multimedia enhance learning through multimodal representations, including text, visuals, animations, symbols, and simulations. Such multimodal environments facilitate meaning-making processes by enabling students to connect conceptual knowledge with appropriate scientific language and representations. In addition, inquiry-based learning materials positively influence learning attitudes by fostering curiosity, motivation, independence, and reflective thinking, which are closely linked to students' confidence in communicating scientific ideas.

Overall, this study concludes that guided inquiry-based teaching materials have strong potential not only to improve the quality of science learning outcomes, but also to promote academic literacy, scientific communication skills, and language-based reasoning across various educational levels. Therefore, the development and implementation of inquiry-based teaching materials are highly recommended as an effective strategy for integrating content mastery with language and literacy development in science education.

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