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Development of an Integrated PjBL E-Module on the Character of Kayuh Baimbai and the SETS Approach to Training Science Literacy

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Abstract

The low level of students' science literacy, as reported in the 2022 Programme for International Student Assessment (PISA), remains a major challenge in physics education. This study aimed to determine the validity of a Project-Based Learning (PjBL) e-module integrated with Kayuh Baimbai character values and the Science, Environment, Technology, and Society (SETS) approach to support the development of students' science literacy. This study employed a research and development design using the ADDIE model, focusing on the development and validation stages. The research subjects consisted of 54 eleventh-grade students from SMAN in Banjarmasin, divided into an experimental class and a control class, each comprising 27 students. The research instruments included validation sheets used to evaluate the developed products, namely the e-module, teaching materials, student worksheets, and learning achievement tests. The level of validity was analyzed using the average validator scores, while reliability was determined using Cronbach's alpha coefficient. The results indicated that all developed learning components achieved the "very valid" category, suggesting that the e-module was suitable for use in physics learning. The integration of local wisdom through Kayuh Baimbai character values with the SETS approach represents an innovative contribution to the development of culturally relevant digital learning materials to support students' science literacy.

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INTRODUCTION

Science literacy is an essential competency in the 21st century, encompassing the ability to understand scientific concepts, think critically, and apply scientific knowledge to real-life situations (Noor et al., 2025; Dewantara et al., 2019; Fitri et al., 2025; Hartini, et al., 2024; Wati, Mahtari, et al., 2023; Wati, Pratiwi, et al., 2023). According to the Programme for International Student Assessment (PISA), science literacy refers to an individual's ability to engage with science-related issues and ideas as a reflective citizen. It includes the ability to explain scientific phenomena, evaluate and design scientific inquiries, as well as interpret data and evidence scientifically (OECD, 2023). Therefore, science literacy is considered a crucial indicator for assessing the quality of science education across countries.

However, the science literacy performance of Indonesian students remains relatively low. Over the past decade, Indonesian students have consistently scored below the international average in PISA assessments. Previous reports indicated scores ranging from 382 to 403 in the 2006, 2009, 2012, and 2015 cycles (Hidayah et al., 2019). Furthermore, the science literacy score of Indonesian students in PISA 2018 was 396 (Apra & Aprilisia,

2022; Ichsan et al., 2023; Lendeon & Poluakan, 2022; Zulyusri et al., 2023). This score further declined to 383 in PISA 2022, which is still categorized as low at the international level (OECD, 2023). These results indicate that many students continue to experience difficulties in understanding, evaluating, and applying scientific information to solve real-world problems.

Several factors contribute to the low level of science literacy, including the curriculum and education system, the selection of teaching models and instructional methods, limited facilities and infrastructure, and the use of learning resources that do not fully support 21st-century learning (Agustin et al., 2021). Consequently, students tend to have limited awareness of environmental issues and scientific developments, including natural phenomena and the local characteristics surrounding them (Yulia et al., 2021). This situation raises serious concerns about the development of competitive human resources capable of addressing both global and local challenges.

Interviews with physics teachers of Grade XI at SMAN 4 Banjarmasin revealed that science literacy has not been explicitly measured in the learning process. Students still experience difficulties in understanding physics concepts and demonstrate limited interest in the subject. The Science, Environment, Technology, and Society (SETS) approach is considered important because it connects scientific concepts with environmental issues, technological developments, and social contexts, enabling students to understand physics in a more meaningful and contextual way (Adhiyah & Pertiwi, 2024; Elistiana et al., 2024; Widiastuti & Purnawijaya, 2021; Wilujeng & Putri, 2020; Yevira et al., 2023; Hartini et al., 2024; Miriam et al., 2025). However, the teaching methods used remain predominantly conventional, and the implementation of the Project-Based Learning (PjBL) model is still limited to simple practical activities.

To address these challenges, it is necessary to develop innovative teaching materials that can foster science literacy while integrating contextual and cultural elements into the learning process. One potential approach is the development of a PjBL e-module integrated with the values of *Kayuh Baimbai* and the SETS approach. *Kayuh Baimbai* represents a form of local wisdom from the Banjar community in Banjarmasin. The term *Kayuh Baimbai* consists of two words, *kayuh* and *baimbai*, which reflect the philosophy that working together leads to greater success than working individually (Hasani et al., 2019). This value emphasizes cooperation, solidarity, and collective responsibility in completing tasks (Wahyu, 2020).

Integrating the *Kayuh Baimbai* character into the learning process is expected to strengthen local wisdom while fostering students' collaborative attitudes. At the same time, the SETS (Science, Environment, Technology, and Society) approach connects scientific concepts with environmental issues, technological development, and societal contexts (Siagian et al., 2023). Through this approach, physics learning becomes more contextual, enabling students to relate scientific concepts to real-world phenomena and community life.

Previous studies have demonstrated that PjBL can improve students' problem-solving skills and conceptual understanding, while the SETS (Science, Environment, Technology, and Society) approach enhances contextual learning by linking science with environmental and societal issues. Similarly, the integration of local wisdom in science education has been shown to increase students' engagement and cultural relevance in learning. However, most previous studies have examined these approaches separately. Research that integrates PjBL, the SETS framework, and local wisdom values within a digital physics learning module to support science literacy remains limited, particularly in the context of static fluid topics.

Therefore, this study aims to address this gap by developing a science literacy-oriented e-module on static fluid topics that integrates the PjBL model, the *Kayuh Baimbai* character, and the SETS approach. The main objective of this study is to evaluate the

validity of the developed e-module as a teaching tool that is suitable for supporting physics learning and fostering students' science literacy.

METHODS

This study employed a research and development (R&D) approach using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. However, this study was limited to the Development stage, particularly the expert validation process. Therefore, the primary objective of this study was to evaluate the validity of the developed learning materials prior to their implementation in classroom learning.

The Analysis stage was conducted to identify students' learning needs, analyze the curriculum, and examine the characteristics of the static fluid topic in physics learning. The Design stage involved designing a science literacy-oriented e-module by integrating PjBL, the values of *Kayuh Baimbai* local wisdom, and the SETS approach. At the Development stage, the e-module and its supporting learning components were developed and subsequently evaluated through expert validation.

The developed learning products included the e-module, teaching materials, student worksheets, and learning achievement tests. These products were evaluated by three validators, consisting of academic experts and practitioner experts. The use of three validators is considered adequate in development research to obtain reliable expert judgments while maintaining practical feasibility in the validation process.

This research was conducted from February to July 2025. Data were collected using a validation questionnaire distributed to the expert validators. The validation instrument employed a four-point Likert scale ranging from 1 (very poor) to 4 (very good). The validation questionnaire consisted of several assessment aspects, including: (1) the overall quality of the e-module, (2) the suitability of the teaching materials with the learning objectives and science literacy indicators, (3) the quality of the student worksheets, and (4) the appropriateness of the learning achievement tests.

The validity level of the developed products was determined by calculating the average score of the validators' assessments using the following formula:

$$\bar{x} = \Sigma X / N \quad (1)$$

where $\bar{x}$ represents the average validity score, ΣX represents the total score obtained from the validators, and N represents the total number of assessment items.

The obtained average score was then interpreted using the validity criteria presented in Table 1.

Table 1 E-module validation aspect criteria

Average Score	Category
$\bar{x} > 3.4$	Very valid
$2.8 < \bar{x} \leq 3.4$	Valid
$2.2 < \bar{x} \leq 2.8$	Adequately valid
$1.6 < \bar{x} \leq 2.2$	Less valid
$\bar{x} \leq 1.6$	Very less valid

Rizki et al. (2021)

To ensure the consistency of the validators' assessments, a reliability analysis was conducted using Cronbach's alpha coefficient. Cronbach's alpha measures the internal consistency of validation results obtained from multiple validators. The reliability of the expert validation data was calculated to determine the consistency of the results obtained from the three validators. The criteria for interpreting Cronbach's alpha values used in this study are presented in Table 2.

Table 2 Reliability criteria using Cronbach's alpha

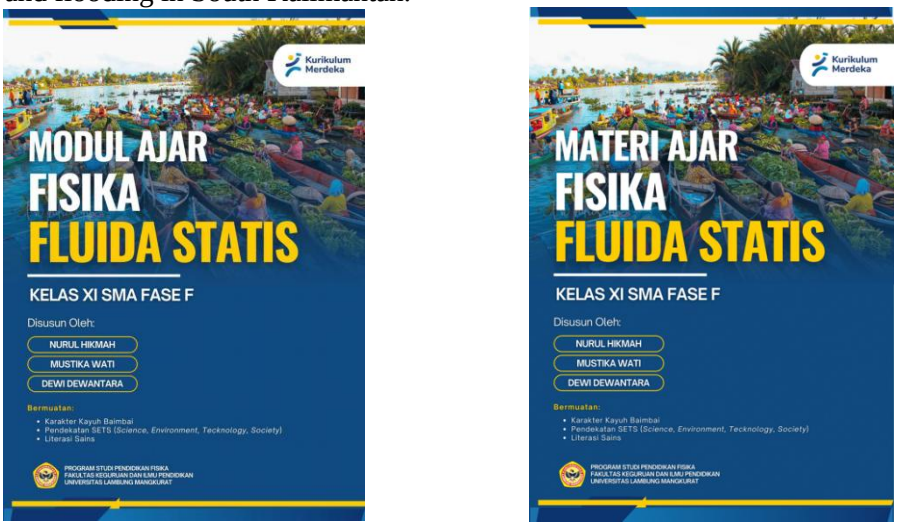
Score Range	Category
$0.80 \leq \bar{r} \leq 1.00$	Very high
$0.60 \leq \bar{r} \leq 0.80$	High
$0.40 \leq \bar{r} \leq 0.60$	Moderate
$0.20 \leq \bar{r} \leq 0.40$	Low
$\bar{r} < 0$	Verey Low

RESULTS AND DISCUSSION

The product developed in this study is an e-module designed as a teaching resource for teachers, containing instructional materials on static fluids, including the subtopics of hydrostatic pressure, Pascal's Law, and Archimedes' Law, as well as student worksheets and learning achievement tests. The e-module is structured in accordance with the Independent Curriculum standards issued by the Ministry of Education, Culture, Research, and Technology, and consists of three main components: general information, core components, and attachments.

As the e-module was developed to foster students' science literacy, its content framework is designed to facilitate the development of science literacy dimensions. In this study, the primary dimension targeted is scientific competence.

Figure 1 illustrates the developed static fluid e-module, which presents the content in a contextual and interactive manner, complemented by project-based activities and reflective components integrating the *Kayuh Baimbai* character values. The SETS approach was implemented by connecting the learning materials to local phenomena, such as floating houses and flooding in South Kalimantan.



(a) (b)

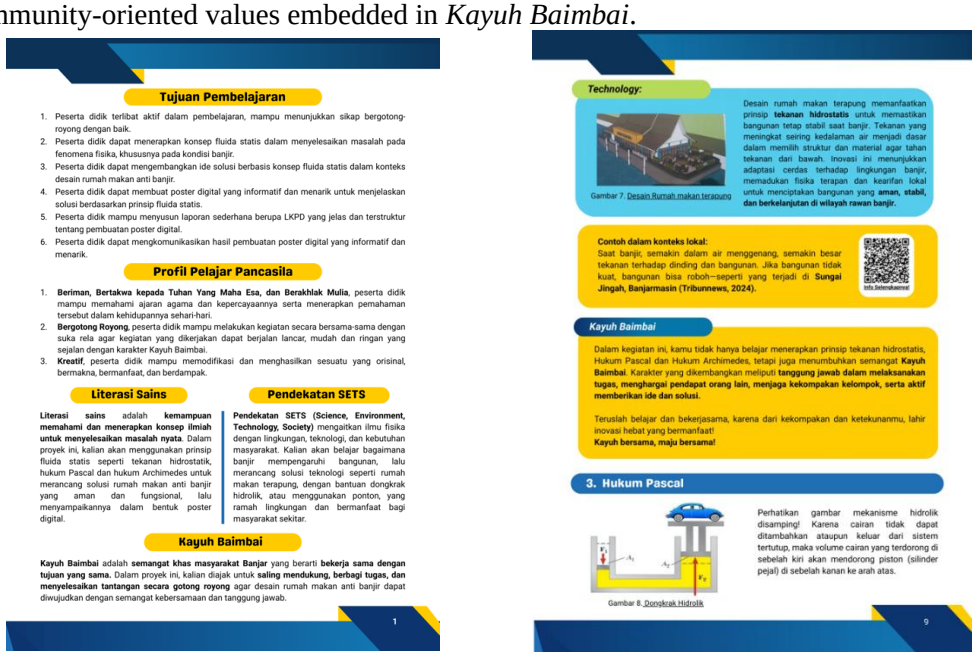
Figure 1 Display of: a) cover of the teaching module; and b) cover of the developed teaching material

The e-module was systematically structured, comprising the cover, module identity, initial competencies, the Pancasila learner profile as the foundation of character values, learning outcomes, learning objectives, meaningful understanding, and guiding questions. The core component consisted of a sequence of learning activities organized into preliminary, core, and closing stages, which were implemented using the SETS approach and the syntax of the PjBL model. In addition, science literacy–based assessments were provided, along with teacher and student reflections as a form of learning process evaluation.

As a supplementary component, the e-module included teaching materials that presented static fluid concepts in everyday contexts, supported by illustrations, worked

examples, integration of the SETS approach, and interesting facts to facilitate students' understanding. Student Worksheet 1 was designed based on contextual problems to train students to explore phenomena, analyze data, and solve real-world problems relevant to their environment. Meanwhile, Student Worksheet 2 focused on the implementation of a PjBL project in the form of a digital poster.

Figure 2 illustrates the integration of the SETS approach and the *Kayuh Baimbai* character values within the developed e-module. Figure 2a presented general information describing how the SETS approach was conceptually linked with the *Kayuh Baimbai* character as the foundation for character education, while Figure 2b showed its practical implementation within the e-module learning activities. This integration was intended to contextualize static fluid concepts through local phenomena while simultaneously strengthening students' character development in line with collaborative, responsible, and community-oriented values embedded in *Kayuh Baimbai*.



(a) (b)

Figure 2 a) information on the integration of the SETS approach and the *Kayuh Baimbai* character; and b) integration of the SETS approach and the *Kayuh Baimbai* character in the e-module

Assessment was conducted using science literacy and higher-order thinking skills (HOTS)-based questions integrated with local contexts and supported by an objective assessment rubric that evaluated knowledge, scientific process skills, and attitudes. These components were systematically integrated to ensure that learning was meaningful, contextual, and supportive of students' character development.

The module validation process involved two academic experts (lecturers in Physics Education at the Faculty of Teacher Training and Education, Universitas Lambung Mangkurat) and one practitioner (a Grade XI physics teacher at SMAN 4 Banjarmasin), who evaluated the module using a validity instrument. The validation results were categorized into four aspects: e-module validity, teaching material validity, student worksheet validity, and learning achievement test validity. When the validation results were deemed satisfactory with minor revisions, the module proceeded to the revision stage.

Teaching Module Validity

Table 3 summarizes the validity and reliability results of the developed teaching module, covering aspects such as module identity, learning approach, core components, assessments, and supporting rubrics, as evaluated by the expert validators.

Table 3 Summary of teaching module validity

Review Aspect	Validity Score	Category
Module identity	4.00	
Pancasila Student Profile	4.00	
Facilities and infrastructure	4.00	
Target students	4.00	
Approach/model	4.00	
Core components	3.78	
Meaningful understanding	4.00	
Prompting questions	4.00	
Learning preparation	4.00	
Learning activities	4.00	
Student & Teacher Reflection	3.93	
Rubric for Student Worksheets	3.83	
Attitude rubric	3.93	
Average Score	**3.96**	**Very valid**
Reliability	**0.83**	**Very high**

Based on Table 1 from Rizki et al. (2021), teaching modules are considered *very valid* if the average validation score exceeds 3.4. In this study, the validation results from three validators indicated that the developed e-module obtained an average score of 3.96, which falls into the *very valid* category. This result was reinforced by the achievement of a perfect score (4.00) in several important aspects, including module identity, Pancasila learner profile, facilities and infrastructure, target learners, learning approach/model, meaningful understanding, guiding questions, and learning preparation and activities.

The high scores in these aspects indicate that the e-module has met the standards of content, presentation, language, and format overall. In line with these findings, Zulfadli et al. (2022) emphasized that well-designed e-modules can significantly support learning effectiveness through attractive and interactive features.

In addition, reliability was calculated using Cronbach's alpha coefficient. A reliability value is considered *very high* if $r \geq 0.80$. The reliability value for the e-module identity aspect reached 0.83, indicating that the validation results demonstrated good consistency among the validators and met theoretical reliability standards.

Teaching Material Validity

The static fluid material was divided into three subtopics: (1) hydrostatic pressure, (2) Pascal's law, and (3) Archimedes' law. These subtopics were designed to foster students' science literacy through the SETS (Science, Environment, Technology, and Society) approach and the integration of the *Kayuh Baimbai* character values.

Table 4 presents the results of the teaching material validity assessment conducted by expert validators. The table summarizes the average scores for each assessed aspect, including reading materials, glossary, and bibliography, along with the overall validity category and reliability level.

Table 4 Results of teaching material validity

Aspect of Teaching Module Review	Validity Score	Category
Reading materials/teaching materials	3.90	
Glossary	4.00	
Bibliography	4.00	
Average score	**3.97**	**Very valid**
Reliability	**0.80**	**Very high**

Based on Table 4, the validation results show that the teaching materials obtained an average score of 3.90, which falls into the *very valid* category. This is in accordance with the validation criteria proposed by Rizki et al. (2021), which state that an average score exceeding 3.4 is classified as *very valid*. Thus, the obtained score of 3.90 exceeded the minimum threshold for the highest validity category.

Meanwhile, the reliability value of 0.80 falls into the *very high* category. This indicates that the assessments among validators were consistent and reliable.

In addition to the main teaching materials, two supporting components, namely the glossary and bibliography, also received very high scores. The glossary received a perfect score of 4.00, indicating that the definitions of terms were presented in a complete, clear, and accessible manner for students. The bibliography also received a score of 4.00, indicating that the references used in the e-module were relevant, credible, and appropriate.

Overall, the average validity score for all aspects of the teaching materials reached 3.97, which indicates that the teaching module falls into the *very valid* category and is suitable for use in the learning process. These results are consistent with the ideal validity criteria based on theoretical studies, indicating that both the content and technical aspects of the e-module have been optimally fulfilled.

Validity of Student Worksheets

The researchers developed student worksheets as an integral component of the assessment within the teaching module to enhance students' process skills, particularly in science literacy and in completing a final project in the form of digital posters. Hartini et al. (2024) stated that the structure of student worksheets includes several key components, such as the worksheet design (cover), a description comprising an introduction and instructions for use, and clearly defined learning objectives.

In this study, the student worksheets were developed by incorporating contextual issues derived from news articles presenting real environmental problems. Students were guided to analyze these issues based on the principles of static fluids (science) and to design solutions as final products in the form of digital posters (technology).

Table 5 presents the results of the student worksheet validity assessment conducted by expert validators. The table reports the average validity score and the corresponding validity category, along with the reliability coefficient based on Cronbach's alpha.

Table 5 Student worksheet validity results

Teaching Module Review Aspects	Validity Score	Category
Student worksheets	3.43	**Very valid**
Reliability	**0.86**	**Very high**

Based on Table 5, the validators' assessment results indicate that the student worksheets obtained an average validity score of 3.43. When compared with the validity criteria proposed by Rizki et al. (2021), this score falls into the *very valid* category. This finding suggests that the developed student worksheets met the required standards in terms of content quality, format, and usability in the learning process.

Furthermore, the reliability of the validation results from the three validators was calculated using Cronbach's alpha, yielding a coefficient value of 0.86. This value is classified as *very high* ($0.80 \leq r \leq 1.00$), indicating a high level of consistency among the validators' assessments.

Considering the obtained validity and reliability scores, as well as the theoretical review of ideal instructional material criteria, it can be concluded that the developed student worksheets were suitable for use in the learning process. In particular, they effectively supported project-based activities designed to enhance science literacy through the SETS (Science, Environment, Technology, and Society) approach and to strengthen the *Kayuh Baimbai* character values.

Learning Achievement Test Validity

The researchers developed a Learning Achievement Test as part of the assessment in the teaching module to measure students' science literacy achievement. The learning achievement test consisted of five essay questions designed based on the dimensions of science literacy, particularly scientific competence. The questions were developed by considering a range of cognitive levels, with a minimum requirement of C3 in accordance with the operational action verbs (KKO) specified in the learning objectives, so that they could reflect variations in students' levels of knowledge mastery.

Table 6 THB validity results by validators

Module Review Aspects	Validity Score	Category
Learning Outcome Test	3.73	**Very valid**
Reliability	0.82	Very high

Based on Table 6, the learning achievement test obtained a validity score of 3.73, which falls into the *very valid* category. This indicates that all items were suitable for use as a tool to measure students' science literacy achievement. Meanwhile, the reliability value of 0.82 falls into the very high category, indicating that the level of consistency among the validators was high and that the assessment results were reliable.

The validators also provided a note for improvement, stating that it is necessary to review the alignment between the operational action verbs used in the questions and the learning objectives, particularly for several items that were considered less operational.

All learning achievement test items were designed by integrating the Kayuh Baimbai character values, the SETS approach, and real phenomena related to static fluids in students' environments. Thus, the learning achievement test items not only assessed students' understanding of physics concepts but also encouraged them to think critically and scientifically in solving contextual problems.

With *very valid* and reliable results, the learning achievement test in this e-module was deemed suitable for use in the learning process. However, formative revisions were still required in certain aspects for improvement.

Overall, the assessment aspects of the e-module were deemed suitable for use, with the note that several improvements were still required. Recommendations for improving the teaching module are presented in Table 7.

Table 7 Recommendations for improving the teaching module by the validator

No.	Recommendations for Improvement	Validator's Comments
1.	Double-check the consistency among CP, ATP, and assessment rubrics for each element to ensure alignment with the assessment instruments.	Academic I
2.	Ensure that all equations are properly numbered and that the concepts presented in the module are accurate.	
3.	Ensure that each learning objective contains only one operational action verb (KKO).	Academic II
4.	Add enrichment and remedial questions to the teaching module.	
5.	Double-check the number of criteria used to assess process skills, as one criterion is missing.	Practitioner
6.	Revise the typographical error in the assessment rubric criteria on page 13.	

After revisions were made in accordance with the recommendations provided by the validators, the final product of this study was obtained, namely an e-module integrating PjBL with the *Kayuh Baimbai* character and the SETS approach to foster science literacy.

CONCLUSION

This study developed a PjBL e-module integrated with the SETS approach and the local character values of *Kayuh Baimbai* for static fluid learning. The module was designed to support the development of students' science literacy, particularly in the dimension of scientific competence, and was structured in accordance with the Merdeka Curriculum. The integration of contextual phenomena, project-based activities, and local cultural values was intended to provide meaningful and relevant physics learning experiences.

The validation results obtained from three validators, consisting of two academic experts and one practitioner, indicated that the developed e-module achieved the *very valid* category with *very high* reliability. These results suggest that the developed module met the expected standards in terms of content, structure, and instructional design, and therefore was considered suitable for use as a supporting teaching material in physics learning.

However, this study was limited to the development and validation stages of the ADDIE model. The effectiveness of the developed e-module in improving students' science literacy has not yet been empirically tested through classroom implementation. Therefore, further studies are recommended to employ experimental or quasi-experimental designs to examine the impact of the developed e-module on students' science literacy, learning outcomes, and engagement in physics learning.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

AUTHOR CONTRIBUTIONS STATEMENT

All authors contributed to the conceptualization, methodology, formal analysis, investigation, and writing of this article.

AI DISCLOSURE STATEMENT

The authors declare that this research was prepared, researched, written, and edited without the aid of artificial intelligence (AI) techniques.

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