Jurnal Pendidikan Sains Universitas Muhammadiyah Semarang. Vol. 13(2) pp 38-48 ISSN:2339-0786
DOI: https://doi.org/10.26714/jps.13.2.2025.38-48

The Development of Problem-Based Learning Based Science Module Charged with Local Wisdom to Improve Students' Critical Thinking Skills

Risma Wati [a,1*], Yudha Irhasyuarna [b,2], Mella Mutika Sari [c,3]

[a,b,c] Science Education, Lambung Mangkurat University, 70123, Indonesia

[1] rismawati.s405@gmailcom
*corresponding author

Article history

Submission : 2025-10-03
Revised : 2025-10-26
Accepted : 2025-11-16

Keyword

Socio-scientific issues
Inquiry learning
Science education
Science learning

Abstract

This research is motivated by students' limited critical thinking skills in the learning process. Science instruction in schools still relies on conventional methods, fails to engage students actively, lacks a variety of teaching materials, and lacks a connection to local wisdom. The mismatch between 21st-century learning needs and suboptimal learning practices demands innovative teaching materials that can stimulate critical thinking. The purpose of this study was to determine the validity, practicality, and effectiveness of a PBL-based science module incorporating local wisdom. This study employed a research and development method with the ADDIE model. The data analysis technique employed was quantitative analysis, which included conducting validity tests, practicality tests, and effectiveness tests. The results of the validity test obtained a percentage of 90.78%, categorized as very valid. The practicality of the science module achieved a readability test score of 80.36% and a large-class test score of 80.42%, both of which are categorized as practical. The effectiveness of the science module in improving students' critical thinking skills achieved an n-gain score of 0.60, categorized as moderate. The science module, developed based on problem-based learning with local wisdom content, is suitable for use because it meets the criteria of being valid, practical, and effective.

1. INTRODUCTION

Education in Indonesia is constantly updating its curriculum to improve the quality of education. Currently, the curriculum of all schools in Indonesia is changing to the Merdeka Belajar curriculum. Hanipah (2023) stated that the independent curriculum is an educational method designed to provide flexibility to students, allowing them to optimize their talents. This curriculum prioritizes the development of 21st-century skills, including critical thinking and problem-solving, to

prepare students for the future. This ability can be honed through the learning process, one of which is in science learning.

According to Idris et al. (2023), science learning not only provides knowledge to learners but also enables them to actively engage and develop critical thinking skills related to the environment through real-world learning experiences. However, the conditions in the field suggest that the critical thinking ability of learners in Indonesia remains a concern. According to PISA data held by the OECD in 2022, the average Indonesian science score was 383, while the overall average score of participants reached 485 (Yuniswara et al., 2024). Based on these data, students need to develop their critical thinking skills in science lessons.

Based on the facts gathered during the learning process at SMPN 15 Banjarmasin, the implementation has not been optimal, and the students' critical thinking skills still need improvement. This can be seen from the lack of active student involvement in learning and the failure to achieve learning outcomes in HOTS questions that do not meet the expected standards of completeness. The lack of students ' ability to think critically is caused by various factors. These factors include the lack of interest among students in learning science, as they perceive science as a subject that is difficult to learn and understand. Ma'wa & Hidayat (2023) stated that some students consider science difficult to understand, which results in less satisfactory learning outcomes for students.

During learning activities, teachers often employ conventional lecture-based learning models, and less frequently associate real-world problems with the material taught, resulting in learners becoming more passive because the teacher dominates the learning process. According to Prabowo et al. (2020), the use of lecture methods in teaching and learning activities tends to make students more passive in their learning and less enthusiastic about the learning process. In fact, most students were hesitant to ask or express their opinions regarding material they did not understand, and some failed to focus when the teacher provided an explanation, which negatively impacted their ability to think critically.

Based on the description above, teachers need to choose the right and effective strategies so that learners are not passive during the learning process. One approach that teachers can adopt is the problem-based learning (PBL) model. This Model is very suitable for use when learning science because it effectively hones the thinking skills of learners. Teachers also need learning tools that support the development of thinking skills, enabling learners to apply the concepts they have learned. Teachers can utilize teaching materials, such as modules, as learning tools.

The use of modules during learning can provide learners with independence in their learning. During the observation, the researchers found that the teaching materials used by teachers during learning are primarily limited to packaged books and student workbooks. The use of monotonous teaching materials can cause students to feel bored and decrease their interest in the learning process. Additionally, the learning process is less connected to science materials in everyday life, such as local wisdom relevant to learners. Mareti & Hadiyanti (2021) stated that in science learning, teachers should provide direct experiences to enable students to understand the material truly. By associating the understanding of science concepts with real-life experiences around students, such as the values of local wisdom, especially those from South Kalimantan, learning becomes more engaging.

Therefore, it is necessary to develop a science module with a problem-based learning model that contains local wisdom as a learning tool for students. Several previous studies have found that PBL-based science modules incorporating local wisdom are effective in enhancing students' critical thinking skills. For example, research conducted by Wahyuni et al. (2023) showed that students' critical thinking skills increased by 86% after using PBL-integrated modules. Research by Rosidi et al. (2023) also revealed that PBL-based modules incorporating local wisdom values were significantly effective in improving students' critical thinking skills. The application of the PBL model, incorporating local wisdom into the module, is expected to enhance critical thinking skills, as learning-related problems can stimulate students' minds to analyze and solve problems. This study aims to assess the validity, practicality, and effectiveness of the developed module.

2. METHOD

The type of research used is Research and Development (R&D). The research is designed to produce teaching materials in the form of problem-based learning science modules containing local wisdom. The development model used is the ADDIE model, which stands for Analysis, Design, Development, Implementation, and Evaluation (Rosidi et al., 2023). This model was chosen because it has clear, systematic, and easy-to-understand development steps, making it suitable for the development of teaching materials. The module research and development process was carried out according to the ADDIE model stages, evaluating each stage of development, as shown in the following figure.

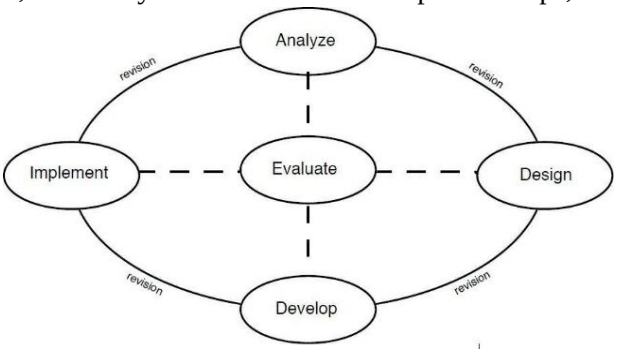

Figure 1. ADDIE model.

The subjects of this study consisted of two expert lecturers and one science teacher who acted as validators, as well as class VIIIG students of SMP Negeri 15 Banjarmasin. The expert lecturers were selected because they possess competency in science and the development of teaching materials, enabling them to provide accurate assessments of the module's feasibility. The science teachers were selected as validators because they understand student characteristics and classroom learning needs. Meanwhile, class VIIIG students of SMPN 15 Banjarmasin were selected as research subjects because they align with the target use of teaching materials intended for that grade level. Furthermore, this school has science learning characteristics relevant to the research problem, allowing the trial to reflect real-world conditions. The research object is a problem-based learning science module with local wisdom content. This research took place from November to December 2024. Data were collected using a questionnaire to measure the validity and practicality of the module, which was compiled based on module assessment indicators using a Likert scale.

Additionally, a test was administered to assess the effectiveness of the module, which consisted of multiple-choice questions that incorporated indicators of critical thinking skills. Data obtained from the validation sheet, student response questionnaire, and student test questions were analyzed quantitatively. The analysis included calculating the module's validity value, the level of practicality based on student responses, and improving learning outcomes through test scores. The formula used to determine the module's validity level is presented below.

$$V_{ah} = \frac{Tse}{Tsh} \times 100\% \quad \text{.....(1)}$$

Description :

V_{ah} = expert validation

T_{se}= Total score obtained

T_{sh}= maximum total score

Then, the validity percentage obtained will be described in accordance with the criteria in the table below

Table 1. Criteria validitas

Percentage	Validity Criteria
81% - 100%	Very Valid
61% - 81%	Valid
41% - 61%	Moderately Valid
21% - 41%	Not Valid
0% - 20%	Very Invalid

(Lubis *et al*, 2021)

Practicality data analysis was reviewed based on the results of the learner response questionnaire, which was then calculated using the following formula.

$$P = \frac{F}{N} \times 100\% \quad \text{.....(2)}$$

Description :
P = percentage of data
F = number of points scored
N = maximum number of points

Furthermore, the practicality value obtained is categorized as follows in the table below.

Table 2. Practicality criteria

Percentage	Criteria
$81\% \leq P < 100\%$	Very Practical
$61\% \leq P < 81\%$	Practical
$41\% \leq P < 61\%$	Moderately Practical
$21\% \leq P < 41\%$	Not Practical
$0\% \leq P < 21\%$	Very Not Practical

The effectiveness of the module is measured by analyzing the results of the initial test (pretest) and the final Test (posttest) obtained by learners before and after using the module. The data analysis of the effectiveness of the developed module utilizes the normalized gain (N-gain) equation as follows

$$< g > = \frac{Skor\ Posstest - Skor\ Pretest}{Skor\ Maksimum - Skor\ Pretest} \quad \text{.....(3)}$$

The value of N-gain obtained is analyzed by referring to the following.

Table 3. Criteria for n-gain score

No.	N-gain value	Criteria
1.	$g < 0,3$	Low
2.	$0,3 \leq g < 0,7$	Medium
3.	$g \geq 0,7$	High

(Nita *et al*, 2020)

3. RESULTS AND DISCUSSION

Stage of Analysis

The analysis stage is the first step taken by the researcher in developing the module. The analysis includes assessing the problems that occur during learning, analyzing the curriculum used and materials that students find difficult to understand, and analyzing the teaching materials used by teachers. Here is the data obtained from the study.

a. Needs analysis

Researchers conduct this step to analyze the problems identified through observation in SMPN 15 Banjarmasin and determine the needs of students. Data obtained after observation indicate that schools have begun to switch to an independent curriculum, but students have not been actively involved because teachers dominate the learning process. Even some students pay less attention when the teacher explains and do not dare to ask questions related to poorly understood material. This has an impact on the low critical thinking ability of learners. In addition, the Learning media that teachers often use are limited to fairly thick package books and worksheets, which can lead to students being less interested in learning. The use of teaching materials in the form of modules is still relatively rare among teachers. Based on this analysis, students require learning resources that can enhance their interest in learning while stimulating their critical thinking skills. Therefore, the

researchers decided to design a teaching device in the form of a module that implements a problem-based learning approach loaded with local wisdom. The development of this IPA module incorporates the syntax of the problem-based learning model in its presentation. It features the local wisdom of the South Kalimantan region, including the cow cart, a monument to Pelaihari city, and the Baayun Mulud custom. This local wisdom can be attributed to business materials and the energy of Class VIII.

b. Curriculum analysis

The analysis process involves studying the curriculum used by the school. Curriculum analysis is conducted to gather information about the materials to be used, ensuring they align with the curriculum applied in the school. Based on the information obtained, Classes VII and VIII of SMPN 15 Banjarmasin have implemented an independent curriculum during learning, while Class IX is still in a transitional period from the 2013 curriculum. After that, the researcher analyzes the learning achievement and prepares learning objectives that will serve as a reference for developing the module. Learning objectives are designed according to the ABCD formula (Audience, Behavior, Condition, and Degree).

Stage of Design

The design stage involves creating a science module that is integrated with a problem-based learning model and incorporates local wisdom. The material used in the module is material about effort and energy. The initial stage of design begins with collecting material references from various sources, including class VIII science books. Then, compile an outline of the material that will be covered in the module, and subsequently, develop the module with the help of the Canva application. The module framework includes a cover, introduction, table of contents, list of figures and tables, usage guide, explanation of the problem-based learning model, achievements and objectives to be achieved, subject matter, exercise questions, bibliography, glossary, answer key, and compiler profile. These module components align with the aspects of the module as outlined by Kosasih (2021). During this design stage, researchers also created an instrument sheet to assess the quality of the module.

Stage of Development

This stage is the module development stage that was previously designed. The developed module is divided into two learning activities: Learning One covers material about effort, and Learning Two covers material about energy. The PBL Model in this IPA module incorporates syntax quoted from Arends, including orienting learners towards problems, organizing learners in learning, guiding individual or group investigations, developing and presenting work, and analyzing and evaluating problem-solving processes. After the development, the next step is to test the validity of the module.

Module Validity

The validity of the modules assessed encompasses three aspects: the feasibility of the content, presentation, and language. According to Nasruddin et al. (2022), teaching materials are considered feasible if they meet these three aspects. The following table presents the results of module validity.

Table 4. Science module validity results

Assessment Aspects	Validator			Percentage	Criteria
	I	II	III		
Content eligibility	63	75	78	90%	Very valid
Presentation	66	73	79	90.83%	Very valid
Language	45	52	54	91.52%	Very valid
Overall Average				**90.78%**	**Very valid**

The results of the validity test in Table 4 above show that the IPA module is designed to obtain an average percentage of 90.78% which includes very valid criteria. The aspects of content feasibility obtained very valid criteria. The material presented has been tailored to the curriculum,

enabling students to achieve learning objectives and gain new insights. The presentation of concepts in the module is well-explained, utilizing illustrations and images that depict real-world conditions, thereby encouraging students to be more engaged in their learning. The material in the module is presented in a coherent and systematic manner, which facilitates learning and encourages curiosity about the material studied (Anindiya et al., 2022).

The presentation aspect of the module is based on the assessment results obtained, which are very valid criteria. The score obtained from the experts shows that the module has fulfilled the presentation element. The module is presented in full accordance with the PBL syntax by presenting the problem at the beginning of the material discussion. The problem presented is related to the situation around the students. The presentation of the module layout is harmonious, with consistent font use and easy-to-read sentences, and the inclusion of appropriate images. Anindiya et al. (2022) stated that the presence of supporting illustrations that clarify the material plays a crucial role in creating practical modules. These illustrations can increase student interest and reduce the monotony of learning.

The linguistic aspect of the module, in general, obtained very valid criteria. The language used in the module has been tailored to accommodate the cognitive development of learners. Spelling accuracy in the module is precise and follows the correct Indonesian grammar rules. Yeni et al. (2021) revealed that using Indonesian in accordance with the rules will facilitate understanding during the learning process. Suggestions and feedback from validators to correct writing errors make the module easier and more transparent for learners to understand. Logan et al. (2021) also explain that the language used in learning materials can affect the extent to which learners master and understand the content of learning

Stage of Implementation

After the module is declared valid based on the validity test, testing is carried out to assess the level of practicality and effectiveness of the developed module. This test was administered to students of Class VIIIG at SMP Negeri 15 Banjarmasin. The results of this study will be explained in detail, relating to the practicality and effectiveness of the products developed, as follows.

Module Practicality

The assessment instrument used in conducting a practicality test is a learner response questionnaire. After the module was improved, the next step was to conduct a trial with ten students. This test phase was conducted to evaluate the readability level of the developed module. The following table presents the results of the readability questionnaire test.

Table 6. Module readability test results

No	Assessment aspect	Practicality Percentage	Criteria
1	Attractiveness of the Module	84.17%	Very Practical
2	Ease of use of the Module	83.13%	Practical
3	Presentation	76.59%	Practical
4	Benefits	80.42%	Very Practical
5	Time Efficiency	77.50%	Practical
Overall Average		**80.36%**	**Practical**

Table 7. Class trial results

No	Assessment aspect	Practicality Percentage	Criteria
1	Attractiveness of the Module	82.05%	Very Practical
2	Ease of use of the Module	80.05%	Practical
3	Presentation	77.80%	Practical
4	Benefits	82.37%	Very Practical
5	Time Efficiency	79.81%	Practical
Overall Average		**80.42%**	**Practical**

The table above presents the value of practicality obtained after distributing response questionnaires to learners, resulting in an overall percentage of 80.42%, which includes practical

criteria. The percentage results demonstrate that the prepared modules are practical and receive positive feedback from learners during the trial process. Most students agree that they can understand the science module well. As for the attraction aspect, obtaining an assessment is an efficient step. This means that the designed teaching materials have appeal both in terms of design and content. Learners agree that the science module has been developed to increase their enthusiasm for learning and reduce boredom while studying. This is because the module design features a harmonious blend of colors and is accompanied by relevant, illustrative images, thereby increasing learner interest. Ismail and Mawardi (2021) state that the use of attractive color combinations and images facilitates learning during learning activities.

The ease of Use aspect of the module gained positive feedback. Students responded that the material presented is relatively easy to understand. The use of language and sentences in the module is very clear and in accordance with the stage of development of learners. In addition, with the instructions for use in the module is able to train the independence of learners in learning. It demonstrates that the designed modules are practical and easy for learners to use, based on existing practicality criteria. When et al. (2021) stated that a product can be considered practical if teachers and learners can utilize it efficiently. As for the presentation aspect, get practical criteria. The presentation of the material is coherent and transparent, making it easier for learners to absorb the module's contents. Some students stated that the PBL-based science module incorporating local wisdom can train critical thinking skills. This is because the exercises are complex, encouraging students to hone their problem-solving skills within the module.

The usefulness aspect of the module is very positive because the module can support teachers in classroom learning. Students can also develop their critical thinking skills and have the opportunity to express their ideas through group discussions and class discussions. In terms of time efficiency aspects, this science module is categorized as good. Most students gave a disagreeing response if the use of modules could make learning not finish on time. This means that the developed module has a practical application that utilizes time effectively. The results of research by Refita et al. (2024) demonstrated that modules offer better time efficiency, enabling students to tailor their learning process to their individual abilities and learning styles.

Module Effectiveness

The effectiveness of the modules is measured through test sheets. To determine the effectiveness of using a PBL-based science learning module incorporating local wisdom, researchers conducted a n-gain analysis based on the pretest-posttest value. Assessment was conducted using 10 multiple-choice questions prepared in reference to the indicators of critical thinking skills proposed by Angelo (Nabyal, 2023). The average pretest-posttest results for learners in relation to critical thinking skills are presented in the following table.

Table 8. Recapitulation of the average score per indicator

Question Number	Critical Thinking Indicators	Average score		Value n-gain	Criteria
		Pretest	Posttest		
2. 3	Analyze	69.23	90.38	0.69	Medium
8. 10	Synthesize	21.15	61.54	0.51	Medium
1. 5	Recognize and Solve Problems	69.23	88.46	0.63	Medium
4. 7	Summarize	25.00	69.23	0.59	Medium
6. 9	Evaluate	17.31	65.38	0.58	Medium
Overall Average		**40.38**	**75.00**	**0.60**	**Medium**

The table shows that students ' pretest results are still lacking. This happens because of the limitations of the initial critical thinking ability that learners have when answering questions. After applying the science module. the test results of the students showed an increase. indicating that they had better mastered the material taught. Rokhim et al. (2018) found that the use of science modules with a PBL approach can enhance students' critical thinking skills compared to traditional learning without modules. The value of n-gain obtained based on critical thinking indicators reached 0.60 with moderate criteria. This proves that the science module is prepared in accordance with the criteria of effectiveness. making it suitable for use in the learning process.

The first indicator is the ability to analyze. specifically the learners' capacity to analyze and detail a given problem (Siahaan et al.. 2024). In this indicator. the ability to analyze learners increases. The increase shows that students can already analyze the problems contained in the problem or module. This can be observed when learners engage in discussions and can answer problems by analyzing domain indicators. Learners can work on problems carefully enough and really understand the problems given well. The second indicator measured is the ability to synthesize. which involves processing and combining information from various references to produce new ideas (Siahaan et al.. 2024). The score obtained by students when using the module increased by 0.51. The increase in the score obtained can be observed when students work on problems in the module and the given questions. Learners can connect the problems in the problem with everyday life to produce the appropriate concept.

The average score of n-gain in the indicator of knowing and solving problems obtained a value of 0.63. which is classified as a medium criterion. The increase in the score achieved shows that learners can recognize and solve the problems presented in the module. They are also actively engaged in the process of understanding the material and solving problems. and participate in discussions to complete the exercises in the module. Most students have been able to solve calculations related to effort and energy. This is because. in learning. students are given explanations in the form of examples of problems and how to calculate them using formulas. Generally. students can already provide thorough and accurate answers to questions. including in writing units and how to calculate them (Rahayu et al.. 2018).

The average normalized gain on the conclusion indicator is 0.59. which is classified as moderate criteria. This shows that students have been able to and have not been able to make conclusions from the images presented in the questions about the smallest effort when playing swing and kinetic energy when a coconut falls to the ground. Idris et al. (2023) stated that some students still struggle to conclude from observing the images in the given questions. The fifth indicator is the ability to evaluate. specifically the ability of students to determine the right or wrong answer to a problem and find appropriate solutions to address it. The average n-gain on the evaluating indicator reaches 0.58. These findings indicate that some students are already able to evaluate. as evidenced by the test results. which have improved since using the module. The ability to evaluate learners is trained during learning by utilizing the modules developed. Learners dare to express the results of the discussion and get the opportunity to provide feedback/input on the work that has been done.

Following the implementation of the science module. there was an increase in students' critical thinking skills across all indicators. This increase occurred because each stage in the problem-based learning model proved effective in honing critical thinking skills. In addition. presenting the context of local wisdom makes the material easier to understand and more relevant to the real-life situation of learners. thus supporting the development of critical thinking skills as a whole. Ningsih et al. (2022) revealed that each stage of PBL trains all critical thinking indicators. The significant difference in the average pretest-posttest value based on critical thinking indicators is shown in the diagram below.

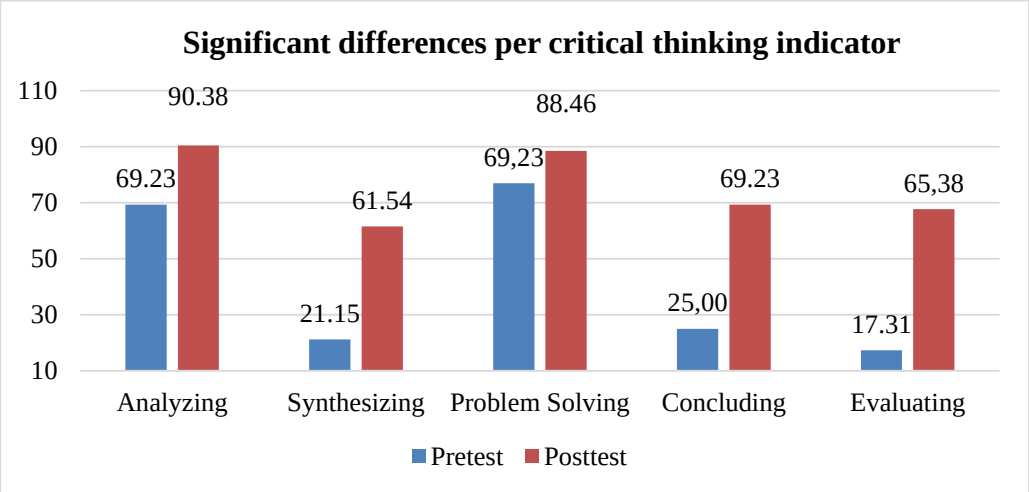

Figure 2. Significant differences in scores per critical thinking indicator

The figure above shows that the ability to analyze is the indicator with the highest value compared to the others. Mustika et al. (2024) stated that the pretest results on the indicators of ability to analyze showed a sharp increase in the most developed class. In line with the research of Hajjah et al. (2022). the critical thinking indicator analyzes the one with the highest percentage. This is because all questions that involve analyzing indicators are real and relate to everyday issues. so learners will find them easier to work on. The ability of learners to answer questions on indicators. synthesize. conclude. and evaluate is still lacking. This is evident from the lower value of the indicator. This indicates that learners struggle to answer questions related to these three indicators.

Stage of Evaluation

The next stage for researchers conducting the evaluation stage is the improvement stage of each development procedure. which begins with the analysis. design. and development stages. This stage involves making improvements to the modules developed. based on suggestions from validators and supervisors. In addition. researchers evaluated the science module by asking students who used it for their responses. Based on the results obtained. students gave positive responses to the science module. Learners feel helped and interested in the existence of this module. making it easier for them to learn materials. especially those related to effort and energy.

4. CONCLUSION

The conclusion obtained is that the PBL-based science module with local wisdom content developed is feasible to use based on the validity test. which obtained a percentage of 90.78% with very valid criteria. and based on the practicality test of the student response questionnaire. obtained a percentage of 80.36% in the readability test and 80.42% in the class test with practical criteria. The developed science module effectively improves students' ability to think critically. as evidenced by an n-gain score of 0.60. which falls within the moderate criteria. Given that the increase in students' ability to think critically is still within the medium criteria. research can be conducted on an ongoing basis. especially on indicators of synthesizing. concluding. and evaluating. to achieve maximum results.

ACKNOWLEDGMENTS

The author expresses his sincere gratitude to all those who have provided assistance and made contributions enabling this research to be carried out effectively.

REFERENCES

Anindiya. I.A.. Enawaty. E.. Sartika. R.P.. Masriani. & Rasmawan. R. (2022). Development of Modules Based on the Scientific Approach to the Materials of Elements. Compounds. and Mixtures. Scientific Journal of Education Citra Bakti. 1(9). 190-204.

Hadi. K. (2017). Development of Problem-Based Learning Model Based on Local Wisdom on Biodiversity Material for Class X. Bionatural: Scientific Journal of Biology Education. 4(2). 42-52.

Hajjah. M.. Munawaroh. F. Wulandari. A.Y.R.. & Hidayati. Y. (2022). Implementation of Experiential Learning Model to Improve Students' Critical Thinking Ability. Journal of Natural Science Educational Research. 5(1). 79-88.

Hanipah. S. (2023). Analysis of Merdeka Belajar Curriculum in Facilitating 21st Century Learning in Senior High School Students. Journal of Bintang Pendidikan Indonesia (JUBPI). 2(1). 264-275.

Idris. H.. Makkasau. A.. & Sahabuddin. E.S. (2023). The Effect of Project-Based Learning Model Implementation on Students' Critical Thinking Ability in Science Class V Elementary School. Inpres Lanraki 1. Tamalanrea District. Makassar City. Pinisi Journal of Science and Technology. 1–12.

Ismail. I. A.. & Mawardi. M. (2021). Flipped Classroom Learning System Guided Inquiry On Thermochemical Materials For High School Students Class XI. International Journal of Progressive Sciences and Technologies (IJPSAT). 30(1). 280–287.

Kosasih. (2021). Teaching Material Development. Jakarta: Bumi Aksara.

Logan. R.M.. Johnson. C.E.. & Worsham. J.W. (2021). Development of an e-learning module to facilitate student learning and outcomes. Teaching and Learning in Nursing. 16(2). 139–142.

Lubis. M. F.. Sunanta. A.. Walid. A. (2021). Development of Ethnoscience-Based Learning Modules on Global Warming Materials to Train Science Literacy Skills of Junior High School Students. Pedagogia: Journal of Educational Studies. Research and Development. 2(12). 206–214.

Ma'wa. J.. & Hidayat. A. (2023). Improving Students' Learning Activities and Critical Thinking Skills in Science Content Using the BATANAM Learning Model. Journal of Kiprah Education. 3(2). 278-284.

Mareti. J. W.. & Hadiyanti. H. D. (2021). Problem Based Learning Model to Improve Critical Thinking Ability and Student Science Learning Outcomes. Journal of Elementaria Edukasia. 1(4). 31–41.

Muliarsa. I. M. A. N.. Sutresna. I. G. L.. & Widiasih. N. L. P. N. (2024). The Effect of a PBL Model Based on Local Wisdom on the Critical and Creative Thinking Skills of Junior High School Students. Journal of Indonesian Education Science. 7(1). 33-41.

Mustika. T.. Zulaiha. F.. & Rifqi. M. (2024). The Effect of Discovery Learning Model Assisted by PhET Media on The Critical Thinking Ability of Class X High School Students. Journal of Physics Education and Science (JPIF). 2(4). 138–149.

Nabila. S.. Adha. I.. & Febriandi. R. (2021). Development of Pop-Up Book Learning Media Based on Local Wisdom in Thematic Learning in Elementary Schools. Basicedu Journal. 5(5). 3928–3939.

Nabyal. M.T. The Effect of Implementing the Thinking Empowerment Model Through Questions in History Subjects on the Learning Outcomes of Class XI Students of SMA Negeri 3 Sentani. Journal of Transformative Scientific Education. 7(12). 153–161.

Nasruddin. S.. D.M.M.. D.. I.P.A.. H.. .... Purwanto. H. (2022). Development of teaching materials. Padang: PT Global Executive Technology.

Nita. R.. Syubhan. A.. & Sari. M.M. (2020). Development of a Science Module on the Material of the Movement System in Living Things Based on Local Wisdom. Indonesian Journal of Science Education (IJNE). 3(1). 281–292.

Ningsih. E.M.. Efendi. N.. & Sartika. S.B. (2022). The Effect of Problem-Based Learning Model on Students' Critical Thinking Skills in Science Subjects. DIKSAINS: Scientific Journal of Science Education. 1(3). 1-6.

Prabowo. W. R.. Purnomo. D.. & Mushafanah. Q. (2020). Cooperative Method Type index Card Match Improves Learning Outcomes of Fifth Grade Students on the Theme of Events in life. Journal of Mimbar Ilmu. 3(25). 380-390.

Rahayu. D.N.G.. Harijanto. A.. & Lesmono. A.D. (2018). The Level of Critical Thinking Ability of High School Students on Dynamic Fluid Material 1) Journal of Physics Learning. 7(2). 162–167.

Rokhim. A.R.. Suparmi. & Prayitno. B.A. (2018). Development of Science Modules Based on Problem-Based Learning on the Material of Claor and its Displacement to Improve Critical Thinking Ability of Junior High School Students in Grade VII. Journal of Inquiry. 1(7). 143-150).

Rosidi. A.. Rohman. F.. Novianti. & Hariadi. I. (2023). Development of PBL-based E-module of Diversity of Living Things with Local Wisdom and its Effect on Critical Thinking Skills. Problem Solving. and Environmental Attitudes. Bioscientist: Scientific Journal of Biology. 2(11). 1662-1677.

Siahaan. Y.. Rohmat. D.. Yani. A.. & Somantri. (2024). Assessment of Renewable Energy Potential Based on Water Resources: A Transformation of Critical Thinking Measurement Instrument for Geography Students. Indramayu: CV Adanu Abimata.

Wahyuni. E.. Hartati. T. S.. & Nuraida. D. (2023). Validity of Science Modules Integrated with Problem-Based Learning to Improve Students' Critical Thinking Skills. ALVEOLI: Journal of Biology Education. 1(4). 20–28.

Yeni. T.. Enawaty. E.. Sahputra. R.. Muharini. R.. & Sartika. R. P. (2021). Development of PBL-Based LKPD with Liveworksheet on Thermochemistry Subject in SMA/MA Pontianak. Pros. Sem. National. Kpk. 4.

Yuniswara. R. A.. Erman. & Ilhami. F. B. (2024). Improving students' critical thinking skills through

inquiry learning based on socio-scientific issues. BIOCHEPHY: Journal of Science Education. 1(4). 447–457