The Integration of West Papuan Local Wisdom into Three-Dimensional Geometry: A Strategic Approach to Enhancing Students' Learning Motivation

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ABSTRACT

This study aims to investigate the enhancement of students' learning motivation and cognitive achievement through the implementation of a module-based instructional model integrated with the local wisdom of West Papua. Employing a quantitative descriptive approach with a one-group pretest–posttest design, data were collected using cognitive tests and a Likert-scale motivation questionnaire. Quantitative analysis was conducted using Minitab software to assess statistical significance, while students' motivational responses were analyzed descriptively. The results revealed a substantial improvement in students' cognitive performance, with the average score increasing from 40.80 (pretest) to 86.40 (posttest). A paired-sample t-test indicated a significant difference between pretest and posttest scores ($t = -8.718$, $p < 0.05$). Meanwhile, the motivation questionnaire results showed a significant enhancement in students' learning motivation, with the mean Likert score rising from 3.2 (pretest) to 4.0 (posttest), corresponding to 100% positive responses categorized as *highly valid*. These findings demonstrate that integrating culturally responsive learning modules can effectively enhance both students' cognitive understanding and their motivation toward learning mathematics. The local wisdom–based module has proven to be a feasible and engaging instructional tool for contextualized mathematics learning.

Keywords: local wisdom; mathematics education; module-based learning; student perception; west papua

INTRODUCTION

Mathematics education in elementary schools plays a crucial role, as it lays the foundation for students to develop logical, analytical, systematic, critical, and creative thinking skills for problem-solving. One effective approach to teaching mathematics is culturally-based learning, which integrates students' immediate cultural environment into instruction. Mathematics and culture are two interrelated domains that have increasingly gained attention in educational discourse, particularly at the elementary level (Muyassaroh & Dewi, 2021). Every culture possesses its own local wisdom that deserves preservation. Local wisdom is often defined as the prevailing norms and practices within a particular community (Suyono, 2022). In mathematics education, local wisdom can bridge the gap between abstract mathematical concepts and students' everyday experiences. Moreover, from the perspective of character education, local wisdom carries intrinsic values rooted in the cultural heritage of a nation (Nasution, 2022).

Integrating local cultural elements into mathematics instruction can foster meaningful learning experiences for students (Gazali, 2016). When instructional materials are linked to real-life phenomena familiar to students, they enhance comprehension and

retention (Salviah, 2021). Ethnomathematics, or culturally contextualized mathematics, supports student understanding by situating abstract content within familiar, local contexts (Nicol et al., 2012). Indonesia is a country rich in cultural, ethnic, racial, linguistic, and traditional diversity, each region with its own unique characteristics (Meliono, 2011). However, classroom learning materials often fail to reflect students' cultural backgrounds, leading to disengagement and difficulty in connecting lessons to real-life experiences. Incorporating local cultural content into teaching not only contextualizes learning but also increases student motivation and comprehension. In addition, culturally relevant instruction promotes character formation, as character development is inherently linked to the cultural values found within a community's local wisdom (Wagiran, 2013). Education rooted in these values can foster positive attitudes such as humanism, nationalism, and tolerance (Meliono, 2011). These values can be integrated across disciplines, including mathematics, to create meaningful learning experiences.

In the context of Grade 6 mathematics education, one of the core topics taught is solid geometry, which includes three-dimensional shapes such as cylinders and cones. These shapes have distinct characteristics, including formulas for calculating volume and surface area. Beyond their mathematical significance, they also commonly appear in students' everyday surroundings, offering opportunities for contextual learning. To grasp the concepts of cylinders and cones, students must understand basic geometric principles, as solid figures are an essential subfield of geometry, which studies points, lines, planes, and space (Bird, 2017). A strong grasp of geometric concepts can help students understand the properties of these shapes and the relationships between their dimensions and associated formulas.

However, mastering this content can be challenging. Research by Badraeni et al. (2020) found that many students struggle with geometric problems, particularly in connecting related concepts and applying formulas accurately in simple and algorithmic calculations. These findings are consistent with an analysis of the Grade 6 mathematics textbook used at SD Inpres 48 Inggramui Manokwari. The textbook, published by the Ministry of Education and Culture in 2018, presents an example in Chapter 3 that asks students to observe the structure of the Gama Tower (Cemindo Tower) in South Jakarta, described as a combination of a prism and a cuboid. While this example may be relevant to students in urban areas like Jakarta, it holds little meaning for students in West Papua. The disconnection between textbook examples and students' local realities creates barriers to comprehension, making it difficult for students to connect abstract knowledge to concrete experiences.

To further understand the local context, classroom observations and teacher interviews were conducted at SD Inpres 48 Inggramui Manokwari. The results revealed that the school lacks teaching materials that align with both students' characteristics and local culture. Moreover, learning remains dominated by teacher-centered methods, which has led to low conceptual understanding and limited student engagement. Teachers reported that students often exhibit low learning motivation, as reflected in mathematics achievement rates of less than 30%. Among the mathematics topics taught, three-dimensional geometry was identified as one of the most difficult areas for students. Many students struggle to visualize shapes, determine appropriate formulas, and distinguish between surface area and

volume. These findings highlight the urgent need for learning materials that are engaging, easy to understand, and contextually relevant to students' daily lives.

Learning difficulties in mathematics are often rooted in low learning motivation (Pratiwi, 2019). Motivation is a psychological energy change within an individual, marked by feelings and directed responses toward a specific goal (Sardiman, 2018). Indicators of low motivation include procrastination and reluctance to complete academic tasks (Fauziyah, 2022). Analysis of classroom needs indicates that students prefer learning materials that are engaging, interactive, visually appealing, and suitable for independent learning, while teachers expect instructional tools that can enhance enthusiasm, creativity, and active participation while improving learning outcomes and incorporating local wisdom. These findings suggest the necessity of developing learning modules that combine both cultural relevance and motivational design.

Integrating West Papuan local wisdom such as traditional Honai houses, carvings, woven patterns, and cultural artifacts into the teaching of three-dimensional geometry has the potential to make abstract mathematical ideas more tangible and meaningful. This approach not only contextualizes mathematical learning but also contributes to cultural preservation and character education. As shown in the study by Rahmi Hayati et al. (2024), the use of ethnomathematics incorporating local cultural values can enhance students' motivation and understanding by embedding mathematical concepts in familiar cultural contexts. Moreover, such integration aligns with the goals of the 2013 Curriculum (K-13), which emphasizes meaningful learning, character formation, and the development of cultural awareness (Fadlilah, 2020). As noted by Sitepu (2015), the curriculum determines the quality of instructional processes, learning outcomes, and students' competencies. Therefore, the development of a local wisdom-based learning module in solid geometry for Grade 6 students at SD Inpres 48 Inggramui Manokwari is expected to improve motivation, comprehension, and character formation while preserving West Papuan cultural identity.

Previous studies on ethnomathematics have demonstrated that integrating local culture into learning materials can enhance students' engagement and understanding. However, few studies have specifically focused on West Papuan local wisdom or its application in three-dimensional geometry learning at the elementary school level. Most available materials remain limited to Java or Sumatra cultural contexts, leaving a gap in representing the unique cultural characteristics of Eastern Indonesia. Furthermore, existing research rarely measures both cognitive achievement and learning motivation as distinct but related outcomes.

Based on these gaps, this study aims to develop and evaluate an interactive local wisdom-based learning module for Grade 6 mathematics—specifically focused on the topic of three-dimensional geometry—integrating West Papuan cultural elements to enhance both students' learning motivation and cognitive achievement. The research follows the 4D model (Define, Design, Develop, and Disseminate) to ensure a systematic development process. Through this approach, the study seeks to contribute to the enrichment of culturally contextualized mathematics education and to promote the preservation of local wisdom through classroom learning.

RESEARCH METHODS

This study was conducted at SD Inpres 48 Inggramui Manokwari. The research employed a pre-experimental design, specifically the *One-Group Pretest–Posttest Design*, which is appropriate for measuring changes in students' mathematical achievement before and after the implementation of West Papua local wisdom–based learning media (Sugiyono, 2016). The population consisted of sixth-grade students at an elementary school in West Papua, and the sample was selected purposely based on classroom characteristics relevant to the study's instructional focus.

The instruments used in this study included a learning module, a mathematics achievement test, and student response questionnaires. The test instrument consisted of five pretest items and seven posttest items to assess students' conceptual understanding of solid geometry topics—particularly cylinders and cones. Non-test instruments included a 15-item Likert-scale questionnaire designed to measure students' perceptions and motivation toward the use of the developed instructional media.

Each instrument underwent expert validation to ensure content and construct appropriateness. The learning module obtained an overall validity score of 88%, categorized as *very valid*. The teacher response questionnaire achieved a validity score of 93.75%, and the student response questionnaire achieved 95%, both of which are also within the *very valid* category. The validation process was conducted by an expert from Universitas Negeri Malang, and the suggestions provided—such as adding mastery criteria for each learning activity—were incorporated to improve clarity and instructional accuracy. Based on these results, all instruments were declared valid for data collection.

The research procedure consisted of three main phases: a) Preparation, which involved developing the research proposal, conducting classroom observations, obtaining research permits, designing and validating instruments, and pilot-testing them; b) Implementation, which included administering the pretest, conducting lessons using the local wisdom–based module (e.g., incorporating traditional West Papuan artifacts such as the *Honai* house to illustrate cylinders and cones), and administering the posttest; and c) Data Analysis, which involved quantitative analysis of pretest and posttest scores using a paired sample t-test with the aid of Minitab software to determine whether a statistically significant difference existed in students' learning outcomes.

While the *one-group pretest–posttest* design was suitable for initial implementation of the developed module, it is acknowledged that this design is susceptible to internal validity threats such as maturation, history, and testing effects. Therefore, future studies are encouraged to employ a quasi-experimental or control-group design to strengthen causal inference.

RESULTS AND DISCUSSION

This study aimed to examine the improvement in students' mathematical thinking abilities following the implementation of a local wisdom-based learning module. Data were collected through pretest and posttest assessments and analyzed quantitatively using Minitab software. In addition, a Likert-scale questionnaire was administered to capture students' responses to the learning experience and motivation toward mathematics learning.

The developed learning module consisted of several structured sections, including *Kata Pengantar* (Preface), *Pendahuluan* (Introduction), *Tes Pengetahuan Awal* (Initial Knowledge Test), three learning activities, *Tes Pengetahuan Akhir* (Final Knowledge Test), and *Daftar Pustaka* (References). These sections were systematically arranged to support the learning process from conceptual understanding to application.

The three core learning activities were designed to integrate West Papuan local wisdom into the teaching of solid geometry:

1. Learning Activity 1: Mathematics in Daily Life
   This section introduces students to solid geometry concepts through real-life examples found in their immediate environment. For instance, students identify geometric shapes in everyday objects such as water containers, baskets, and cooking tools.

2. Learning Activity 2: Recognizing the Properties of Cylinders and Cones
   This part connects the mathematical properties of geometric solids to local Papuan objects, including *honai*(traditional houses), musical instruments such as *tifa* drums, and conical cooking utensils. Through these analogies, students are able to visualize and understand the properties of cylinders and cones in a culturally meaningful way.

3. Learning Activity 3: Volume and Surface Area
   In this section, students are guided to calculate the volume and surface area of geometric solids using examples based on local culture. For instance, the *tifa* drum is used as a model for cylindrical surface area calculation, while conical utensils are used to understand the cone's lateral area and volume.

The student response questionnaire consisted of 15 statements rated on a 4-point Likert scale. As shown in Table 1, the average score reached 4.00 (100%), categorized as *highly valid*, indicating that students responded very positively to the developed module. The students agreed that the module made learning mathematics more interesting, easier to understand, and relevant to their daily lives.

Table 1. Student Response

No	Evaluation Aspect	Average Score	Description
1	The presence of the solid geometry module makes me enjoy learning mathematics.	4	Highly valid
2	Using the solid geometry module makes learning mathematics more interesting and enjoyable.	4	Highly valid
3	Learning mathematics using a module is a new experience for me.	4	Highly valid
4	I find it easier to understand solid geometry concepts with the help of the module.	4	Highly valid
5	I study more diligently because of the solid geometry module.	4	Highly valid
6	The module motivates me to study more regularly at home.	4	Highly valid
7	The content presented in the module is related to everyday life.	4	Highly valid
8	The material in this module is easy for me to understand.	4	Highly valid
9	The presentation of the material in the module encourages me to discuss with other students.	4	Highly valid

10	I am more focused on learning with the solid geometry module.	4	Highly valid
11	I enjoy completing the tasks and exercises in the module without being forced.	4	Highly valid
12	The sentences in the module are clear and easy to understand.	4	Highly valid
13	The language used in the module is easy for me to understand.	4	Highly valid
14	The font used is easy to read.	4	Highly valid
15	The colors and layout are visually appealing.	4	Highly valid
	Total Score	60	

To evaluate cognitive improvement, pretest and posttest scores were analyzed quantitatively. The results, summarized in Table 2, show that students' mean pretest score was 40.80, while the mean posttest score was 86.40, indicating a substantial increase in learning outcomes after the intervention.

Table 2. Students' Pretest and Posttest Results

NO	Name	Score		Description
		Pre-Test	Post-Test	(Score Minimum = 70)
1	AH	60	80	Pass
2	AMH	20	80	Pass
3	AIT	100	100	Pass
4	A	40	60	Failed
5	AS	20	100	Pass
6	BAR	0	80	Pass
7	FS	40	80	Pass
8	FJS	60	100	Pass
9	FSM	60	100	Pass
10	HH	60	80	Pass
11	JJ	40	80	Pass
12	MER	40	80	Pass
13	MDS	20	100	Pass
14	MD	60	100	Pass
15	MSR	80	100	Pass
16	NAS	0	60	Failed
17	NDM	20	60	Failed
18	NAP	60	80	Pass
19	OR	60	100	Pass
20	OF	80	100	Pass
21	OY	0	60	Failed
22	SR	60	80	Pass
23	SC	20	100	Pass
24	SU	0	100	Pass
25	VD	20	100	Pass

To determine whether this improvement was statistically significant, a paired samples *t*-test was conducted using Minitab software. As shown in Table 3, the mean difference between pretest and posttest scores was -34.804, with a *t*-value of -8.718, degrees of freedom (df) = 24, and a significance level of p = 0.000 < 0.05. This confirms that there was a significant difference between students' learning outcomes before and after using the local wisdom-based learning module.

Tabel 3. Statistical Analysis

		Mean	N	Std. Deviation	Std. Error Mean
				Paired Samples Statistics	
Pair 1	PreTest	40.80	25	27.976	5.595
	PostTest	86.40	25	14.967	2.993

Table 4. T-test Results

		Paired Differences	t	df	Sig. (2-tailed)
		Paired Samples Test			
		95% Confidence Interval of the Difference			
		Upper			
Pair 1	PreTest - PostTest	-34.804	-8.718	24	0.000

Furthermore, the Normalized Gain (N-Gain) value was calculated to measure the magnitude of improvement. The N-Gain score of 0.77 falls into the *high category*, indicating that the implementation of the local wisdom-based learning module was highly effective in improving students' mathematical achievement.

In addition to cognitive gains, motivational aspects were also significantly enhanced. The integration of familiar cultural contexts, such as traditional architecture, musical instruments, and household objects, transformed abstract geometry into tangible, meaningful experiences. Students expressed greater enthusiasm and engagement, as they could relate mathematical concepts to real elements of their culture. For example, learning about the surface area of cylinders was linked to the *tifa* drum, while conical shapes were associated with cooking tools and decorative ornaments used in Papuan daily life.

This culturally grounded approach not only fostered understanding but also strengthened students' sense of identity and appreciation for their local heritage. The findings are consistent with Sugiyono (2016) and Slavin (2018), who emphasize that contextualized and culture-based learning environments enhance both motivation and comprehension.

Overall, the results demonstrate that embedding local wisdom within instructional media can effectively bridge cultural familiarity and academic learning. The developed module was proven to be pedagogically sound, statistically effective, and culturally responsive leading to a significant improvement in both students' mathematical achievement and motivation.

CONCLUSION

Based on the results of the study, it can be concluded that the use of a West Papua local wisdom-based learning module is proven to be effective in enhancing students' mathematical thinking abilities. This is evidenced by the increase in the average scores from the pretest to the posttest, as well as the results of the t-test indicating a statistically significant difference with a p-value < 0.05. In addition, student responses to the use of the module were highly positive, with average scores across all questionnaire aspects reaching 100%, categorized as "highly valid." Therefore, the developed module not only improves student learning outcomes but also fosters motivation, independence, and interest in mathematics, particularly in the topic of three-dimensional geometry. The module is deemed highly feasible for use and further development as a contextual learning medium that is relevant to local cultural values.

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