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Development of an Inquiry-Based Physics Laboratory Module Integrating a Traditional Catapult for Teaching Energy Conservation

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ABSTRACT

Direct formula-based instruction in physics often limits students' engagement in conceptual discovery and the development of their mathematical, scientific, and literacy skills. The catapult, as a traditional game, has the potential to serve as a contextual learning medium that illustrates physics concepts. This project seeks to create an inquiry-based physics laboratory module that incorporates the traditional catapult game to teach the law of conservation of energy, evaluate its feasibility, and analyze its applicability for 10th-grade students. This study utilizes a Research and Development methodology grounded in the Cennamo and Kalk model, encompassing the steps of definition, design, demonstration, development, and delivery. The result is a printed laboratory module that combines inquiry activities with local cultural contexts. The feasibility test findings were analyzed by professionals using Aiken's V, while practicality was evaluated through student response questionnaires. The findings reveal that the module demonstrated significant validity, as evidenced by an Aiken's V score exceeding the minimal permissible threshold, and considerable practicality. This module supports students in exploring the concept of energy conservation through inquiry-based experiments while promoting cultural literacy. Therefore, the developed module can serve as an innovative and relevant learning resource for students.

ARTICLE INFORMATION

Keywords:
catapult; energy; inquiry; laboratory module

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INTRODUCTION

Education is at the forefront of human resource development, preparing individuals to compete in an increasingly advanced and modern society (Sudarmono et al., 2021). The Program for International Student Assessment (PISA) serves as a global benchmark for educational excellence by evaluating students' competency in mathematics, science, and reading. However, Indonesia's PISA scores over the past 10 to 15 years have not shown a significant increase, placing it among countries with consistently low performance (Winata et al., 2021). This outcome indicates a need for improved learning in mathematics, science, and literacy in schools. Physics is one subject that combines these three disciplines. However, research indicates that most students view physics as a challenging subject because the learning process has not yet enabled them to relate concepts to real-world events (Astuti & Bhakti, 2022).

Additionally, overreliance on presenting formulas directly leads students to struggle to deeply understand concepts (Ulfani et al., 2022). This is also consistent with the literature review and field findings by Rizkita and Mufit (2022), which indicate that teachers tend to present formulas immediately, thereby limiting students' active involvement in the process of independently

discovering and constructing concepts. The learning process is also generally abstract and not accompanied by practice or experiments, whether in real life or in a virtual setting (Delvia et al., 2021). In fact, learning through experiments (experimental learning) provides a deeper understanding than the direct presentation of formulas.

Observations and interviews at several schools in Semarang indicate that experimental activities are still rarely conducted due to time constraints and a lack of laboratory equipment. Furthermore, the results of a needs assessment survey conducted among students at Nasima High School in Semarang revealed that the majority expressed a strong interest in learning physics through experimentation. One solution for experiment-based learning is to implement inquiry-based learning. This methodology is a scientific approach to thought exploration (scientific inquiry) commonly practiced by scientists (Hartanto et al., 2018). According to interviews conducted by Budi (2021), low student learning outcomes in physics classes may result from a lack of experience with inquiry-based learning. In this approach, students conduct experiments or practical work themselves to discover scientific concepts through the analysis of phenomena. The analysis used in these experiments is adapted to phenomena around the students, including cultural phenomena. Physics learning that analyzes cultural concepts is called ethnoscience. Ethnoscience surrounding students helps make learning easier because students directly observe and experience the application of indigenous science in society, such as in the catapult game (Haspen et al., 2021). The catapult, as a traditional game, still exists and has the potential to serve as a contextual learning medium that links physics concepts to daily life. The concept addressed is energy conservation, a material for 10th grade in the Merdeka Curriculum. A practical experiment utilizing the conventional catapult game was conducted to gather data on the correlation among spring potential energy, kinetic energy, and gravitational potential energy. Students analyzed this data to formulate equations that helped them understand the concept of energy conservation.

Various studies have developed inquiry-based and ethoscience-based learning tools for physics education. Inquiry-based learning tools can facilitate students in conducting scientific practices and activities aligned with the material being studied (Kurniati et al., 2018). The framework of this learning paradigm comprises orientation, conceptualization, investigation, conclusion, and discussion (Nurwahid et al., 2024; Nulhakim et al., 2022; Pedaste et al., 2015; Siregar et al., 2023). Furthermore, a study indicated that incorporating conventional games into physics training through contextual, inquiry-based, problem-based, and project-based methodologies might facilitate efficient, adaptable learning, enabling students to explore their capabilities effectively (Putranta et al., 2021). Nevertheless, the majority of these studies have focused on creating instructional materials that use cultural phenomena broadly. No research has yet been found that specifically integrates the traditional catapult game as a real experimental object into an inquiry-based lab module on energy conservation. In fact, such a development could not only enhance students' conceptual understanding but also improve their scientific process skills and cultural literacy.

The traditional catapult game was chosen not only because it is relevant to students' daily lives but also because it aligns with the characteristics of the inquiry-based learning approach. A study revealed that, through training and guidance, the catapult can foster collective awareness, strengthen local cultural identity, and instill motor, social, and character values in students (Rijal, 2025). In this game, students can directly observe the conversion of elastic potential energy into kinetic energy and, subsequently, into gravitational potential energy through straightforward experiments conducted in a school environment. This helps students build an understanding of energy conservation through the observation and analysis of experiments, rather than simply memorizing formulas. Thus, integrating the traditional catapult game not only presents learning in a cultural context but also serves as a means to develop scientific process skills and cultural literacy.

Implementing inquiry-based experiments requires a laboratory module that integrates the investigative process with the cultural context of the catapult game. This laboratory module serves as a medium that encourages students to construct and formulate concepts through hands-on experiments without developing misconceptions. However, no inquiry-based laboratory modules integrated with the catapult game have yet been identified in educational settings. The learning tools frequently used in schools are student worksheets and commercial textbooks (Sarwi & Subali, 2019). This indicates that the development of innovative modules remains limited. The scarcity of structured modules and teachers' lack of readiness make inquiry-based learning rarely practiced in the classroom (Aminah et al., 2021).

Furthermore, research in South Africa indicates that resource, material, time, and access limitations to interactive simulations pose challenges for inquiry-based learning practices internationally (Akuma & Callaghan, 2019). Boring teaching methods also make it difficult for students to learn and understand physics (Ihsan et al., 2022). This results in physics instruction that is purely theoretical (Sawitri et al., 2021) and teacher-centered, with low student engagement (Ningrum et al., 2019). These conditions result in a lack of scientific process skills and cultural literacy among students. Therefore, this work seeks to create a physics laboratory module that incorporates inquiry-based learning alongside the standard catapult game. The developed module will be analyzed to identify its characteristics, assess its feasibility, and evaluate its practicality in classroom instruction. This study's uniqueness resides in the incorporation of inquiry-based learning and experiments using a catapult as an ethoscience context, an approach that has not been widely combined in previous research. This development is expected to provide a viable and practical alternative teaching tool, enrich ethoscience studies in physics, and address the limitations of previous research, which generally focused on only one aspect in isolation.

METHOD

This study utilizes a research and development (R&D) technique grounded in the Cennamo and Kalk paradigm. This method is also known as the ASC cycle (Ask, Solve, and Check) (Kalk & Cennamo, 2003). This model consists of five instructional design phases: the define phase, the design phase, the demonstrate phase, the develop phase, and the deliver phase (Cennamo & Kalk, 2019). The research activities began with the define phase from September to October 2026, the design phase from November to December 2026, the demonstrate phase in January 2026, the develop phase, which included product validation in February 2026 and field testing from February through March to April 2026, and the disseminate phase in May 2026. The define phase was executed by a literature study of prior linear studies and field research that included observation and the dissemination of needs assessment questionnaires; the design phase involved establishing the product design, designing learning objectives, and determining learning strategies; the demonstrate phase was carried out through the creation of a product prototype and limited-scale testing; the develop phase was carried out through the development of the final product, expert validation, and refinement; and the deliver phase was carried out by presenting the module on a large scale to assess the product's practicality.

The study was carried out at Nasima High School in Semarang. This school was selected because its student population aligns with the requirements for developing the laboratory module. Participants in the research were chosen by purposive sampling. This strategy entails selecting individuals based on attributes and features anticipated to yield pertinent information for the investigation (Hadi, 2015). The selected subjects were students from classes X.1 and X.2 for the 2025/2026 academic year, each consisting of 19 students.

The data acquired from this study comprises qualitative data, including descriptions, assertions, narratives, and images, alongside quantitative data represented by numerical values (Sugiyono,

2017). Both types of data were collected using non-test instruments that were first validated by experts (expert judgment) to ensure reliability and unbiasedness. The expert validation was performed to confirm that each item in the instrument adequately reflected the construct being measured, therefore ensuring content validity prior to the data collection phase. Table 1 presents the data gathering procedures, instruments, and analytic methods.

Table 1. Data collection methods, data collection instruments, and data analysis methods

Data Types	Data Collection Methods	Data Collection Instruments	Data Analysis Methods
Qualitative	Observation	Observation sheet	Descriptive
Qualitative	Documentation	Supporting document sheet	Descriptive
Quantitative	Questionnaire	Needs assessment questionnaire	Percentage
Quantitative	Questionnaire	Readability questionnaire	Percentage
Quantitative	Questionnaire	Feasibility validation questionnaire	Aiken's Formula
Quantitative	Questionnaire	Student response questionnaire	Percentage

Table 1 illustrates that the outcomes of the qualitative data analysis are presented directly as statements, whereas the quantitative data are represented through numerical processing. Quantitative data include a questionnaire to assess the feasibility of the laboratory module and a student feedback questionnaire on the practicality of learning with the module. These assessments of feasibility and practicality were analyzed using a Likert scale. The Likert scale rating system was modified from Sugiyono (2017) to a 4-point scale: 4 for "very good", 3 for "good", 2 for "fair", and 1 for "poor". The data analysis technique for assessing the feasibility of the laboratory module used Aiken's formula, with content validity indices calculated for each aspect (Widodo et al., 2022). Aiken's V formula was selected because it assesses content validity by evaluating experts' consensus on the pertinence of each instrument item. This method is widely used in research on the development of instructional materials because it is suitable for a relatively small number of validators and produces a validity index that is easy to interpret.

The V value calculated using Aiken's formula was then compared with the V values listed in the table, using the criteria outlined by Aiken (1980). An instrument item is said to have content validity if its Aiken's V value meets or exceeds the critical value corresponding to the number of validators and the rating category, as specified by Aiken. The data analysis technique for assessing the practicality of the lab module uses percentage scores that can be interpreted quantitatively based on the assessment criteria from the student response questionnaire (Sugiyono, 2017). This percentage analysis describes trends in student responses regarding the module's practicality. Percentage scores of $85\% < P \leq 100\%$ are classified as very high, $70\% < P \leq 85\%$ as high, $50\% < P \leq 70\%$ as moderate, and $1\% < P \leq 50\%$ as low.

RESULTS AND DISCUSSION

This project resulted in the creation of a printed laboratory module utilizing an inquiry-based learning methodology, dubbed "Physics Laboratory Module Based on the Traditional Catapult Game on the Law of Conservation of Energy for Phase E of 10th Grade High School/Vocational School/Equivalent". This laboratory module was developed using the Cennamo and Kalk model. This model is considered an instructional design method with a more flexible practical approach. Instructional design does not have neat, easily replicable solutions; rather, each design project creates new works, new content, different student groups, or changing delivery systems (Kalk & Cennamo, 2003). The Cennamo and Kalk model comprises five steps: a) the define stage encompasses a literature

review and preliminary observation; b) the design stage, carried out through the planning and creation of the practical module; c) the demonstrate stage, conducted through a small-scale pilot test; d) the develop stage, involving improvements to the practical module; and e) the deliver stage, carried out through the presentation of the module on a large scale followed by evaluation (Cennamo & Kalk, 2019).

In the definition phase, problems were identified through various facts about challenges in the physics learning process, based on literature reviews and field studies. The facts indicate that a) physics instruction has not yet been able to encourage students to connect concepts with everyday events, so that most students consider physics a difficult subject (Astuti & Bhakti, 2022), b) teachers tend to present formulas immediately without encouraging student engagement in deriving them (Rizkita & Mufit, 2022), c) physics instruction remains abstract and is not presented through practice or experiments (Delvia et al., 2021), and d) there are no laboratory guides available that can encourage students to experiment and discover physics equations through their daily experiences. Additionally, the literature review was conducted by examining relevant previous studies. Several of these studies indicate that laboratory modules can enhance skills (Dalimunthe et al., 2021; Adriyani & Purwanti, 2018) Inquiry-based learning helps enhance students' scientific process skills (Nunaki et al., 2020); the creation of inquiry modules helps enhance critical thinking abilities (Ariani et al., 2018) and modules grounded in local wisdom effectively enhance students' learning motivation and literacy (Masie et al., 2025). In the meantime, a field study was conducted through direct observation and the administration of a needs analysis questionnaire regarding the laboratory module. Figure 1 illustrates the findings of the student needs questionnaire.

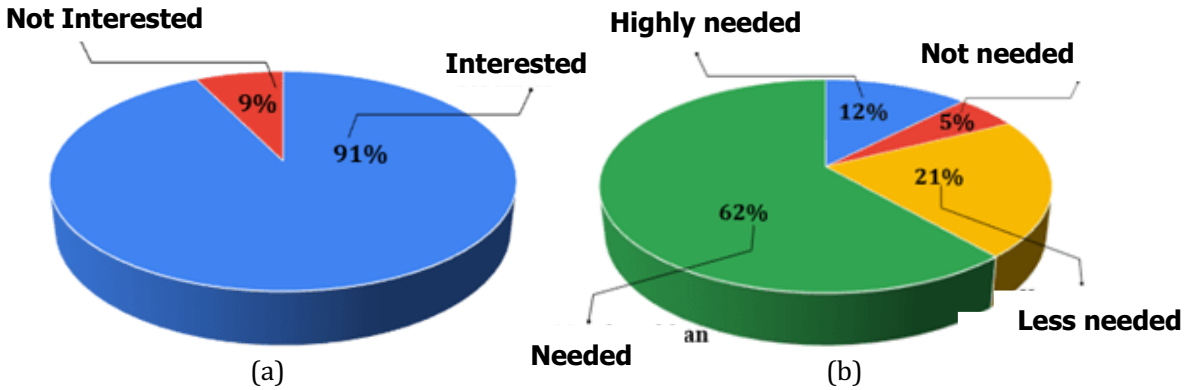

Figure 1. Results of the student needs survey regarding a) students' interest in physics lab sessions based on a catapult game and b) their needs for the corresponding module

Figure 1 shows that 91% of students are interested in learning about the law of conservation of energy using a traditional catapult. In addition, 62% of students feel they need, and 12% feel they strongly need, a physics lab module based on the traditional catapult game. The survey results reveal that most students are interested in the laboratory and would benefit from a physics lab module centered on the catapult game. Next is the design (planning) stage, which involves determining the product design in accordance with the learning objectives and creating an assessment plan, learning strategies, and a product piloting plan. This stage begins with creating a product design comprising an introduction, main body, and conclusion. The structure of each section is shown in Table 2.

Table 2. Laboratory module design plan

Section	Structure	Description
Introduction	Title page	A cover page containing the title, author's name, and book affiliation.
	Foreword	A message from the author to the reader.
	Table of contents	A table of contents listing the topics in the order they appear.
	List of figures, tables, and graphs	A list of figures, tables, and graphs indicating their page numbers in the book.
	Module user guide	Guidelines for each section to help students use the module.
	Learning activity features	Explanations of each activity feature that characterizes the module.
	Laboratory procedure guide	Explanations of the steps and management of laboratory activities.
Main Content	Learning outcomes	Learning outcomes for students.
	Concept map	Graphic illustrations showing the relationships between concepts.
	Laboratory introduction	Activities to review and recall previous material through various learning features.
	Laboratory main content	A section containing the objectives of the laboratory activity, theoretical foundations, and inquiry-based steps to demonstrate and understand physics concepts.
	Laboratory conclusion	Activities to formulate final concepts, reflections, and evaluations of the learning process.
	Science Process Skills Assessment Test	Non-cognitive tests to measure the achievement of psychomotor learning outcomes.
	Cultural Literacy Skills Assessment Test	Formative tests to measure the achievement of students' cognitive learning outcomes.
	Remediation or Enrichment	Activities for students who have or have not met the achievement standards.
Conclusion	Bibliography	A collection of reference sources.
	Glossary	A collection of definitions of important words or terms.
	Author Profile	Author's identity and background.
	Back cover	Summary or synopsis of the book.

Next was the demonstration phase, which involved designing and developing the lab module. A pilot test followed the initial design of this module. The pilot test was conducted with 10 tenth-grade students from SMK Global Multimedia Semarang. This group was selected because they had already completed the energy-related material in their classroom instruction. The small-scale pilot test aimed to assess students' responses to the product's readability, covering aspects of language, presentation, graphics, and material comprehension. Readability refers to the suitability of a text's structure for

readers, in terms of how difficult or easy it is to read (Idhoofiyatul & Sofi, 2019). The instrument used was a readability questionnaire with a five-point Likert scale. The acquired data were analyzed descriptively and qualitatively, utilizing readability rating criteria (Narayani et al., 2021). Furthermore, the readability assessment used an average score and was classified according to readability criteria (Widoyoko, 2013). The readability assessment of the practicum module is shown in Table 3.

Table 3. Summary of the module's readability evaluation outcomes by students

Indicator	Score	Criteria
Language aspects	3,85	Readable
Presentation aspects	3,60	Readable
Graphic design aspects	4,33	Readable
Comprehension aspects	3,93	Readable
Average	3,93	Readable

Table 3 indicates that the physics lab module, grounded in traditional games, was easily comprehensible for students. The outcomes of the small-scale pilot test will inform the development phase. The development phase involves transforming the lab module into a final product that demonstrates its characteristics. The developed laboratory module aligns with the characteristics of teachers and students at the target school. The primary distinctive feature of this laboratory module is the systematic presentation of each inquiry stage centered on cultural themes within the catapult game. A systematic presentation of the stages of inquiry can help students construct concepts through direct investigation. This is because the focus of inquiry-based learning is on constructing personal experiences as students' primary source of learning (Sa'diyah & Aini, 2022).

Furthermore, this learning model also guides students to delve deeper into the learning process, thereby enhancing their investigative and analytical skills (Hidayat et al., 2022). However, the module developed in this study has distinct characteristics: it not only applies the inquiry method but also integrates experiments with the traditional slingshot game as an ethoscience context. This program is anticipated to improve students' science process abilities and cultural literacy. This illustrates that incorporating culturally informed contextual learning helps connect scientific principles with students' real-world experiences. This module guides students in conducting direct scientific investigations of the catapult game, enabling them to independently discover mathematical equations related to energy concepts without the direct presentation of formulas. The title of the practical module is printed on the front and back covers, as well as the book jacket. Additionally, this module features a distinctive cover design and graphics on every page that highlight the ethoscience theme in the catapult game. The book cover is shown in Figure 2.

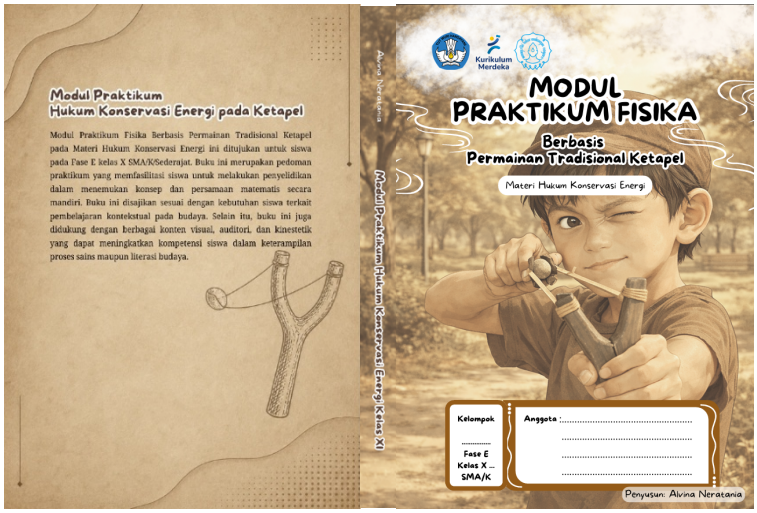

Figure 2. Cover page of the development lab module

The inquiry-based physics lab module, which integrates the traditional slingshot game, consists of three parts: an introduction, the main content, and a conclusion. The introduction includes several guides, such as instructions for using the lab module, guidelines for conducting the lab, and assessment guidelines, which distinguish it from other lab modules. The directions for utilizing the module aim to facilitate student engagement; the instructions for conducting the lab are intended to help students carry out lab activities systematically; and the assessment guidelines are intended to explain general and specific instructions for completing the assessment effectively. The content section of the lab module is designed to present learning activities. These activities are intended to review material, explain concepts, and foster students' collaboration, literacy, and psychomotor skills. The learning activity features are also designed to support all student learning styles—visual, auditory, and kinesthetic. This is because these features are presented through a variety of original images and illustrations, podcasts, videos, projects, and core lab activities. Furthermore, these learning activity features are presented using the names of iconic Javanese wayang characters, as shown in Figure 3.



Figure 3. Names of wayang characters used as learning features

Figure 3 shows several characters that have been used to name learning activities, including "Abyasa (*Ayo bertanya seputar bab!*)", "Pandu (*Praktikum sederhanaku*)", "Adirata (*Ayo diskusi bersama kita*)", "Semar (*Sekilas materi*)", "Gareng (*Kegiatan bareng*)", "Petruk (*Proyek tentang ragam*

budaya kita)", "Prabu (*Pengetahuan ragam budaya*)", and "Laksmi (*Latihan kompetensi seputar materi*)". The characters and traits of these figures are explained in the module's user guide, along with instructions for using the features. It is hoped that these names will help introduce students to Javanese wayang culture, thereby fostering a sense of patriotism (Fianti & Neratania, 2024). All the learning features of this activity are distributed throughout the module, which consists of a lab introduction, the main lab section, and a lab conclusion. The lab introduction presents learning features that review and help students recall previously studied material. This introduction is crucial for helping students understand the concepts underlying the lab topic. Some of the available features include one Abyasa activity, two Adirata activities, and two Semar activities.

Next, the core section of the lab consists of the lab objectives, theoretical background, and inquiry-based lab stages designed to verify and discover physics concepts. The stages of inquiry encompass orientation, conceptualization, investigation, conclusion, and discussion. Activities at this phase encompass the orientation period, which involves presenting contextual problems to spark students' curiosity about the material; the conceptualization stage, which connects prior knowledge with the physics concepts to be studied, thereby providing a conceptual foundation for formulating questions and generating hypotheses; the investigation stage, which consists of exploration and experimentation and thus forms the most crucial part of the laboratory module; the conclusion stage, which encourages students to interpret data so they can conclude; and the discussion stage, which involves reflecting on the process and results of the experiment and communicating them.

The main section of the lab module is the investigation phase, which consists of exploration and experimentation. During the exploration phase, students gather lab equipment and materials, followed by the experimentation process using the Pandu feature. This section presents four experiments: determining the spring constant of a rubber catapult; determining the potential energy of a rubber catapult and predicting the projectile's kinetic energy; determining the projectile's gravitational potential energy; and identifying factors that inhibit mechanical energy. The various inquiry stages presented are unique in that they help students practice their ability to observe surrounding phenomena (observing), formulate problems in line with learning objectives (formulate problem), formulate hypotheses to predict answers to problems (formulate hypothesis), measuring experimental data and presenting it in graphical form (measuring), communicating experimental results orally and in writing (communicating), and drawing conclusions (concluding). These diverse talents constitute the scientific process skills students must acquire to comprehend physics in a scientific, systematic, and thorough manner.

The final section, which is another characteristic of the lab module, is the lab conclusion. This section includes a summary of key concepts, reflections, and an evaluation of the learning process. The features presented in this section include one Abyasa activity, one Petruk activity, and two Laksmi activities. Laksmi (Competency exercises related to the material) consists of formative assessments that measure students' psychomotor skills and summative assessments that measure students' cognitive skills. Psychomotor assessment is conducted using science process skills tests, while cognitive assessment is developed based on cultural literacy. In addition to the assessment, this laboratory module includes enrichment activities for students who are expected to have exceeded the minimum curriculum proficiency standards (Dewantara, 2019) and remedial instruction for students who have not attained the requisite curricular proficiency standards (Ishmah et al., 2016). Finally, the concluding section includes a summary of the practical module, along with a bibliography, a glossary, an author profile, and a back cover. The glossary lists key terms with definitions to help students understand them; the bibliography lists the sources referenced in the practical module; the author profile provides a brief biography of the author; and the back cover includes a synopsis that offers an overview of the practical module. Following the development process, the practicum modules were

evaluated for suitability by five subject-matter and media experts, all physics education faculty members at Sebelas Maret University. In addition, five physics teachers served as validators. The validation data were assessed using the Aiken Validity Index (Aiken V) to determine the appropriateness of the product across each dimension. These aspects included content, presentation, language, and graphics. Table 4 presents the findings of the feasibility validation analysis for the practical module.

Table 4. Outcomes of the feasibility evaluation for the laboratory module

Aspect	Calculated V	Table V	Criteria
Content quality	0.88		Valid
Presentation quality	0.96		Valid
Language quality	0.86	0.73	Valid
Graphic quality	0.93		Valid
Average	0.90		Valid

Table 4 shows that the physics lab module is evaluated based on content appropriateness, presentation, language, and graphics. The content suitability assessment includes indicators of material appropriateness (0.88); integration of inquiry-based learning (0.86); integration of ethnoscience (0.91); relevance of science process skills assessment (0.90); and relevance to cultural literacy (0.87). This means the laboratory modules are deemed appropriate in terms of the depth of the material, clarity of the topics, appropriateness of the inquiry-based learning syntax, cultural integration, and activities that support science process skills. Meanwhile, the presentation appropriateness assessment includes indicators of technique (0.90) and completeness (0.99). This signifies that the laboratory module is coherent, consistent, engaging, and systematic throughout all sections, including the introduction, main body, and conclusion.

Regarding linguistic suitability, it includes the readability indicator (0.86), indicating that the module demonstrates clarity, consistency, appropriateness, and accuracy in both information and language. Finally, graphic quality includes the graphic quality indicator (0.96) and cover design (0.90). This quality indicates that the practical module features an appealing selection of image illustrations, layout, size, color, and design. Based on the overall feasibility assessment, this lab module received a valid rating across all aspects. Consequently, it may be inferred that the constructed lab module is appropriate for instructional use. This aligns with a study indicating that a physics module centered on guided inquiry learning regarding dynamic electricity was considered appropriate in terms of content, media, and language (Ariani et al., 2018). A further study determined that an ethnoscience-based learning module centered on the Telok Tomini folktale was considered suitable, pragmatic, and efficacious in augmenting students' learning motivation and literacy (Masie et al., 2025).

In addition to providing ratings, each evaluator also offered suggestions and comments to help improve the module. Based on the validators' comments and suggestions, several revisions were made to improve the developed laboratory module. The concept map section was initially considered too general and did not adequately explain the main activities of the laboratory session; therefore, the concept map related to the topic of energy conservation was elaborated in greater detail. In addition, the learning outcomes were revised because they did not follow the latest version of the ABCD framework (Audience, Behavior, Condition, and Degree) and were not fully aligned with the research objectives. Consequently, the learning outcomes were updated using the ABCD framework and adjusted to support science process skills and cultural literacy. Furthermore, the reflection section was deemed too simple and insufficiently engaging to facilitate a comprehensive evaluation of students. As a result, this section was revised to assess not only the achievement of learning outcomes

but also students' feelings and experiences after participating in the laboratory activities. The outcome of the development phase is a complete and valid laboratory module, allowing the process to proceed to the final phase: the delivery phase. In this phase, the final product is presented in a large-scale pilot test for adoption in classroom instruction. This phase was conducted with 38 tenth-grade students at Nasima High School in Semarang. After the students completed the learning activities using the practical module, a feedback questionnaire was distributed to gather input on the module, including reactions, responses, and comments. The questionnaire results were analyzed using percentages, yielding the results shown in Table 5.

Table 5. Summary of the practicality assessment of the practical module

Aspect	Percentage (%)	Criteria
Completeness of the Module	85.6	Very High
Module Usability	79.0	High
Integration of Inquiry-Based Learning	80.1	High
Integration of Traditional Games	83.3	High
Assessment of Science Process Skills	82.1	High
Assessment of Cultural Literacy	79.4	High
Module Readability	82.6	High
Physical Appearance of the Module	83.0	High
Average	81.9	High

Table 5 demonstrates that the evaluation of the laboratory module's practicality, in terms of completeness, reveals an exceptionally high standard. This aligns with the findings of Sari et al. (2020), who stated that the highest level of relevance in development lies in completeness, with identity including the educational institution, grade level, indicators, and alignment of competencies, all scoring at the "very good" criterion. Besides the completeness criterion, the practical module was assessed on usability, the incorporation of inquiry-based learning, the integration of conventional games, and the evaluation of science process abilities. Research by Intika and Jumiati (2020) on ethnoscience-based development for pempek indicated that the approach was appropriate, elicited favorable responses from students and teachers, and effectively improved learning outcomes and scientific process abilities. The evaluation of student replies includes assessments of cultural literacy, readability, and the module's visual presentation. This corresponds with Masie et al. (2025), who assert that the creation of e-modules is essential for integrating local cultural elements to improve student involvement and cultural literacy. The evaluation of physical appearance encompasses the quality of the instructional material's cover, its aesthetic appeal, and its overall components (Amri, 2018).

CONCLUSION

This study developed an inquiry-based laboratory module entitled "Physics Lab Module Based on the Traditional Slingshot Game on the Law of Conservation of Energy for Phase E of 10th Grade High School/Vocational School/Equivalent," designed to meet the requirements of educators and learners. The primary characteristic of this laboratory module is its incorporation of a conventional game, allowing students to gain hands-on experience analyzing physics concepts through the slingshot game. This lab module serves as a guide for conducting investigations, with inquiry-based steps that lead students to discover concepts and formulate mathematical equations independently, without being directly presented with formulas. In addition, this module also features learning activities that incorporate differentiated learning content visual, auditory, and kinesthetic through a variety of

original images or illustrations, videos, podcasts, projects, and hands-on experiments. Another unique aspect is that the names of these learning features are abbreviated to refer to wayang (shadow puppet) characters, which is intended to foster a sense of patriotism. The feasibility test findings for the practicum module, assessed by five expert validators and five practitioner validators on content, presentation, language, and graphics, yielded an average V value of 0.90, above the table V value of 0.73. The results demonstrate that the practicum module is both valid and appropriate for instructional usage. Simultaneously, the outcomes of the practicality assessment, derived from student answer questionnaires, yielded an average of 81.9%, satisfying the "high" criterion and indicating that the lab module is practical for student use. Consequently, this instructional material is considered appropriate and effective for application in the learning process. Moreover, the implementation of this innovative lab module has had a significant impact by addressing the limitations of school laboratory equipment, improving science process skills through independent problem-solving, and strengthening cultural literacy in contextual physics learning.

DECLARATION OF GENERATIVE AI

The authors declare that no generative AI or AI-assisted technologies were used in the writing process of this manuscript.

CONFLICTING INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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