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Development of Sound Energy Teaching Module Based on Integrated PjBL Learning Model with Local Wisdom to Improve Scientific Reasoning Ability

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ABSTRACT

This study aims to develop a sound energy teaching module based on the PjBL learning model integrated with local wisdom to improve scientific reasoning skills and test feasibility. The type of research used in this study is a quantitative research type with the Research and Development (R&D) research method. With the ADDIE development model used analysis, design, development, implementation and evaluation. The results of the validation research by media experts show that in the media aspect, technical quality and media size with a presentation value of 84.90%, 89.02%, 91.55% so it is concluded that it is very good. The results of the material expert analysis clearly show that in terms of material coverage, material accuracy, up-to-dateness and stimulating desire, media presentation with a presentation value of 85.73%, 88.58%, 97.30%, 90.72%, 95.81% so it is concluded that it is very good. The results of the analysis of linguists clearly show that in terms of clarity, suitability with student development and suitability with language rules with a presentation value of 88.16%, 90.07%, 95.35%. The results of the overall feasibility test for individual, group and field validation with a percentage of 89%, 87% and 95% qualifications are very suitable. The results of the gain normality test analysis obtained a result of 0.89 so that it can be concluded that there is an increase in the scientific reasoning ability of students who are taught with the sound energy teaching module based on the PjBL learning model integrated with local wisdom.

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1. Introduction

A teaching module is a document containing a learning implementation plan developed from the Learning Objectives Flow (ATP) and Learning Outcomes (CP). A teaching module is a learning tool or learning plan based on the applicable curriculum, applied with the aim of achieving predetermined competency standards. Teaching modules play a key role in assisting teachers in designing learning. In developing learning tools, teachers play a crucial role; their thinking skills are honed to enable them to innovate in the teaching modules they create. Therefore, in creating teaching modules, teachers' pedagogical competencies need to be developed, so that their teaching techniques in the classroom are more effective and efficient, and do not deviate from the discussion of achievement indicators (Salsabilla, et al.: 2023).

The subject of sound energy requires students to observe, gather information, experiment, process information, and communicate it, thus requiring scientific reasoning skills to build knowledge, understanding, and problem-solving. Scientific reasoning skills are essential for students to face increasingly fierce competition in the global era. Reasoning is the ability to use evidence and facts connected to existing knowledge to draw conclusions. Scientific reasoning skills are a high-level thinking skill that involves systematic and logical thinking in the scientific method process (Hadi, 2021). Scientific reasoning skills are the ability to think systematically and logically in solving problems using scientific methods. Scientific reasoning skills are analytical activities using scientific logic (Mandella, et al.: 2021).

Scientific reasoning ability is one of the abilities tested in the Programme for International Student Assessment (PISA) test. PISA results show low scientific reasoning of students from the results of the PISA test in 2009. Indonesia in the PISA test, especially science, ranked 60 out of 65 countries and got an average score of 383 from the average score set by the OECD of 501. Trends in Mathematics and Science Study (TIMSS) is an international study of students' mathematics and science achievement. Students' science achievement in Indonesia in 2011 was ranked last, namely 40th out of 40 countries. This is due to the low percentage of correct answers of TIMSS participants. The low ability of Indonesian students in PISA and TIMSS is caused by students not being accustomed to being invited to think scientifically and reason scientifically. So far, education in Indonesia has focused on conceptual thinking skills alone without training scientific reasoning skills. The Ministry of Education and Culture (2016) cited the TIMSS infographic which showed that Indonesia's score or average correct answer for students in science class was 32 and the international average was 50. In 2015, Indonesia's science education was ranked fifth out of eight countries for a score of 297 (Khumaira, et al: 2023).

Lack of scientific reasoning ability due to several factors including Lack of opportunity to practice solving problems systematically and using scientific methods can cause students to be less skilled in scientific reasoning, Lack of understanding of basic concepts of science and scientific methods can limit students' ability to think scientifically as well as learning methods/models that are less reasoning oriented. Therefore, it is important to develop teaching modules based on appropriate learning models to improve students' scientific

reasoning. Student-centered learning models can train students to think critically, solve problems, and make decisions based on scientific evidence such as the project-based learning (PjBL) learning model.

The PjBL learning model prioritizes modeling a project that has a product as its output. The learning process involves sharing project experiences, resulting in a product derived from the educator's activities (Lestari & Ilham, 2022). Project-Based Learning (PBL) aims to deepen students' knowledge and skills by providing students with a problem that can be solved through a project related to the material and competencies they possess. PjBL learning emphasizes student activity in producing products as a form of applying research, analysis, creation, and presentation skills based on concepts learned through real-world experiences (Undari, 2023).

To enhance students' insights and experiences that are appropriate to their local area of residence, learning can be integrated with values based on the local wisdom of the students' area. The importance of applying local wisdom values in learning is beneficial in improving understanding and increasing students' knowledge and scientific reasoning skills to recognize local wisdom in their environment. As well as serving as a medium for instilling a love for local wisdom in their area and equipping attitudes and behaviors that align with the values and rules that apply in the area around the students.

Muskania's research results state that the development of teaching materials based on STEM-PJBL integrated with local wisdom can improve students' scientific literacy (Muskania, 2023). Sukma & Diyana (2024) developed a project-based learning model module based on local wisdom in an effort to improve understanding of physics concepts. Sanjaya Integrated PjBL with Local Wisdom can Improve Students' Collaborative Skills (Siloto, 2023).

2. Research Methods

The type of research used in this study is quantitative research with the Research and Development (R&D) research method. According to Sugiyono in Riyanto (2020), this R&D research aims to develop a product based on findings, then revised and so on. This research will produce a product, namely linktree. The ADDIE model is a learning system design model that shows the basic stages of a learning system that are easy to implement. There are five stages in the ADDIE development model, namely: 1) analysis, 2) design, 3) development, 4) implementation, 5) evaluation.

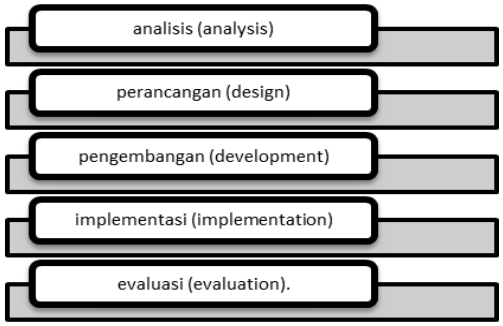

Figure 1. ADDIE Development Steps

The development of a sound energy teaching module based on the PjBL learning model integrated with local wisdom adopts the Addie development model. The stages of the ADDIE model are Analysis, Design, Development, Implementation, and Evaluation. The subjects in this study were all students in the PGSD study program at Al Muslim University of Bireuen. The research sample was students of the PGSD study program in the media development and learning resources course in the even semester of the 2025/2026 academic year. The number of research samples was 60 students divided into 2 unit groups, namely the VE unit, VF in each unit totaling 30 people. The sampling technique used the Purposive sampling technique is a sampling determination technique with certain considerations.

This research was conducted at Almuslim Bireuen University, one of the private universities in Aceh, located at Jalan Almuslim Matangg Glumpang Dua, Peusangan District, Bireuen Regency.

The instruments used in this study were observation sheets, questionnaires, interviews and documentation.

a. Validation Analysis
   The validation test was carried out in several stages, namely: (1) validation by learning media experts, (2) validation by material experts, (3) individual testing, (4) small group trials, and (5) field trials.
b. Product Feasibility Data Analysis
   Product data analysis is conducted to assess the overall appearance of the product to be developed. It validates the basic assumptions of the product idea, assists in idea development, and estimates the product's potential market share. The data obtained is then calculated using the following formula:

$$P = \frac{f}{N} x100\%$$

Information:

P = Assessment Percentage
f = Score obtained
N = Overall score

Then the data is interpreted into Table 1 as follows (Fauziah: 2020):

Table 1. Eligibility Criteria

Presentation % e	**Category**
81 – 100%	Very worthy
61 – 80%	Worthy
41– 60%	Quite decent
21– 40%	Not worthy

c. Data Analysis Improves Scientific Reasoning Skills
   To see the extent to which students' cooperative skills have improved in learning, the n-gain test is used. N-gain (normalized gain) is used to measure the improvement in

students' scientific reasoning skills between before and after learning. This test is carried out based on the results of a questionnaire developed with 4 indicators of cooperative skills, namely 1) identifying and controlling variables (control of variables), 2) proportional thinking, 3) probabilistic thinking, and 4) hypothetical-deductive reasoning (Handayani, 2020). The score is done by calculating the difference between the pretest score (the test before the application of a certain method (treatment)) and the posttest score (the test after the application of a certain method (treatment)). The results are then calculated using the formula:

$$\text{N-Gain} = \frac{POSTTEST - PRETEST}{TOTAL\ SCORE - PRETEST}$$

The results of the calculations using the formula above are then interpreted into gain score (g) criteria categories. The gain score (g) criteria categories can be seen in Table 2 below:

Table 2. N-Gain Categories

Gain Value	Category
$g > 0.7$	Tall
$0.3 \leq g \leq 0.7$	Currently
$g < 0.3$	Low

3. Research Result and Discussion

The results of research and development of sound energy teaching modules based on the PjBL learning model integrated with local wisdom that follows the general model of research design from ADDIE. for this purpose, a procedure was carried out that obtained the following results: 1. Analysis, at this stage an analysis was carried out on the independent learning curriculum, student characteristics, needs analysis and analysis of books used in the field. 2. Design, based on the results of the analysis, the design and development stages were carried out, namely content aspects, graphic aspects, and language aspects. The results of the design of the sound energy teaching module based on the PjBL learning model integrated with local wisdom at this initial stage were called prototype 1. Furthermore, the teaching materials were validated by conducting evaluations and discussions with experts. The results of the revisions to Prototype 1 were called Prototype 2. Next, a One To One Evaluation or individual evaluation was carried out.

As the final form of this product is in the form of a module, this teaching material is arranged sequentially in each project, objectives, steps, teaching materials, and assessment instruments needed in one complete learning unit. The main page interface display is as shown in Figure 2.

Figure 2. Module Cover Page View

The design of this module was carried out by determining the idea of developing a PjBL module with local wisdom of Rapai as the discussion theme in teaching sound energy material. The steps taken were compiling the module, scientific reasoning instruments, learning outcomes, student responses, and validation sheets. The module was arranged according to the desired design including the cover display, module introduction, material placement design, and the closing design containing creative thinking instruments and competency tests. After the module was completed, the lesson plan was prepared according to the module.

a. Expert Validation Analysis

Before testing the product on students, the results of which will be analyzed by experts, product validation was conducted with media experts and material experts. The media experts' assessment of the resulting product was carried out by providing teaching materials in the form of modules and an assessment sheet in the form of a questionnaire containing 20 statements related to the product being developed. The following are the results of the validation by media experts, language experts, and material experts. The material expert analysis can be seen in Table 3:

Table 3. Results of Media Expert Validation Analysis

No	Rated aspect	Presentation	Information
1	Media	84.90%	Very good
2	Technical quality	89.02%	Very good
3	Physical size	91.55%	Very good

Based on Table 3, the results of the media expert analysis clearly show that each aspect has very good criteria. In the media aspect, the presentation value is 84.90%, so it is concluded as very good. In the technical quality aspect, the presentation value is 89.02%, so it is concluded as very good. In the media size aspect, the presentation value is 91.55%, so it is

concluded as very good. This is because the sound energy teaching module based on the PjBL learning model integrated with local wisdom is designed with content contained in writings that are summarized generally showing images of local wisdom. By providing projects in the module, students are encouraged to use their creativity starting from the process of planning the product, making the product (building knowledge, understanding and skills, developing the product) presenting and evaluating the product. The results of Zulfa's (2025) research on LKPD-PjBL integrated with Local Wisdom on Creative Thinking Skills. In line with that, Husna (2024) stated that LKPD project-based learning integrated with local wisdom is suitable for use. For the analysis of material experts, it can be seen in Table 4 below:

Table 4. Results of Material Expert Validation Analysis

No	Rated aspect	Presentation	Information
1	Coverage of material	85.73%	Very good
2	Accuracy of material	88.58%	Very good
3	Updates	97.30%	Very good
4	Stimulate desire	90.72%	Very good
5	Media presentation	95.81%	Very good

Based on Table 5, the results of the material expert analysis clearly show that each aspect has very good criteria. In the aspect of material coverage with a presentation value of 85.73%, it is concluded as very good. In the aspect of material accuracy with a presentation value of 88.58%, it is concluded as very good. In the aspect of up-to-dateness with a presentation value of 97.30%, it is concluded as very good. In the aspect of stimulating interest with a presentation value of 90.72%. In the aspect of media presentation with a presentation value of 95.81%, it is concluded as very good. This is because the sound energy teaching module based on the PjBL learning model integrated with local wisdom is designed to suit the topics presented in terms of content, presentation, language, and graphics. The results of Chandra & Afandi's (2021) research. Development of E-Modules Based on PjBL Integrated with Local Cultural Wisdom is suitable for use. For the analysis of language experts can be seen in Table 5:

Table 5. Results of the Language Expert Validation Analysis

No	Rated aspect	Presentation	Information
1	Straightforwardness	88.16%	Very good
2	Compliance with student development	90.07%	Very good
3	Conformity with language rules	95.35%	Very good

Based on Table 5, the results of the media expert analysis clearly show that each aspect has very good criteria. In the aspect of language clarity with a presentation value of 88.16%, it is concluded as very good. In the aspect of suitability with student development with a

presentation value of 90.07%, it is concluded as very good. In the aspect of conformity with language rules with a presentation value of 95.35%, it is concluded as very good. This is because the sound energy teaching module based on the PjBL learning model integrated with local wisdom uses language that is easy to understand so that the language delivered in the material, communication media, and language style used are in accordance with Indonesian language rules. The results of Utami & Astawan's (2025) research. The Project Based Learning Model Based on Local Wisdom is suitable for use

b. Product Feasibility Data Analysis

The product feasibility analysis was conducted through three trials: individual trials, small group trials, and field trials. The results of the feasibility tests can be seen in the following graph:

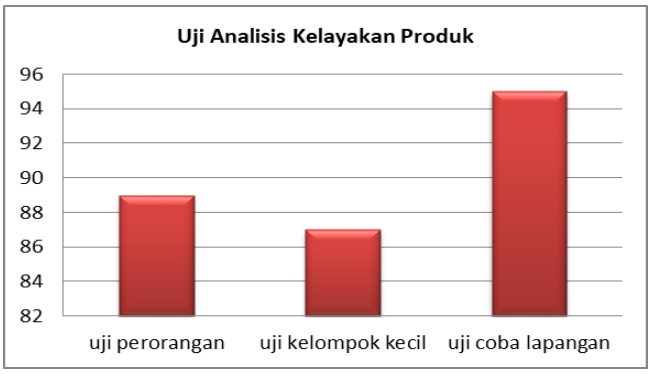

Figure 3. Product Feasibility Analysis Graph

Based on the graph above, the results of the sound energy teaching module trial based on the PjBL learning model integrated with local wisdom show that overall validation by individuals, groups, and field personnel has very good qualifications and does not require revision. The discussion of the trial validation results presents recommendations, suggestions, and criticisms from the field trial subjects. The recommendations, suggestions, and criticisms are focused on aspects of language that are easy for students to understand and comprehend. The solution to this problem is to add a special page for the meaning of difficult words. The module that has been tested and validated can be seen in Figure 1. LKPD Page.

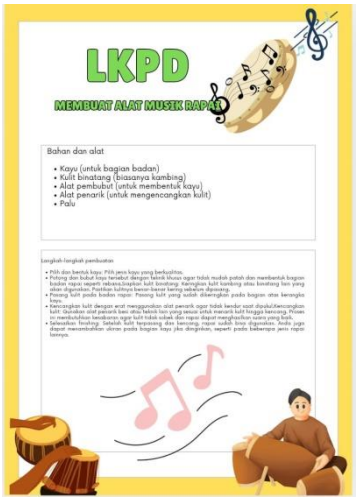

Figure 4. Sound Energy Teaching Module Based on Integrated Local Wisdom PjBL

c. Data Analysis Improves Students' Scientific Reasoning Abilities

The gain normality test was conducted based on the results of the analysis of the cooperation ability questionnaire sheet with 4 indicators of cooperation ability, namely 1) identifying and controlling variables (control of variables), 2) proportional thinking, 3) probabilistic thinking, and 4) hypothetical -deductive reasoning. To see how much the value of the increase in students' scientific reasoning abilities in learning using the sound energy teaching module based on the PjBL learning model integrated with local wisdom. The N-gain results can be seen in table 7:

Table 7. Results of N-Gain Analysis

Treatment	Average value	N-Gain	Category
Pretest Score	55	0.89	Tall
Posttest score	95		

Based on the table of the results of the gain normality test analysis, the result was 0.89, so it can be concluded that there was an increase in students' scientific reasoning with a high category. This is because the sound energy teaching module based on the PjBL learning model integrated with local wisdom helps stimulate children to think inductively, deductively, design experiments, cause and effect reasoning, concept formation, hypothesis testing, and integration of local wisdom which can provide a deeper and more relevant learning experience, support cultural preservation, and strengthen student identity. Muskania's research results say that the development of teaching materials based on stem-pjbl integrated with local wisdom can improve students' scientific literacy (Muskania, 2023). Sukma & Diyana (2024) project-based learning model module based on local wisdom in an effort to improve understanding of physics concepts. Sanjaya PjBL Integrated with Local Wisdom can Improve Students' Collaborative Skills (Siloto, 2023).

4. Conclusion and Suggestions

Conclusion

The results of the study indicate that the sound energy teaching module based on the PjBL learning model integrated with local wisdom is suitable for use by students, this is based on validation by material experts and media experts as well as individual, group and field trials. The results of the study also show that the sound energy teaching module based on the PjBL learning model integrated with local wisdom can improve the scientific reasoning abilities of Umuslim Bireuen students.

Suggestions

This research is still not perfect and needs to be improved for the effectiveness of learning and the use of media and learning models.

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