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ORIGINAL RESEARCH

Development of a physics learning module based on local wisdom in the traditional Pado'a Sabu Raijua dance to improve students' critical thinking skills.

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Abstract

This study employs the Research and Development (R&D) method, utilizing the ADDIE model, which comprises five stages: analysis, design, development, implementation, and evaluation. The subjects of the study were students of class XI IPA at SMA Negeri 1 Hawu Mehara. The instruments used included validation sheets by material experts and design experts, teacher and student response questionnaires, and critical thinking tests conducted before and after using the module (pretest and posttest).The validation results showed that this local wisdom-based physics learning module fell into the feasible category, with scores 78% from material experts and 85% from design experts. The module was also considered practical by teachers and students in small and large group tests. Additionally, the module proved effective in enhancing students' critical thinking skills, with an average N-Gain value of 0.7, which falls within the moderate category.

Keywords: Physics learning module · local wisdom of pado'a dance · critical thinking skills

INTRODUCTION

The 21st-century education emphasizes the importance of mastering high-level thinking skills, in-depth understanding of concepts, and the ability to relate knowledge to real-life contexts (Mahmud & Wong, 2022; Nurhidayati et al, 2023; Nilimaa, 2023). A study shows that high school students' critical thinking skills are in the moderate category, so an effective effort is needed (Williamson; 2023; Muliakoswara, et al 2024; Yassin, 2024). In this context, learning physics as part of science requires an innovative and contextual approach so that students not only understand physics concepts abstractly, but are also able to apply them in everyday life. Unfortunately, learning physics in high schools is still often considered difficult, abstract, and less relevant to students' daily lives. The disconnect between the material taught and the students' local context causes their interest and understanding of physics to be low (Zahra & Basri, 2017; Wilujeng et al 2024).

One contributing factor to this problem is the expository learning approach, which lacks innovation. The learning media used often do not reflect the needs and characteristics of students, especially those in areas with high cultural and traditional diversity (Sartono, et al. 2022). Therefore, a contextual, inclusive learning model based on students' real-life experiences is needed. The Independent Curriculum currently implemented in Indonesia emphasizes the

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importance of project-based learning, differentiation, and character building based on students' socio-cultural environments (Ministry of Education and Culture curriculum, 2024).

In this context, a local wisdom-based learning approach is highly relevant. Local wisdom embodies cultural, social, and ecological values that have developed within communities over generations. Integrating local wisdom into learning can be an effective way to ground scientific concepts, making them easier for students to understand and accept (Panis et al., 2023; Liliawati et al. 2025). Furthermore, this approach contributes to the preservation of local culture and the development of student character that values their traditions and regional identity (Wahyuni, 2015; Wijayanti, 2025).

One form of local wisdom that has the potential to be integrated into physics learning is traditional dance (Susanto et al., 2023). Traditional dances involve many repetitive movements, beats, turns, and rhythms that can be studied from a physical perspective, including aspects of kinematics, force, energy, and sound. Pedagogically, dance can be a fun, contextual, and relevant learning resource for students (Alencar et al., 2025; Ekeh et al., 2025).

The Pado'a dance is a traditional dance of the Sabu Raijua people of East Nusa Tenggara. It is typically performed in groups in a circle or line, with rhythmic footwork, producing a distinctive sound from the “ketupat” (a bamboo instrument tied to the dancer's feet). The movement and sound elements in the Pado'a dance are closely related to physics concepts such as linear motion, circular motion, speed, acceleration, action-reaction forces, friction, and sound waves. Therefore, the Pado'a dance has great potential as a context for authentic and meaningful physics learning.

The use of learning modules that integrate local wisdom, such as the Pado'a dance, is a concrete solution to address the gap between scientific concepts and students' cultural realities. Modules are systematically structured, self-paced teaching materials that can be used by students for active and independent learning. Local culture-based modules not only enrich learning content but also provide integrative, cognitive, affective, and psychomotor learning experiences. However, the development of physics learning modules based on local wisdom, particularly the Pado'a dance, is still very limited, both in terms of quantity and empirical research. Therefore, systematic efforts to develop, assess the feasibility, and measure the practicality of physics learning modules based on the Pado'a dance are crucial to support innovation in physics learning in secondary schools, particularly in areas with a high local cultural richness such as Sabu Raijua.

METHOD

This research is a research and development (R&D) that aims to produce a product in the form of a physics learning module based on local wisdom of traditional Pado'a dance on the kinematics of straight and circular motion, as well as to test the feasibility, practicality and effectiveness of the module. This research was conducted at SMA Negeri 1 Hawu Mehara. The subjects in this study were students of class XI IPA SMA Negeri 1 Hawu Mehara, Physics Teachers, and Lecturers of the Physics Education Study Program, Nusa Cendana University Kupang. The development model used is the ADDIE model which consists of five stages, namely Analysis, Design, Development, Implementation, and Evaluation.

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Analysis stage

The analysis phase deals with the obstacles in physics learning that arise during a lesson. The analysis was conducted by identifying learning needs, student characteristics, and analyzing the curriculum and physics materials relevant to the context of the Pado'a dance, particularly on the topic of linear and circular motion kinematics. The technique used was an interview with a physics teacher at a public high school in Sabu Raijua Regency. The analysis results showed that physics learning is still abstract and not related to the context of students' lives, so that a contextual learning module based on local culture is needed.

Design stage

At the design stage, the development of local wisdom-based learning modules is carried out, including the module structure, content and display design, as well as the formulation of local culture-based learning activities, collecting images or illustrations of local wisdom that are related to the kinematics of straight and circular motion material, compiling the initial design of the learning module, and compiling validation instruments and response questionnaires to assess practicality.

Development stage

The development stage includes the complete module creation process, from content, illustrations, to evaluation questions. After the module based on local wisdom on the traditional Pado'a Sabu Raiju dance on the kinematics of straight and circular motion is completed, validation will be carried out by experts. The assessment includes 2 aspects, namely the material aspect and the media design aspect, involving 2 lecturers from the Physics Education study program, Nusa Cendana University, Kupang. The feasibility assessment is carried out using a validation sheet instrument and will be analyzed using the following equation:

$$P = \frac{\Sigma x}{\Sigma x_i} \tag{1}$$

where P is percentage (%); Σx is measure score; and Σx_i is ideal score. To determine the feasibility and practicality or benchmark for the learning module created using the assessment criteria presented in Table 1 (Riduwan, 2013).

Table 1. Criteria for assessment of feasibility and practicality

Percentage (%)	Criteria
80-100	Very Feasible/Practical
61-80	Feasible/Practical
41-60	Quite Decent/Practical
21-40	Less Feasible/Practical
0-20	Very Less Feasible/Practical

Impementation stage

The module was tested on students of class XI MIPA of SMA Negeri 1 Hawu Mehara through two stages, namely small groups (10 students) and large groups (25 students). To assess the practicality of the module, a student and teacher response questionnaire instrument was used. This questionnaire covered aspects of appearance, content/material, learning, readability,

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general module, critical thinking skills. All data were analyzed qualitatively and quantitatively. Qualitative data were sourced from teacher interviews. While quantitative data came from filling out validation questionnaires and response assessment questionnaires during small and large group trials. The instrument used to determine the improvement of students' critical thinking skills was a critical thinking ability essay test developed based on critical thinking indicators according to Fisher, (2011) & Ennis, (1996). The indicators measured include: 1) interpretation, which refers to students' ability to understand and interpret relevant data or information; 2) analysis, which reflects students' ability to analyze information from various sources, including linking physics concepts to local cultural elements; 3) evaluation, which involves the ability to assess arguments or ideas, including judging the truth or appropriateness of physics concepts within the context of local wisdom; 4) inference, defined as the ability to draw logical conclusions based on existing evidence or data; 5) explanation, which is the ability to systematically explain a physics phenomenon or concept related to dance and to connect scientific knowledge with real-life experiences; 6) problem-solving, referring to students' ability to apply physics concepts in real-life contexts; and 7) self-reinforcement, which describes students' ability to reflect on and regulate their own thought processes in understanding the material.

The questions were given in the same pretest and posttest form, consisting of 14 open-ended descriptive questions with weights for each indicator. The pretest and posttest data were analyzed quantitatively using the Normalized Gain (N-Gain) formula to determine the increase in students' critical thinking skills after using the module. The N-Gain formula according to Hake (1999) is:

$$< g >= \frac{Score_{posttest} - Score_{Pretest}}{Score_{ideal} - Score_{Pretest}} \quad (2)$$

Then, the N-Gain results are classified into the categories as seen in Table 2.

Table 2. N-Gain criteria

Score	Criteria
$< g > > 0,7$	High
$0,3 < < g > \leq 0,7$	Moderate
$< g > \leq 0,3$	Low

Evaluation stage

Formative evaluation is an evaluation during the development and implementation process for module improvement, while summative evaluation is an evaluation to assess the effectiveness of the module in improving students' critical thinking skills based on the results of the pretest and posttest. The evaluation results are used as a basis for concluding the feasibility, practicality, and effectiveness of the physics learning module based on the local wisdom of the Pado'a dance.

RESULTS AND DISCUSSION

Analysis Stage

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The analysis phase was conducted by identifying the conditions of physics learning in schools, as well as the potential of local culture that can be integrated into learning. Based on the results of interviews with teachers at one of the State Senior High Schools in Sabu Raijua Regency, it was found that students had difficulty in understanding the material on motion and force because the material was abstract and lacked concrete examples relevant to their environment. The curriculum analysis showed that the physics material for grade XI, such as linear motion, circular motion, and force, is very possible to be integrated with the traditional Pado'a dance movements performed by the Sabu Raijua community. This dance is characterized by marching movements, circular formations, and foot stomping that produces sounds that can be studied from the aspects of kinematics and dynamics. This phase resulted in the formulation of the need to develop a learning module that is able to present physics material in a local cultural context that is close to the students' experiences.

Design Stage

In the design stage, the researcher developed the module's structure and components, including topic determination (linear motion and circular motion), concept maps, learning objectives, student activity scenarios, evaluations, and illustrations to support understanding. This module was also designed to support independent learning, with an attractive layout, simple language, and visual illustrations that help students relate physics concepts to dance movements. This design was developed based on the principles of effective modules according to Arsyad (2002), namely: systematic, communicative, applicable, and flexible. For more detailed, the design framework provided in Table 3.

Table 3. Design framework for physics learning modules based on local wisdom in traditional Pado'a dance

Module Framework	
Module Components	*Description/Contents*
Front Cover	• Module title: Physics Learning Module Based on Local Wisdom in the Traditional Pado'a Sabu Raijua Dance • Illustration of local culture (Pado'a dancer)
Introduction	• The compiler's explanation of the background, objectives of module development, and benefits of the module for local culture-based learning.
List of contents	• Contains a complete table of contents with module sub-components, chapters, and pages.
Glossary/Vocabulary	• List of important terms in the module, for example: acceleration, angular velocity, centripetal force, and cultural terms such as "Pado'a".
Concept maps	• A flowchart that explains the relationships between topics in a module.
Module Section	*Description/Contents*

Introduction	• Short description: Explanation of the importance of local wisdom-based physics learning.
	• Prerequisite Material: Basic knowledge that students need to master.
	• Instructions for using the module for students and teachers.
	• Competence:
	  ○ Learning objectives are based on the Learning Outcomes (CP) elements of the independent curriculum.
	  ○ Learning objectives: Focus on students' critical thinking skills
	• Initial test/check of student abilities
	• Diagnostic questions to determine students' initial abilities.

Learning activity	• Consists of several learning activities (Learning Activity 1 & Learning Activity 2):
Learning Activity 1	• Topic: The concept of straight motion and its application in the Pado'a Dance. • Material: Basic explanation of speed, acceleration, distance, and time.

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Module Framework	
Learning Activity 2	• Activity: Watching a video of the Pado'a dance and analyzing the straight movements of the dancers. • Assignment: Student Worksheet (LKPD) to calculate the average speed of dancers in certain movements. • Topic: Circular motion and its application in pado'a dance. • Material: Concept of centripetal acceleration, angular velocity, and centripetal force. • Activity: Identifying circular movement patterns in the Pado'a dance. • Assignment: LKPD to analyze acceleration in circular motion based on observation data.
Summary	• A conclusion that summarizes the learning in the module and encourages students to continue learning to integrate science with local culture.
Evaluation	*Description/Contents*
Formative Test	• Multiple choice questions and short essays related to the concept of straight and circular motion in the context of the Pado'a dance.
Practice Test	• Data analysis from observations of Pado'a dance movements, for example calculating acceleration or force based on the data provided. • Presentation of a short report on the analysis of physics in the Pado'a dance.
Module Closing Section	*Description/Contents*

Reflection	• Reflection question:
	  ○ What have students learned about the relationship between physics and culture?
	  ○ How can students preserve culture through science?

Closing	• Contains follow-up actions and expectations for students and teachers in studying the local wisdom-based module.
References	• Contains a list of sources used as references in developing the module.
Back Cover	• Author or module compiler profile • Supporting illustrations or images • Institution logo

Development stage

The development stage was carried out by compiling a complete module, both in terms of content, visual appearance, and evaluation instruments. After completion, the module was validated by two experts, namely learning media design experts and material experts. From the results of the learning media design experts' assessment in the aspects of module standards and size, design and layout, and suitability of content and material, an average value of 85% was obtained, indicating very suitable criteria. The results of the assessment by material experts in the aspects of introduction, learning, content, assignments/evaluation/assessment, summary, obtained an average value of 78% with suitable criteria. The summary of the validation results by the two experts is shown in Table 4.

Table 4. Module validation results

No.	Experts	Score	Percentage	Criteria
1.	Learning Media Design Expert	54	85%	Very feasible
2.	Subject Matter Expert	122	78%	Feasible
Average		88	82%	Very feasible

This validation demonstrates that the module meets eligibility standards in terms of both content and media. The resulting module can be accessed through this link: https://drive.google.com/file/d/1jWjh0inPr48dvauUMPo4ui-uOs-6JckY/view?usp=drive_link

Implementation stage

The validated module was then piloted with 11th-grade Mathematics and Natural Sciences students at SMA Negeri 1 Hawu Mehara in two groups: a small group of 10 students and a large group of 25 students. Teachers also assessed the module's practicality. Student and teacher responses were collected through a practicality questionnaire (see Table 5 and 6)

Table 5. Results of the questionnaire assessing practicality by students

No.	Aspect	Score	Percentage (%)	Criteria
1	General Module	533	88,83	Very good
2	Tampilan	554	92,30	Very good
3	Isi/Materi	415	92,20	Very good
4	Pembelajaran	141	94	Very good
5	Keterbacaan	423	94	Very good
Rata-Rata		413,2	92,27	Very good

Table 6. Results of practical assessment by 2 teachers

No.	Aspect	Score	Percentage (%)	Criteria
1	Physics Content	13	65	Good
2	Learning Activity	24	80	Good
Average		18	72,5	Good

Students found the module helpful in understanding the material because it presented a context they were familiar with. Teachers stated that the module facilitated the delivery of material that had previously been difficult for students to grasp. Validation and practicality tests showed that the Pado'a dance-based physics learning module fell into the "very feasible" and "very practical" categories for use in classroom learning. These findings align with research by Wahyuni (2015) and Sibrani (2018), which demonstrated that local wisdom-based learning media not only enriched the material content but also supported the achievement of learning objectives more meaningfully.

The effectiveness aspect can be seen from the effective value of students from the posttest results at the large group test stage using local wisdom-based modules and the posttest results using regular modules. The posttest results using local wisdom-based modules obtained 92% of students who obtained scores ≥ KKM and were in the very effective category. Meanwhile, the posttest results using regular modules obtained 64% of students who obtained scores ≥ KKM. The improvement in students' critical thinking skills using local wisdom-based modules in the traditional Pado'a Sabu Raijua dance can be seen in Table 7.

Table 7. Results of the N-Gain test of critical thinking skills using local wisdom-based modules

N-Gain	Nilai
Rata-Rata	0,7
Kategori	Sedang

Based on Table 7 above, it can be seen that the N-Gain test in the large group test is 0.7 with a medium category. Then, Table 8 inform the result of student critical thinking skill after using this module.

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Table 8. Critical thinking skills results

Critical Thinking Achievement Percentage	*Pretest*	*Postest*
Average	43%	86%
Category	Enough	Very good

Based on Table 8, it can be seen that the results of students' critical thinking skills in learning using the local wisdom-based learning module on the traditional Pado'a Sabu Raijua dance during the pre-test were 43%, which is in the sufficient category, and during the post-test, 86%, which is in the very good category. This represents an increase of 43%. The following graph shows the results of critical thinking skills for each critical thinking indicator when learning using the local wisdom-based module developed:

Table 9. Results of critical thinking skills for each indicator

No.	Critical Thinking Skills Indicators	Pretest	Posttest
1	Interpretation	45,42%	78,33%
2	Analysis	42,50%	76,25%
3	Evaluation	38,75%	74,58%
4	Inference	38,33%	72,92%
5	Explanation	41,46%	74,17%
6	Problem Solving	31,67%	75,00%
7	Self-Regulation	23,75%	62,50%

Evaluation stage

The evaluation stage in this study includes formative and summative evaluations. Formative evaluations were conducted at each stage of ADDIE development and indicated that the module needed to be adjusted in terms of language clarity, the relationship between physics concepts and Pado'a dance movements, and visual displays to make it more communicative and easier for students to understand. Module revisions were made based on input from material experts, media design experts, and teacher and student responses in small and large group trials, which showed that the module was practical and easy to use in learning. Summative evaluations were conducted to assess the effectiveness of the module by comparing the results of the pretest and posttest of students' critical thinking skills. The results of the summative evaluation showed an increase in students' critical thinking skills from 43% to 86% with an N-Gain value of 0.7 (moderate category), so it can be concluded that the physics learning module based on local wisdom of the Pado'a dance is effective in improving students' critical thinking skills.

CONCLUSION

This research successfully developed a physics learning module based on local wisdom in the traditional dance of Pado'a Sabu Raijua with the Addie development model. The developed local wisdom-based module can improve students' creative thinking skills. The wisdom-based module was developed through five stages, namely: analysis, design, development, implementation, and evaluation. The resulting module was declared feasible with an average percentage of 82%. The feasibility test was carried out by 2 experts consisting of material experts and learning design experts. Material experts gave an overall assessment of the material aspects of the local wisdom-based module, getting a percentage of 78% for the practicality aspect, getting an assessment of 92.27% and learning design experts gave an assessment of all

aspects of the learning design in the local wisdom-based module on the Pado'a dance, getting a percentage of 85%. And included in the very good category. The physics learning module based on traditional Pado'a dance has proven effective in improving students' critical thinking skills, this is evidenced by the n-gain value of 0.7 (moderate category).

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