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Development of Problem Based Learning Teaching Materials Based on the Ethnoscience of the Ramela Tribe and Its Impact on Students' Critical Thinking Skills

Putu Victoria M. Risamasu[1]*, Jan Pieter[2]
Physics Education, Cenderawasih University
Corresponding Author: Putu Victoria M. Risamasu putuvicka@gmail.com

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A B S T R A C T

The study aims to develop ethnoscience-based Problem Based Learning teaching materials for the Ramela tribe in Jayapura and to observe its impact on critical thinking skills. This type of research is the research and development of the 4D model of Thiagarajan and Melvyn (1974). The research population was seventh grade students of Public Junior High Schools in Jayapura City. The eight courses that made up the research sample were divided into four experimental classes that used teaching materials based on local knowledge from Jayapura and four control groups that used traditional teaching materials. Additionally, a randomized pretest-posttest control group design was employed in a quasi-experiment. The study's findings demonstrated the beneficial effects of the created instructional materials and revealed a notable improvement in students' critical thinking abilities.

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INTRODUCTION

Education is a purposeful and planned attempt to establish circumstances and learning processes so that students have an active part in developing their potential. In accordance with this background, the desired curriculum is education founded on Pancasila and the 1945 Constitution, anchored in religious, cultural, and Indonesian national values, and sensitive to changing circumstances. The government's efforts to realize this action to educate the nation are by implementing a formal education system whose implementation is carried out in educational institutions (schools). Educational activities in educational institutions are a teaching and learning process that focuses on changes in the cognitive aspect (knowledge), the affective aspect (attitude), and the psychomotor aspect (skills) (Nurtanto & Sofyan, 2015). In the cognitive aspect, learning outcomes are a reference for students' academic mastery; the better the students' academic mastery, the better the learning outcomes obtained.

As an integral part of the Unitary State of the Republic of Indonesia, Papua is a province that is relatively lagging behind in terms of education compared to other regions. The Human Development Index (HDI) data for 2024 reached 73.83, far below the national average of 75.02, far behind other provinces (BPS Papua, 2024). This data is supported by the results of research by (Pieter & Risamasu, 2024) and (Risamasu & Pieter, 2024) which showed that students' mastery of science concepts in Jayapura City is still low. The results of interviews and observations conducted with students also showed that students' mastery of concepts and critical thinking skills were also low. The results of observations of learning activities in the classroom found students who were not enthusiastic when interacting with teachers in class, students who were reluctant to ask or answer questions given by the teacher, and students who did not pay attention to the teacher's explanations during the lesson. Students preferred being given calculation problems rather than working on analysis problems that use their critical thinking skills.

The researchers' observations found that Physics learning in schools is more oriented towards modern or contemporary Physics concepts, where teaching emphasizes theories that are too high, but cannot be digested by students' knowledge. This condition is exacerbated by the absence of examples to make it easier for students to digest the theories or physics concepts taught by teachers. This situation causes students to assume that physics is a difficult science to understand and is in the clouds, and has an impact on low motivation to learn physics lessons. In fact, Physics is a science that can be explained with everything in the surrounding environment, by using examples of local wisdom *Apen/Barapen* makes it easier for students to understand the theory and concept of Thermodynamics.

In fact, Papua has a lot of local wisdom that can be used to support the learning process in the classroom. For example, the diversity of fauna and flora is endemic which is different from other regions in Indonesia, and also various products from natural materials such as koteka and Sali (men's and women's genital coverings), Honai houses, and Noken bags and the way of cooking Apen/Barapen (stone burning) which is done by most of the Papuan people,

especially the Port Numbay community in Jayapura in their daily activities contains the concept of Physics and is used in learning in the classroom (Pieter & Risamasu, 2024).

The Ramela tribe is an indigenous Papuan people originating from the Tabi region, specifically occupying the Skouw area, from Skow Sae and Skow Yambe to the border of Papua New Guinea (PNG). With its diverse local wisdom containing diverse natural science concepts found in farming activities. Fishing, carpentry tools, musical instruments, and other scientific diversity, the Ramela tribe has great potential for application in learning, especially in science learning in the classroom. However, unfortunately, this potential has not been applied by science teachers in schools, science teachers have not been able to identify, let alone apply, the scientific ethnoscience concept of the Ramela tribe to be used in science teaching.

Based on the description of the problems above, this study attempts to develop teaching materials for the Problem Based Learning model based on the ethnoscience of the Ramela Tribe in Jayapura City and obtain an overview of its impact on the critical thinking skills of students in Jayapura City.

LITERATURE REVIEW

In the 21st century, the demand for students to have "4C" competencies, namely: critical thinking and problem solving, creativity and innovation, communication and collaboration to compete in a global society ((Hasanah et al., 2021); Ma et al., 2023). Some of the important changes and trends in education during the 21st century include: educational technology: the use of technology in education has become increasingly common; student-centered approaches to learning: a shift from teacher-centered to more student-centered approaches to teaching; emphasis on skills such as creativity, problem solving, collaboration, critical thinking, and digital literacy are becoming increasingly important in the workplace; increased attention is being paid to inclusive education, which accommodates the needs of students with diverse abilities and needs; globalization and educational mobility have brought about greater educational mobility; emphasis on lifelong learning; adoption of relevant curriculum: education today emphasizes the importance of a curriculum that is relevant to the real world. Curriculum is designed to teach students about the social, environmental, and economic issues facing society today and prepare them to play a role in addressing these challenges. Thus, education reflects the changes and challenges associated with technological developments, job market needs, and an increasingly connected global perspective and aims to prepare students to succeed in an ever-evolving world that provides equal opportunity for all individuals (Rapi et al., 2022).

Critical thinking is a potential that everyone has, and this ability can be measured, trained, and developed (Lambertus, 2009). In this case, critical thinking is not just an intellectual ability but also a skill that allows a person to become skilled and active in understanding, applying, synthesizing, and evaluating various information obtained from observation, reflection, reasoning, communication, and experience (Spector & Ma, 2019, Rahman, 2019). In other

words, critical thinking is a process that involves various interconnected cognitive and affective aspects. Therefore, educational institutions need to create a learning environment that supports the development of these skills so that students can practice and hone their critical thinking skills optimally.

METHODOLOGY

The type of research used in this study is research and development (R&D), development research is research used to produce products and conduct effectiveness tests on the resulting products. The development research used in this study refers to the 4-D (Four D) development model developed by Thiagarajan and Melvyn (1974) in Sugiyono (2015) which consists of 4 (four) stages, namely, Define, Design, Develop and Disseminate, in this study the researcher only carried out three stages, namely define, design and develop. To obtain an assessment related to the developed teaching materials, a questionnaire instrument was used which was then assessed by 5 expert validators consisting of two lecturers of Mathematics and Natural Sciences Education, FKIP, Cenderawasih University and three senior science teachers from junior high schools in Jayapura City. The data obtained is quantitative data obtained based on the validator's assessment on the questionnaire. The teaching materials validation sheet assessed several aspects, namely the cover, illustrations, format, content/material, and language used. The research results were processed using a Likert scale ranging from 1 to 4 (Sugiyono, 2015).

Validation data for the developed teaching materials and the implementation of the learning models and devices were made into a questionnaire instrument and analyzed using descriptive statistical analysis techniques by calculating the percentage using the following formula (Koyan, 2012:19).

$$P = \frac{\sum x}{\sum xi} \times 100\% \quad (1)$$

Information :
P = percentage
$\sum x$ = total number of respondents answers
$\sum xi$ = total number of ideal scores in one item

The guidelines used to provide meaning and decision-making regarding product validity and implementation (product feasibility) are presented in Table 1 below.

Table 1. Five absolute scale feasibility conversion guidelines

No.	Score range (%)	Qualification
1	90,00 – 100,00	Highly valid
2	75,00 – 89,00	Valid
3	65,00 – 74,00	Enough
4	55,00 – 64,00	Less
5	0,00 – 54,00	Very less

(Sugiyono, 2015)

The product feasibility test (validity and feasibility) is considered successful if it achieves a minimum score of 75% with a minimum good score. If the score falls below this minimum, further revisions are required. Validation and reimplementation are then carried out. This process continues until the minimum good score is met.

To determine whether or not the implementation of teaching materials based on Jayapura local wisdom has an effect on the science process skills of students in the experimental and control classes, a difference test (t-test) was used. The t-test calculation was assisted by using the SPSS 23 program.

Furthermore, to find out how the impact of the developed teaching materials on students' mastery of concepts between the experimental class and the control class, N-gain analysis was used (Hake, 1999).

$$g = \frac{S_{Post} - S_{Pre}}{S_{Maks} - S_{Pre}} \quad (2)$$

Information:
g = normalized gain
S_{maks} = maximum score of tests
S_{Post} = posttest scoree
S_{Pre} = pretest score

The high and low values of normalized gain can be classified by Hake (1999) in Table 2 below.

Table 2. Normalized N-gain category values

g valeu	N-gain Category
g > 0,7	High
0,3 ≤ g ≤ 0,7	Medium
g < 0,3	Low

Furthermore, to determine the effectiveness of product use on students' critical thinking skills, statistical tests were used, either parametric or inferential. To determine whether or not the implementation of teaching materials based on Jayapura's local wisdom had an effect on students' science process skills in the experimental and control classes, a difference test (t-test) was used. The t-test calculation was assisted by using the SPSS 23 program.

RESEARCH RESULT

In this section, the researcher describes the results of the development of ethnoscience-based teaching materials for the Ramela tribe in Jayapura City (Port Numbay) and the validation results provided by experts and practitioners. The cover of the resulting teaching materials is shown in Figure 1.

The validators who validated the developed teaching materials consisted of two lecturers from the Department of Science Education, Cenderawasih University with scientific criteria, expertise and research experience in the field of Science Education and two junior high school teachers with senior teacher

qualifications who had been certified and had a scientific background in Science Education.

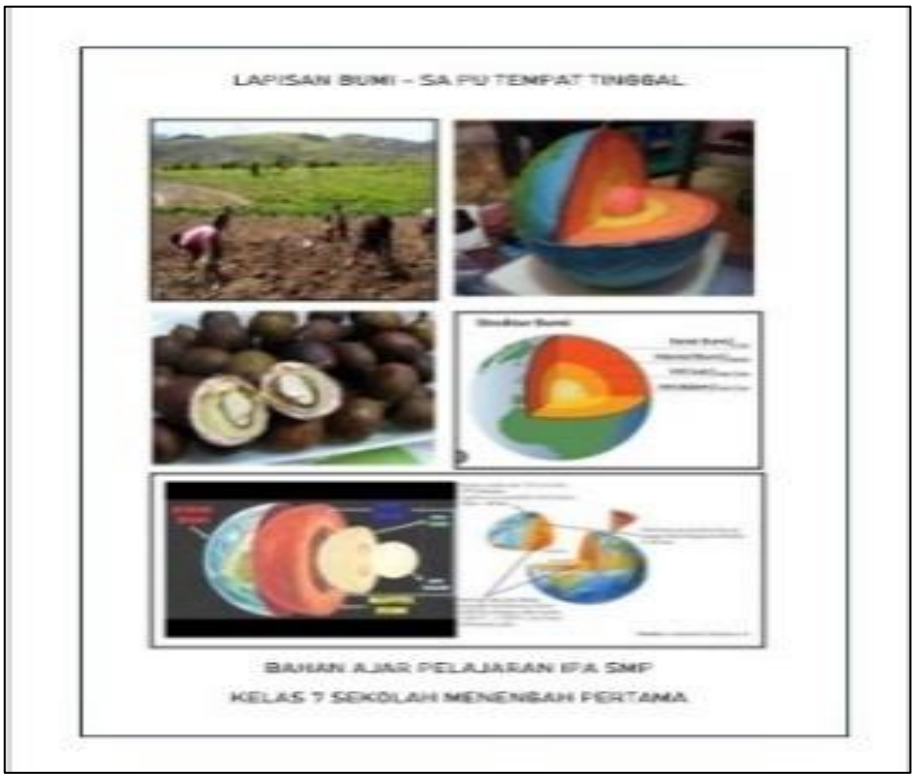

Figure 1. Cover of the developed teaching materials

From the results of the validation of teaching materials, it was found that content/material experts provided responses to the teaching materials developed in this study. Content assessment was carried out by content and material experts on 5 (five) components, namely (1) cover, (2) illustration, (3) format, (4) content/material, and (5) language. The assessment was carried out by giving a score of one to four which represents the response, namely a score of 1-5.

The findings of the study reveal that the expert validator who verified the content and material gave a response in the very excellent category (94.17%), which means that the quality of the instructional materials according to the content and material experts is very good, as shown in Table 3 below.

Table 3. Validation results by expert validators (expert judgment)

No.	Component	Mark		Mean (%)	Qualification
		Val. I	Val. II		
1.	Cover	91,67	100	95,83	Highly valid
2.	Ilustration	83,33	100	91,67	Valid
3.	Format	90	100	95	Highly valid
4.	Content/Material	95	90	92.5	Highly valid
5.	Language	91,67	100	95,83	Highly valid
	Mean			**94,17**	**Highly valid**

Furthermore, the results of validation by practitioners on the developed teaching materials are presented in Table 4 below.

Table 4. Validation results by practitioners

No.	Component	Mark			Mean (%)	Qualification
		Prac. I	Prac. II	Prac III		
1.	*Cover*	91,67	100	100	97,44	Highly valid
2.	Ilustration	100	91,67	91,67	94,44	Highly valid
3.	Format	95	91,66	95	93,89	Highly valid
4.	Content/Material	95	91,67	95	93,89	Highly valid
5.	Language	100	91,67	100	97,23	Highly valid
	Mean				**95,33**	**Highly valid**

The analysis of the teaching materials validated by practitioners yielded an average score of 95.33% (categorized as very good). This validation score indicates that practitioners assess the developed teaching materials as suitable for use. The revision notes provided by the five validators have been improved, allowing these learning materials to be used in science (Physics) instruction in schools.

In accordance with the method in this study, there are students who are sorted into an experimental class that learns using teaching materials based on the Ramela Tribe's ethnoscience and the use of the Problem Based Learning model lesson plan which is contextual learning and a control class where students learn using a conventional learning model. At the beginning of the study, to determine the initial abilities of students before giving treatment, the researcher conducted an initial assessment (pre-test) which was then continued with learning using the developed teaching materials, at the end of the learning, another final assessment (post-test) was conducted. The same thing was also done in the control class, the difference being the use of teaching materials based on the local wisdom of the Ramela Tribe in Jayapura City and the use of the Problem Based Learning model lesson plan which is contextual.

To determine whether there was an increase in students' critical thinking skills, normalized gain (N-gain) data analysis was used. Data on the percentage increase in N-gain in students' concept mastery are presented in Table 5.

Table 5. Percentage Increase in N-gain Concept Mastery

No.	Class Data	N-gain (%)	Category
1	Experiment class	72	High
2	Control class	35	Low

Based on the results data presented in Table 5 above, it can be concluded that the percentage of increase in N-gain of critical thinking skills was higher in the experimental class that used teaching materials based on Ramela tribe ethnoscience and the Problem Based Learning model of Port Numbay (Jayapura) contextual learning compared to the control class that studied using conventional textbook teaching materials.

The researcher then utilized a t-test to assess whether the generated instructional materials had a distinct influence on the critical thinking abilities of students in the experimental and control groups. The t-test may be performed if the data are normally distributed and homogenous. The researcher utilized SPSS 23 to conduct the normality and homogeneity tests. The t-test results are reported in Table 6.

Table 6. Recapitulation of the t-test results for both classes

No.	Class data	T test		Conclusion
		t	Sig.	
1	Pre-test of control and experimental classes	0,165	0,875	There is no significant difference in both classes
2	Post test of control and experimental classes	5,472	0,000	There is a significant difference in both classes

The results of the t-test in Table 6 show a significant difference in the critical thinking skills of students in both classes with the use of ethnoscience-based teaching materials of the Ramela tribe in Jayapura City with the use of the Problem Based Learning learning model or it can be concluded that the use of ethnoscience-based teaching materials of the Ramela tribe in Jayapura City is better than conventional learning on the Earth's Layers material in class VII.

DISCUSSION

From the research results, it was found that the Problem Based Learning model teaching materials based on ethnoscience of the Ramela tribe in Jayapura City that were developed received assessment results in the very good category, where the expert validator gave an average assessment of 94.17 for the assessment of cover, illustration, format, content/material and language, while the practical validator gave an average assessment of 95.33 in the very good category.

For students' concept mastery, it was found that there was a significant difference in N-gain between the experimental class and the control class. Based on the results presented in Table 5, it can be concluded that the percentage increase in N-gain in concept mastery was higher in the experimental class compared to the control class (72 > 35).

The t-test results in Table 6 show a significant difference in the critical thinking skills of students in both classes when using ethnoscience-based teaching materials from the Ramela tribe in Jayapura City. Therefore, it can be concluded that the use of ethnoscience-based teaching materials from the Ramele tribe in Jayapura provides better results in students' critical thinking skills compared to conventional learning on the Earth's Layers material in grade VII.

The results of this study are in line with the findings of Dwiyanti et al.'s (2017) research which shows that the implementation of a science domain-based learning model by integrating local wisdom in learning is highly favored by science teachers. Furthermore, Suastra (2005) stated that science teachers can accept the development of a learning model based on local Balinese culture well. Andriyana et al. (2017) stated that the use of big book media based on local

wisdom in a learning process is proven to attract students' attention, this is because the learning is in accordance with the context of their daily lives. A number of research results above are in line with the theory of situated cognition expressed by J. Lave, which states that students learn naturally in relation to authentic activities, context, and culture (Roth & Jornet, 2013).

Critical thinking ability according to the opinion of several experts is a habit of analyzing, synthesizing and evaluating information to solve problems (Salim et al. 2014). According to Facione (2013) experts interpret critical thinking as a drive for self-regulation through interpretation, analysis, evaluation, explaining based on evidence, concepts and contextual considerations. Critical thinking involves an activity, such as analyzing, synthesizing, making considerations, creating, and applying new knowledge to the real world (Hatari, Widiyatmoko, and Parmin 2016). Critical thinking ability is a cognitive process and mental activity to acquire knowledge (Muh. Nasir, Jufri, and Muhlis 2015). Critical thinking ability is a person's ability to reason to integrate their knowledge in order to analyze facts, create and defend ideas, make a comparison, and draw conclusions to solve problems (Abd. Ghofur, Durrotun Nafisah 2016). So critical thinking is a reasonable and reflective thinking to solve problems that students believe themselves with the knowledge they already have. Critical thinking ability is an activity of collecting various information and analyzing information by using the knowledge that students already have to draw a conclusion. Critical thinking is thinking that makes sense and how decisions are made about what to do or believe.

This is in line with (Larsson, 2017) that critical thinking is defined as a person's effort to find the truth from information based on evidence, logic, and belief. Critical thinking can be developed in biology learning by conducting experiments or trials. Thinking skills are one of the assets that students must have to face the development of science and technology (IPTEK) in today's era (Dwijananti and Yulianti 2010). Critical thinking includes using previous knowledge, facts, and data to solve problems. Critical thinking is the ability to distinguish information that is in accordance with reality and is not based on belief (Changwong 2018). According to Ennis (2013), critical thinking involves the value of arguments, credibility, identifying and drawing conclusions. Students' critical thinking skills are students' skills in observing, asking questions, conducting experiments, interpreting experimental data, analyzing, drawing conclusions, and percentages are stated as very poor, poor, moderate, good, and very good (Suriasa 2018). Critical thinking skills are very important for students because with these skills students are able to act rationally and choose the best alternative options for themselves.

Furthermore, the results of research from Aji Pamungkas, Bambang Subali & Suharto Lunuwih (2017) show that the implementation of a science learning model based on local wisdom has an effect on student learning outcomes. The t-test results show that there is a significant difference between the science learning model based on local wisdom and the scientific approach learning model on student learning outcomes. Significance here means that there is a difference in student activity before and after being given treatment, namely the

implementation of a science learning model based on local wisdom in learning. The effect of the implementation of a science learning model based on local wisdom on creativity is first from the posttest results. The test is in the form of essay questions that make students think divergently or broadly to combine several ideas related to understanding the concept of learning material with the local wisdom of the Pranata Mangsa calendar.

The results of the study showed that the posttest scores in the experimental class were higher than those in the control class. The significant difference in the average posttest scores in the experimental and control classes was due to the influence of the students' learning process in the experimental class. Learning in the experimental class that combines learning materials with local wisdom can provide students with broader experiences, compared to the scientific approach learning model. The significant difference in the average posttest scores between the experimental and control classes also shows that the local wisdom-based science learning model can improve student learning outcomes, where students are better able to solve problems when working on the questions.

The implementation of a local wisdom-based science learning model provides students with the opportunity to develop their creativity. Students become active in the learning process by implementing a local wisdom-based science learning model through discussions and conducting experiments. Setiawan, et al. (2017) stated that a local wisdom-based science module can improve students' scientific literacy. The results of Dewi, et al.'s (2023) research also supported the research findings, finding that the integration of local potential in science learning can improve students' critical thinking skills.

CONCLUSIONS AND RECOMMENDATIONS

From the results of data processing and discussion that have been carried out in the section above, the researcher draws the following conclusions:

a. The teaching materials for the Problem Based Learning model based on the Ramela Tribe's ethnoscience that were developed obtained results in the very good category, where the expert validator gave an average rating of 94.17 for the assessment of cover, illustration, format, content/material and language, while the practitioner validator gave an average rating of 95.33 in the very good category.
b. There is a significant difference in N-gain between the experimental class and the control class. It was found that the percentage increase in N-gain in critical thinking skills of students in the experimental class was higher than in the control class (72 > 35).
c. There is a significant difference in the science process abilities of students in both classes, where the use of teaching materials based on the Ramela tribe's ethnoscience provides better results in students' critical thinking abilities compared to conventional learning on the Earth's Layers material in class VII (Sig 0.00).

In connection with the research results and conclusions that have been obtained, the researcher provides the following suggestions:

a. Education practitioners, especially teachers, are expected to develop various forms of Ramela local wisdom in science learning activities in the classroom. This can be started by identifying and exploring the local wisdom they have and adapting it to the content of the material being taught.
b. The development and preparation of local wisdom-based learning tools in Port Numbay (Jayapura) can be carried out collaboratively within the Science Subject Teachers' Consultation (MGMP) group. This aims to build shared awareness regarding the importance of using local wisdom in learning and collaboration in developing the learning tools.
c. There needs to be a legal umbrella that regulates the inclusion of local wisdom values of the Port Numbay Community (Jayapura) in learning at schools in Jayapura City to support the Pancasila Student Profile Strengthening Project (P5) that has been initiated by the government.

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