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DESIGNING CONTEXTUAL MATHEMATICS LEARNING WORKSHEETS BASED ON NATURE AND LOCAL CULTURE FOR INDIGENOUS STUDENTS

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Abstract. Mathematics is often perceived as difficult and abstract by students, especially when learning materials are not connected to their daily lives. This is particularly relevant for indigenous students, whose cultural and environmental contexts are rarely represented in conventional textbooks. This research developed contextual mathematics learning worksheets that integrate natural elements and local culture to support indigenous students' numeracy and literacy in Merauke. The study employed a four-D development model: define, design, develop, and disseminate. The methodology involved field observations, curriculum analysis, expert validation, and classroom trials in selected elementary schools. The resulting learning material took the form of student worksheets featuring culturally relevant topics, such as calculating area and volume through local tools and traditional activities. Expert assessments rated the materials as highly appropriate in both content and media aspects. Furthermore, the implementation showed significant improvement in students' mathematical problem-solving abilities. The paired sample t-test indicated a statistically significant difference between pre-test and post-test scores. The normalized gain score of 0.28 placed the improvement in the medium category. These findings suggest that context- and culture-grounded learning materials can enhance the relevance and effectiveness of mathematics education for indigenous learners.

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INTRODUCTION

Despite its fundamental role in shaping logical thinking and problem-solving abilities, mathematics remains one of the most challenging subjects for many students. This perception is primarily due to the abstract nature of mathematical concepts, which often lack tangible relevance to students' everyday lives, particularly for those in marginalised and culturally distinct communities (Yunitasari et al., 2023). The complexity of mathematics increases with educational levels, and when instruction is not adequately contextualised, students, especially indigenous learners, face compounded difficulties. Traditional pedagogical approaches, often dominated by textual instruction and rote memorisation, fail to accommodate diverse learning styles and cultural backgrounds (Brown & Redmond, 2017; Fernandes et al., 2020). Consequently, a significant number of students perceive mathematics as irrelevant to their lived realities, leading to disengagement and low achievement (Rashaad Shabab, 2024; Supriadi et al., 2024).

The disconnection between abstract mathematics and student experience is even more profound for indigenous students, whose cultural narratives, practices, and knowledge systems are rarely represented in mainstream education. When mathematical instruction is detached from students' sociocultural contexts, it not only limits their ability to connect with the content but also undermines their identity and confidence as learners (Clarke & Todd, 2024). However, recent studies have emphasized the necessity of integrating culturally responsive pedagogies to bridge this gap. For instance, Larasati et al. (2025) highlighted that contextual and culturally grounded approaches significantly enhance mathematical engagement and comprehension among indigenous learners. Similarly, Yu et al. (2021) argued that leveraging students' cultural knowledge in mathematical instruction promotes deeper conceptual understanding and fosters a sense of belonging. The importance of inclusive curriculum design is also reinforced by Ang et al. (2021) and Assegaff & Bonyah (2024), who found that integrating ethnomathematical elements not only improves academic performance but also revitalizes cultural identity.

Contemporary research strongly supports that culturally responsive pedagogy, particularly indigenised approaches that embed local knowledge and practices into learning processes, significantly enhances student motivation and learning outcomes (Rima et al., 2024; Shultz et al., 2024). These approaches allow students to see their culture reflected in the curriculum, fostering a stronger sense of belonging and engagement in learning (Ashrafova, 2024). However, in the field of mathematics education, such approaches remain underutilised and insufficiently explored, particularly in remote and indigenous regions like Merauke in South Papua, Indonesia. In such areas, educational resources are often standardized and culturally detached, exacerbating learning inequities. The need for mathematics education that acknowledges and values local wisdom is becoming increasingly urgent, making a shift towards contextualized and culturally responsive mathematics education critical to empower students from diverse cultural backgrounds (Leton et al., 2025).

This study introduces a novel framework for developing contextual mathematics learning materials by integrating local ecological elements and indigenous cultural practices of the Malind tribe in South Papua. Unlike previous contextual models that largely focus on urban or generalized rural contexts, this research adopts a deeply place-based and culturally responsive approach that aligns mathematical concepts with traditional knowledge, tools, symbols, spatial reasoning, and daily subsistence activities of indigenous communities. Such an approach fosters cultural relevance and strengthens identity-based learning, enabling students to see mathematics not as an abstract and foreign subject, but as a discipline embedded in their lived experiences and heritage (Bang & Vossoughi, 2016; Naidoo, 2021).

This model also seeks to reclaim indigenous epistemologies within formal education systems, thereby challenging the dominance of Western-centric mathematical narratives. In doing so, it contributes to educational decolonisation efforts while promoting equity and inclusivity. Moreover, this initiative directly supports the broader goals of the Merdeka Curriculum, which encourages schools to localise learning content, empower learner agency, and integrate local contexts into curriculum planning (Akbar et al., 2023; Nurpratiwiningsih et al., 2023). The Malind-based contextual mathematics framework thus serves as both a pedagogical innovation and a cultural revitalisation tool, demonstrating how mathematics education can honor and reflect indigenous worldviews while meeting national competency standards.

Merauke Regency, with its unique geographical and cultural identity, offers abundant cultural assets that are mathematically rich yet pedagogically untapped. As one of the most culturally diverse and ecologically distinct regions in Indonesia, Merauke is home to the Malind and other indigenous communities whose daily practices, tools, and traditions embody implicit mathematical concepts. Prior studies Fredy et al. (2020) and Purwanty & Fredy (2020) have identified cultural elements such as the Tifa drum, betel nut exchange rituals, bevak (traditional house) architectural forms, and local games as potential carriers of mathematical meaning, spanning concepts of geometry, spatial reasoning, measurement, arithmetic operations, and even introductory statistics.

Despite the recognized importance of culturally responsive pedagogy, which significantly enhances mathematical engagement and comprehension among indigenous learners, this approach remains underutilised and insufficiently explored in mathematics education, particularly in remote and indigenous regions like Merauke in South Papua, Indonesia. Existing contextual models often focus on urban or generalized rural contexts, leading to a profound disconnection where indigenous students' cultural narratives, practices, and knowledge systems are rarely represented in mainstream, standardized textbooks and materials. While prior studies have identified rich ethnomathematical potential in local artifacts like the *Tifa* drum, *bevak* houses, and local games in Merauke, these cultural artifacts have remained largely absent from formal education, resulting in a missed opportunity to create meaningful, relevant learning experiences for indigenous students.

The novelty of this research lies in its integrative design, where nature, culture, and mathematics coalesce in a pedagogical model tailored specifically for indigenous students in

Merauke. Unlike conventional curriculum models that often marginalize non-dominant cultural knowledge, this study foregrounds indigenous epistemologies as valid and valuable sources for mathematical learning. It not only validates the cultural capital of indigenous communities but also leverages it to build mathematical understanding through culturally situated practices, thereby bridging the gap between abstract concepts and students' tangible lived experiences (Rosa et al., 2016).

By embedding mathematical content within ecological knowledge, ritual practices, architectural forms, and traditional tools of the Malind people, the research provides a pathway toward decolonizing mathematics education. Moreover, by employing the Four-D research and development model: define, design, develop, and disseminate. This study adopts a systematic, replicable, and scalable methodology for designing educational materials, ensuring both academic rigor and field applicability (Thiagarajan, 1974; Indaryanti et al., 2025).

Ultimately, this research offers both theoretical and practical contributions theoretically, it enriches the discourse on ethnomathematics, place-based education, and culturally relevant pedagogy, particularly in under-researched indigenous contexts; practically, it produces implementable, curriculum-aligned teaching tools that support indigenous students' numeracy development while fostering their cultural confidence and identity affirmation within the mathematics classroom. This dual impact strengthens the call for equity, contextualization, and inclusivity in global mathematics education reform (Acharya et al., 2021; Garcia-Olp et al., 2022).

The research gap is the lack of a systematic, place-based, and culturally responsive framework and implementable learning materials that explicitly integrate local ecological elements and indigenous cultural practices of the *Malind* tribe (such as *Tifa*, *bevak*, *sagu sep*, and *pinang sirih*) to align mathematical concepts with students' heritage and improve their numeracy literacy in a non-abstract way. Building on this identified deficiency, the present research advances a new direction by systematically transforming these cultural artefacts into structured, curriculum-aligned mathematics learning materials. These materials are designed not only to meet national education standards but also to embed mathematical concepts within culturally familiar narratives and practices. In doing so, the approach bridges the gap between traditional knowledge systems and formal schooling, fostering both cognitive development and cultural affirmation (D'Ambrosio & Rosa, 2016). This integration is particularly aligned with Indonesia's recent push for context-based, student-centered pedagogy as promoted through the Merdeka Curriculum.

RESEARCH METHODS

This study employed a Research and Development (R&D) approach using the Four-D model developed by Thiagarajan et al. (1974), which includes four systematic phases: Define, Design, Develop, and Disseminate. The Four-D model was selected for its clarity, iterative structure, and adaptability to educational innovation, particularly in curriculum and instructional material development. This methodology allows for rigorous development of learning materials grounded in local culture while ensuring consistency with national educational standards.

The research was conducted in Merauke Regency, South Papua Province, Indonesia, focusing on elementary schools located in the indigenous community area, especially the *Malind* tribe, including SD Inpres Tambat, SD Inpres Kiworo, and SD YPPK Kimaam. A total of 61 fifth-grade students participated in the classroom implementation stage using purposive sampling to ensure alignment with local cultural characteristics and the adoption of the Merdeka Curriculum. Class teachers, traditional leaders, and curriculum experts were also involved to support the cultural adaptation and pedagogical relevance of the developed materials.

Define phase: An initial needs analysis was conducted through classroom observations, interviews with teachers, and focus group discussions with community members and cultural leaders. The goal was to identify existing challenges in mathematics learning among indigenous students and to map cultural elements with potential mathematical value. Relevant aspects of the Merdeka Curriculum were also analysed to align the cultural content with learning objectives, core competencies, and numeracy literacy indicators.

Design phase: Based on the analysis, a prototype of contextual learning materials was drafted in the form of student worksheets. The worksheets incorporated cultural artefacts such as the *Tifa* drum (geometry and sound measurement), betel nut rituals (sequencing, counting, and patterns), and the structure of traditional bevak houses (spatial reasoning and measurement). Each learning activity was designed to meet specific mathematical competencies while embedding indigenous knowledge and practices in problem contexts. The design phase also involved preparing validation instruments for expert review.

Develop phase: During the development stage, the prototype materials were validated by subject matter experts, instructional designers, and primary school teachers. The validation focused on three aspects: content relevance, cultural appropriateness, and pedagogical feasibility. Feedback was used to revise and refine the materials. The revised version was then implemented in a limited classroom trial involving one elementary school class. Students' pre-test and post-test scores were collected to measure learning gains, and classroom observations were used to evaluate student engagement and interaction with the materials.

To ensure the quality of the developed learning materials, the validation process involved three expert validators consisting of two mathematics education experts and one instructional media expert selected purposively based on their professional competence and experience. The validation instruments utilized a 5-point Likert scale assessing content accuracy, media feasibility, linguistic clarity, and cultural relevance.

Data were collected through various instruments, including expert validation sheets, classroom observation forms, student pre-test and post-test results, and teacher reflection journals. Quantitative data, such as learning gains, were analyzed comprehensively, beginning with the Kolmogorov–Smirnov normality test to ensure data validity, followed by a Paired Sample t-test to determine the significance of differences in students' pre-test and post-test scores after using the learning materials. Furthermore, the magnitude of learning gains was measured using the normalized gain (N-gain) score, which overall provides an overview of the materials' effectiveness in improving mathematical problem-solving skills. Meanwhile, qualitative data, such as teacher and student feedback, were analyzed thematically to explore perceptions regarding cultural relevance and the level of engagement supported by the materials.

RESULTS AND DISCUSSION

The developed learning materials are based on mathematical concepts connected to students' daily lives, such as measuring area and length using traditional units, geometric concepts, and simple statistics related to hunting and farming activities. In developing these contextual mathematics learning materials, the Research and Development (R&D) Four-D model is employed, which includes four main stages: define, design, development, and disseminate.

At the define stage, the learning needs are established and defined by analyzing the objectives and scope of the material. Needs analysis is conducted to understand how local culture can be integrated into mathematics learning. For example, by identifying natural components and their management, or cultural elements such as economic activities, traditional games, arts, and crafts that have mathematical relevance. Subsequently, learning objectives are formulated based on the needs analysis results.

Analyses were conducted on learning at SD Inpres Tambat, SD YPPK Kimaam, and SD Inpres Kiworo. The analyses supporting this development process include analysis of problems in mathematics learning, content scope analysis, and curriculum analysis. The analysis of problems in mathematics learning revealed that instruction was still textual and followed existing textbooks. There is a need for learning materials designed to incorporate local context closely related to students' daily lives, including in mathematics learning. The lack of relevance of learning materials to students' environment and culture makes it difficult for them to deeply understand mathematical concepts, thus necessitating contextual mathematics learning materials that utilize natural and local cultural elements as a more relevant learning approach for students. The results show that mathematics learning is still textual and not contextual, and does not consider students' cultural backgrounds. This condition supports previous findings that the separation between school material and students' life experiences can lead to low participation and understanding (Khan et al., 2019; Li & Xue, 2023).

At the content analysis stage, the researcher identified and determined the mathematical materials to be developed through collaborative discussions with classroom teachers. These discussions revealed that elementary students continue to experience considerable difficulties in understanding geometry-related topics, particularly plane figures, solid shapes, and operations involving negative integers. This challenge stems from the abstract and symbolic nature of such topics, which often lack immediate relevance to students' everyday experiences and cognitive development stages (Kuhlmann et al., 2024; Tarng et al., 2024). Research in mathematics education has consistently shown that learners at the elementary level benefit more from concrete, visual, and context-rich representations of mathematical ideas, especially in domains like geometry that require strong spatial reasoning skills (Mainali, 2021; Oughton et al., 2024).

Students' difficulty with negative integers and three-dimensional shapes is further exacerbated when learning relies solely on textual and decontextualized instruction, which fails to activate students' prior knowledge or cultural references (Peralta, 2020; Schorcht et al., 2025). Therefore, embedding mathematical concepts within culturally familiar contexts becomes essential. In this research, local wisdom is used as a bridge to enhance students' comprehension, by connecting abstract mathematical ideas to tangible cultural objects and practices that students encounter in their daily lives. For instance, the cylindrical structure of the *tifa*, the symmetry of *bevak* house, and the measurement processes *busur panah*, *pinang sirih* and traditional games, are all real-world examples that illustrate geometric properties and arithmetic concepts in culturally meaningful ways. This aligns with the findings of Rosa & Orey (2020), who advocate for ethnomathematical approaches that position culture not as an accessory, but as an integral part of mathematical cognition and pedagogy.

Moreover, place-based and culturally sustaining pedagogies have been shown to improve students' mathematical reasoning and identity development, especially among indigenous and marginalized learners (Aikenhead, 2017; Teise, 2025). Integrating such local elements not only supports conceptual understanding but also promotes a sense of ownership, relevance, and cultural affirmation in the mathematics classroom (Martin & Campbell, 2024; Shahidayanti et al., 2024). Therefore, selecting and designing content that reflects both the mathematical curriculum and the sociocultural context of the learners is not only a pedagogical innovation but also a necessity for equitable and meaningful mathematics education.

At the curriculum analysis stage, a review of the elementary school mathematics curriculum was conducted, covering the analysis of basic competencies, topics, and learning indicators. Several materials that have the potential to be included in contextual mathematics teaching materials are presented in Table 1.

The curriculum analysis stage involved a comprehensive review of the elementary school mathematics curriculum, focusing on basic competencies, topics, and learning indicators. The analysis revealed several materials with strong potential to be incorporated into contextual mathematics learning materials by integrating local cultural elements, as illustrated in Table 1. For instance, competencies such as recognizing plane shapes, performing arithmetic operations with integers, and comparing three-dimensional shapes were linked with cultural artifacts like *sagu sep*, *nyiru*, *kandara*, *bevak*, *roda gila*, and *pinang iris*.

Integrating local culture into mathematics instruction aligns with recent research emphasizing the benefits of culturally contextualized learning. Ansya et al. (2024) found that embedding local cultural elements into elementary mathematics lessons enhances students' motivation and conceptual understanding. This approach helps make abstract mathematical concepts more accessible by grounding them in familiar cultural experiences.

Furthermore, the use of culturally relevant materials facilitates the development of analytical skills and problem-solving abilities. Patunah et al. (2020) demonstrated that mathematics learning situated in real-world and culturally meaningful contexts significantly improves students' analytical thinking and problem-solving competence. For example, deriving and calculating the area of a circle using objects such as *sagu sep* and *nyiru* provides tangible experiences that reinforce theoretical knowledge.

Table 1. Material Presented In Contextual Mathematics Learning materials

Basic Competency	Mathematics material	Cultural material	Indicators
Recognize various plane shapes (triangle, quadrilateral, polygons, and circle)	Discovering the Area of a Circle	*sagu sep, nyiru*	a. Derive the formula for the area of a circle b. Calculate the area of a circle
Explain and perform arithmetic operations of addition, subtraction, multiplication, and division involving integers	Addition and Subtraction of Integers	*kandara, bevak, roda gila*	a. Analyze addition operations on negative integers b. Analyze subtraction operations on negative integers c. Solve problems involving addition of negative integers d. Solve problems involving subtraction of negative integers
Compare prisms, cylinders, pyramids, cones, and spheres	Discovering the Volume of Prisms and Cylinders	*pinang iris*	a. Identify the properties and parts of prisms and cylinders b. Create nets of prisms and cylinders c. Formulate the volume formulas for prisms and cylinders

(Primary data analysis, 2024)

The incorporation of concrete cultural objects also supports the visualization of geometric and volumetric concepts. Ratnaningsih et al. (2022) highlighted that using local cultural media to represent geometric nets and calculate volumes of prisms and cylinders helps students better grasp spatial reasoning and volume formulas. These findings underscore the pedagogical advantage of integrating cultural artifacts in teaching three-dimensional shapes.

Moreover, embedding culture within mathematics education fosters both cognitive and affective domains. Sakti et al. (2024) revealed that culturally contextualized learning not only improves cognitive skills but also strengthens students' pride and connection to their cultural identity. This dual impact encourages a more holistic learning experience that supports student engagement and identity formation.

In summary, the curriculum analysis demonstrates the feasibility and educational value of integrating local cultural materials into mathematics teaching. Supported by recent studies, this culturally responsive approach enhances mathematical understanding, problem-solving skills, and cultural appreciation among elementary students.

In the development stage, the researcher developed a prototype of the learning materials and conducted validation by media and content experts. Any shortcomings found during validation were revised according to expert feedback. The revised learning materials were then tested in the classroom, and feedback was collected from both students and teachers. Based on this feedback, the materials were refined to ensure their effectiveness and relevance.

Product evaluation was conducted after the development of the learning materials was completed. This evaluation aimed to obtain feedback and assessments from lecturers to improve the student worksheet. Feedback on the content aspect included the need to align conceptual sequences more closely with the curriculum and indicators, including solution strategies. It was also suggested to give students more freedom during the initial discussion of the problems presented in the worksheets. Meanwhile, feedback on the media aspect included the need to adjust illustrations to be more appropriate for elementary school students and to improve illustration quality in the exercises.

The final stage of this research was the evaluation of the student worksheet. Evaluation is a process to determine whether the developed product is usable. This stage plays a crucial role in improving the quality of the Student Worksheet. The evaluation involved assessments by lecturers regarding both the content/learning aspect and the media aspect. At this stage, the final product a local wisdom-based student worksheet was deemed feasible as learning materials for classroom learning. During the evaluation phase, results were obtained for the content and learning aspects, media aspects, and student responses. The evaluation of content and learning is presented in Table 2, while the media aspect evaluation is presented in Table 3.

Table 2. Assessment Results of Content and Learning Aspects

No.	Assessment Aspect	Indicator	Average
1.	Content Feasibility	Alignment of material with topic and learning objective	4,89
		Accuracy of material	4,56
		Currency of material	4,89
2.	Presentation Feasibility	Clarity of material presentation	4,67
		Coherence and logical flow of thought	4,78
	Overal average		4,46
	Category		Excellent

Table 2 presents the results of the content and learning aspects assessment conducted by two content experts. The assessment focused on key indicators including alignment of material with topics and learning objectives, accuracy, currency of the material, clarity of presentation, and coherence and logical flow of ideas.

The results indicate a high level of content feasibility, with an average score of 4,89 for alignment with learning objectives and currency of material, and 4,56 for material accuracy. Presentation feasibility was also rated highly, with clarity of material presentation scoring 4,67 and coherence of ideas 4,78. Overall, the average score across all indicators was 4,46 out of a maximum of 5, placing the developed student worksheet within the "excellent" category.

This evaluation aligns with the standards outlined by Plomp & Nieveen (2013), who emphasize the importance of content accuracy, relevance, and clarity in educational material development to enhance learning effectiveness. Moreover, a similar study by Suastra et al. (2024) supports the use of expert validation as a reliable method to ensure the quality and feasibility of learning materials, highlighting that materials scoring above 4,0 generally meet the criteria for effective learning resources.

The high scores for currency and alignment indicate that the materials are up-to-date and well-tailored to meet curriculum goals, which is critical in fostering meaningful learning experiences, as noted by Aquino (2024). Furthermore, the positive evaluation of presentation aspects supports findings by McCallum (2023) that clarity and logical flow significantly impact student comprehension and engagement.

In conclusion, the expert assessment confirms that the developed student worksheet is of high quality, demonstrating both content validity and instructional clarity, which are essential for facilitating effective mathematics learning in elementary education. Meanwhile, as shown in Table 3, the overall average score from the media expert evaluation was 4,60 out of a maximum score of 5. Based on this assessment, the student worksheet is also categorized as excellent.

Table 3. Assessment Results of Media Aspects

No.	Assessment Aspect	Indicator	Average
1.	Graphical Feasibility	Size	4,44
		Cover design	4,78
		Content design	4,89
2.	Presentation Feasibility	Communicative	4,56
		Dialogic and interactive	4,33
		Suitability for student development level	4,67
		Adherence to language rules	4,56
		Use of symbols	4,56
	Overal average		4,60
	Category		Excellent

As shown in Table 3, the media aspects of the developed student worksheet were evaluated by media experts, yielding an overall average score of 4,60 out of a maximum of 5. This score places the media aspect of the worksheet in the "excellent" category. Specifically, graphical feasibility indicators such as content design (4,89), cover design (4,78), and size (4,44) received high scores, indicating the materials are visually appealing and appropriately designed for the intended audience. Presentation feasibility indicators, including communicativeness (4,56), dialogic and interactive elements (4,33), suitability for student development level (4,67), adherence to language rules (4,56), and use of symbols (4,56), further support the quality and effectiveness of the media design.

These findings correspond with studies such as those by Aulia et al. (2024), which emphasize that well-designed instructional media with clear, interactive, and developmentally appropriate features can significantly enhance student engagement and learning outcomes. Additionally, Mayer (2009) underscores the importance of coherent design and clear communication in multimedia learning materials to optimize cognitive processing.

Table 4. Student Responses to the Student Worksheet

No.	Assessment Indicator	Average
1.	Response to content	4,34
2.	Response to language	4,35
3.	Interest in the Student Worksheet	4,38
	Overal average	4,35
	Category	Good

Furthermore, the student response questionnaire, summarized in Table 4, shows an overall average score of 4,35, categorized as good. Students expressed positive responses towards the content (4,34), language (4,35), and their interest in the worksheet (4,38). This aligns with research by Portana et al. (2021), who argue that student interest and positive reception are critical indicators of instructional material effectiveness and acceptance.

Combining these findings with the previously assessed content and learning aspects (excellent category), it can be concluded that the developed student worksheet is both feasible and effective for classroom use. The integration of expert validation and positive student feedback strengthens the reliability and applicability of the learning materials, suggesting they can contribute to improved mathematics learning outcomes in elementary education settings.

The implementation phase was carried out using the developed learning materials in the form of student worksheet. This phase aimed to evaluate the extent to which students' problem-solving abilities in mathematics improved before and after using the Student Worksheet during learning activities. The implementation was conducted in Grade V. The implementation phase of the study began with administering a pre-test to assess students' initial problem-solving abilities. The pre-test results showed an average score of 78,70, indicating the baseline performance level. Following the instructions in the developed student worksheet, a post-test was conducted to measure improvement in students' problem-solving skills. The post-test average score increased to 83,36, suggesting a positive impact of the instructional intervention (Table 5).

To statistically evaluate the significance of this improvement, a paired-samples t-test was conducted in SPSS. This test is appropriate for comparing the means of two related groups in this case, the same students' scores before and after the intervention under the assumption of normal data distribution. Prior to the t-test, the Kolmogorov-Smirnov test was performed to assess the normality of the post-test data distribution.

Table 5. Paired Samples Statistics

Pair	Mean	N	Std. Deviation	Std. Error Mean
pre-test	78,70	61	6,380	1,165
post-test	83,36	61	8,446	1,542

Statistical analysis was conducted using a paired sample t-test and n-gain calculation with the help of SPSS. The paired sample t-test was used to compare the difference between two means from the same sample measured at two different times, assuming the data are normally distributed. The Kolmogorov-Smirnov test was used to check for normality.

Table 6. Tests of Normality

Kolmogorov-Smirnov	df	Sig.	Shapiro-Wilk	df	Sig.
0,241	60	0,001	0,927	60	0,096

a. Lilliefors Significance Correction

As shown in Table 6, the Kolmogorov-Smirnov test yielded a significance value of 0,001, which is greater than the 0,05 threshold, indicating that the data do not significantly deviate from normality. Therefore, the assumption of normality is met, validating the use of the paired sample t-test for this analysis. Additionally, the n-gain score was calculated to measure the magnitude of learning improvement. This combined statistical approach ensures a robust evaluation of the instructional effectiveness of the Student Worksheets in enhancing elementary students' problem-solving abilities in mathematics.

Table 7 presents the paired samples correlation analysis between pre-test and post-test scores, showing a moderate positive correlation coefficient of 0,632, which is statistically significant ($p < 0,001$). This significant correlation indicates a meaningful relationship between students' initial and post-instruction problem-solving abilities, affirming that the students' performance after intervention is closely related to their baseline abilities.

Table 7. Paired Samples Correlations

Pair	N	Correlation	Sig.
Pre-test & Post-test	61	0,632	0,000

Further statistical analysis using the paired samples t-test (Table 8) revealed a calculated t-value of -9,893 with a significance level of 0,000 ($p < 0,05$). This significant result confirms that the difference between pre-test and post-test scores is not due to chance, demonstrating that the Student Worksheet intervention led to a significant increase in students' mathematical problem-solving scores. These findings are consistent with previous studies highlighting the effectiveness of well-designed instructional materials in improving student learning outcomes (Munna & Kalam, 2021).

Table 8. Paired Samples Test

Treatment		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	pre-test post-test	-11,967	6,625	1,210	-14,441	-9,493	-9,893	60	0,000

The normalized gain (n-gain) score of 0,28, classified as a medium level of improvement, suggests that while the Student Worksheet has a positive effect, there is still potential for further enhancement. This level of gain aligns with Hake (2019) framework, which categorizes n-gain values between 0,3 and 0,7 as moderate improvement in learning. Such moderate gains are typical in educational interventions that aim to enhance complex cognitive skills such as mathematical problem solving (de Vreeze-Westgeest & Vogelaar, 2022).

According to constructivist learning theory Vygotsky (1978), effective learning occurs when students actively construct knowledge through meaningful tasks that connect new information to prior experiences. The student worksheet, designed with contextual cultural elements and problem-solving tasks, appears to embody this principle by engaging students in relevant and scaffolded learning activities. In conclusion, the developed student worksheet meets the criteria for feasibility and demonstrates a statistically significant and educationally meaningful improvement in elementary students' problem-solving abilities. This supports the continued development and use of culturally contextualized learning materials in mathematics education.

Although the results of this study successfully demonstrated that the contextual mathematics worksheets significantly improved indigenous students' mathematical problem-solving abilities (n-gain 0,28), the findings must be interpreted in light of several methodological constraints. Firstly, regarding the sample limitation, the research utilized a restricted sample size from selected elementary schools and focused specifically on the educational context of the *Malind* Tribe in Merauke. This specific cultural focus, while deep, inherently limits the generalizability of the findings to other indigenous groups or regions with different cultural practices. Secondly, the scope of cultural integration was primarily centered on readily observable elements of local culture and nature (e.g., local tools, traditional architecture). While effective, a broader exploration of complex ethnomathematical thinking or traditional knowledge systems was not fully integrated into the worksheets design.

Finally, concerning the trial stage limitation, the study only reached the limited trial stage (develop phase) of the 4-D model. As a result, the research lacked data from a large-scale dissemination trial and long-term assessment, which would be crucial for determining the material's sustained effectiveness and feasibility for wider adoption across the region. Future studies should address these limitations by expanding the sample, deepening the cultural scope, and conducting a full-scale dissemination trial.

CONCLUSIONS AND SUGGESTIONS

The development and limited trial implementation of the contextual mathematics learning worksheets, which successfully integrate the natural environment and local culture of the *Malind* Tribe in Merauke, confirmed the materials' high appropriateness by expert validators and empirically demonstrated a statistically significant improvement in students' mathematical problem-solving abilities (n-gain 0,28, medium category). This success carries significant implications: theoretically, it reinforces the tenets of ethnomathematics and culturally responsive pedagogy by showing how the use of cultural artifacts effectively mediates abstract mathematical concepts, thereby bridging the formal and informal gap; practically, it provides a validated and relevant instructional resource for elementary school teachers implementing contextual learning and the *Kurikulum Merdeka* framework, ultimately enhancing numeracy literacy in indigenous communities. Moving forward, however, it is recommended that future studies address the current limitations by conducting a large-scale dissemination trial for long-term sustainability assessment, expanding the scope to qualitative research on motivational and cultural identity impacts, and investigating the material's potential to foster higher-order mathematical thinking skills beyond basic problem-solving.

REFERENCES

Acharya, B. R., Kshetree, M. P., Khanal, B., Panthi, R. K., & Belbase, S. (2021). Mathematics educators' perspectives on cultural relevance of basic level mathematics in Nepal. *Journal on Mathematics Education*, *12*(1), 17–48. https://doi.org/10.22342/JME.12.1.12955.17-48

Aikenhead, G. (2017). Enhancing School Mathematics Culturally: A Path of Reconciliation. *Canadian Journal of Science, Mathematics and Technology Education*, *17*, 73–140. https://doi.org/10.1080/14926156.2017.1308043

Akbar, T., Fajri, A., & Andarwulan, T. (2023). Implementation of the Merdeka Curriculum in Indonesia: Challenges and Opportunities. *Journal of Education Innovation*, *10*(2), 204–212. https://erudio.ub.ac.id/index.php/erudio/article/view/634

Ang, W. H. D., Shorey, S., Hoo, M. X. Y., Chew, H. S. J., & Lau, Y. (2021). The role of resilience in higher education: A meta-ethnographic analysis of students' experiences. *Journal of Professional Nursing : Official Journal of the American Association of Colleges of Nursing*, *37*(6), 1092–1109. https://doi.org/10.1016/j.profnurs.2021.08.010

Ansya, Y. A., Salsabilla, T., & Mailani, E. (2024). The Role of Local Culture in North Sumatra in Improving Mathematical Ability in the Learning of Space Shapes for 5th Grade Elementary School Students. *Jurnal Ilmu Manajemen Dan Pendidikan*, *4*(2), 147–154. https://doi.org/10.30872/jimpian.v4i2.4329

Aquino, E. T. M. (2024). Analysis of the Alignment of Curriculum, Instruction, and Assessment in Higher Education Mathematic. *American Journal of Multidisciplinary Research and Innovation*, *3*(5), 8–23. https://doi.org/10.54536/ajmri.v3i5.3376

Ashrafova, I. (2024). Culturally Responsive Teaching: Strategies for Promoting Inclusivity in the Classroom. *Global Spectrum of Research and Humanities*, *1*(1), 102–112. https://doi.org/10.69760/2wbtm276

Assegaff, N., & Bonyah, E. (2024). *Development of Ethnomathematics-Based Teaching Materials through Interactive Games to Improve Students' Mathematical Literacy*. *14*(2), 112–128. http://doi.org/10.23969/pjme.v14i2.16364

Aulia, H., Hafeez, M., Mashwani, H. U., Careemdeen, J. D., Mirzapour, M., & Syaharuddin. (2024). The Role of Interactive Learning Media in Enhancing Student Engagement and Academic Achievement. *International Seminar on Student Research in Education, Science, and Technology*, *1*, 57–67. https://journal.ummat.ac.id/index.php/issrectec/article/view/22378

Bang, M., & and Vossoughi, S. (2016). Participatory Design Research and Educational Justice: Studying Learning and Relations Within Social Change Making. *Cognition and Instruction*, *34*(3), 173–193. https://doi.org/10.1080/07370008.2016.1181879

Brown, R., & Redmond, T. (2017). Privileging a Contextual Approach to Teaching Mathematics: A Secondary Teacher's Perspective. *Mathematics Education Research Group of Australia*, 109–116. https://eric.ed.gov/?id=ED589546

Clarke, J. B., & Todd, W. F. (2024). Indigenous students face disparities in STEM. *Open Access Government*, *42*(1), 270–271. https://doi.org/10.56367/oag-042-11134

D'Ambrosio, U., & Rosa, M. (2016). Ethnomathematics and Its Pedagogical Action. *13th International Congress on Mathematical Education*, *July*, 24–31. https://cead.ufop.br/images/NOTICIAS_2016/05-08-16_Opening_TSG35_Milton.pdf

de Vreeze-Westgeest, M. G. J., & Vogelaar, B. (2022). Cognitive Training in the Domain of Mathematics for Potentially Gifted Children in Primary School. *Education Sciences*, *12*(2). https://doi.org/10.3390/educsci12020127

Elcullada Encarnacion, R., Galang, A. A., & Hallar, B. J. (2021). The Impact and Effectiveness of E-Learning on Teaching and Learning. *International Journal of Computing Sciences Research*, *5*(1), 383–397. https://doi.org/10.25147/ijcsr.2017.001.1.47

Fernandes, A. C., Lima, G. F., Lima, J. F., & Silva, A. P. A. da. (2020). Contextualized education in the teaching of Mathematics: a case study at the Kindergarten and Elementary School Manoel Rodrigues do Nascimento. *Research, Society and Development*, *9*(10), 1–29. http://dx.doi.org/10.33448/rsd-v9i10.9207

Fredy, F., Halimah, L., & Hidayah, Y. (2020). Malind-Papua Ethnomathematics: Kandara Musical Instrument as Learning Media for Geometry Concepts in Elementary School. *Jurnal Iqra' : Kajian Ilmu Pendidikan*, *5*(1), 43–57. https://doi.org/10.25217/JI.V5I1.872

Garcia-Olp, M., Chris, N., & and Saiz, L. (2022). Decolonizing Mathematics Curriculum and Pedagogy: Indigenous Knowledge Has Always Been Mathematics Education. *Educational Studies*, *58*(1), 1–16. https://doi.org/10.1080/00131946.2021.2010079

Hake, R. R. (2019). Analyzing Change/Gain Scores. In *Dept. of Physics, Indiana University* (Vol. 1, Issue 1). https://doi.org/10.24036/ekj.v1.i1.a10

Indaryanti, R. B., Murtiyasa, B., & Soemardjoko, B. (2025). *4D Research and Development Model: Trends, Challenges, and Opportunities Review*. *25*(1), 91–98. https://doi.org/10.31599/na7deq07

Kaino, L. M., & Kasanda, C. (2015). Some Indigenous Strategies in Mathematics Teaching: Taking the Artefacts into the Classroom. *Journal of Communication*, *6*, 67–74. https://doi.org/10.1080/0976691X.2015.11884849

Khan, F. N., Begum, M., & Imad, M. (2019). Relationship between Students' Home Environment and their Academic Achievement at Secondary School Level. *Pakistan Journal of Distance & Online Learning*, *5*(2), 223–234. https://eric.ed.gov/?id=EJ1266643

Kuhlmann, S. L., Plumley, R., Evans, Z., Bernacki, M. L., Greene, J. A., Hogan, K. A., Berro, M., Gates, K., & Panter, A. (2024). Students' active cognitive engagement with instructional videos predicts STEM learning. *Computers and Education*, *216*(February), 105050. https://doi.org/10.1016/j.compedu.2024.105050

Larasati, I., Pramasdyahsari, A. S., & Harun, L. (2025). Enhancing elementary student ' s numeracy skills through ethnomathematics-based learning : An analysis of minimum competency assessment results. *Journal of Honai Math*, *8*(April), 71–88. https://doi.org/10.30862/jhm.v8i1.861

Leton, S. I., Lakapu, M., Dosinaeng, W. B. N., & Fitriani, N. (2025). Integrating local wisdoms for improving students' mathematical literacy: The promising context in learning whole numbers. *Infinity Journal*, *14*(2), 369–392. https://doi.org/10.22460/infinity.v14i2.p369-392

Li, J., & Xue, E. (2023). Dynamic Interaction between Student Learning Behaviour and Learning Environment: Meta-Analysis of Student Engagement and Its Influencing Factors. *Behavioral Sciences*, *13*(1). https://doi.org/10.3390/bs13010059

Mainali, B. (2021). Representation in teaching and learning mathematics. *International Journal of Education in Mathematics, Science and Technology*, *9*(1), 1–21. https://doi.org/10.46328/ijemst.1111

Martin, M., & Campbell, A. R. (2024). Shaping Explicit Instruction to Foster Culturally Responsive Math Instruction Through Word Problems for Elementary Learners. *Insights into Learning Disabilities*, *21*(2), 133–151. https://www.ldw-ild.org/images/Martin__Campbell.pdf

Mayer, R. E. (2009). *Multimedia Learning* (Second). Cambridge University Press. https://doi.org/10.1017/CBO9780511811678

McCallum, W. (2023). Making Sense of Mathematics and Making Mathematics Make Sense. *New ICMI Study Series*, *33*, 511–521. https://doi.org/10.1007/978-3-031-13548-4_33

Munna, A. S., & Kalam, M. A. (2021). Teaching and learning process to enhance teaching effectiveness: literature review. *International Journal of Humanities and Innovation (IJHI)*, *4*(1), 1–4. https://doi.org/10.33750/ijhi.v4i1.102

Naidoo, J. (2021). Integrating Indigenous Knowledge and Culturally based Activities in South African Mathematics Classrooms. *African Journal of Teacher Education*, *10*(2), 17–36. https://doi.org/10.21083/ajote.v10i2.6686

Nurpratiwiningsih, L., Rusdarti, Joko Widodo, & Sanjoto, T. B. (2023). Local Wisdom as Learning Innovation in Elementary Schools. *International Conference on Science, Education and Technology*, 408–413. https://proceeding.unnes.ac.id/ISET/article/view/2452

Oughton, R., Nichols, K., Bolden, D. S., Dixon-Jones, S., Fearn, S., Darwin, S., Mistry, M., Peyerimhoff, N., & Townsend, A. (2024). Developing 'deep mathematical thinking' in geometry with 3- and 4-year-olds: a collaborative study between early years teachers and university-based mathematicians. *Mathematical Thinking and Learning*, *26*(3), 306–325. https://doi.org/10.1080/10986065.2022.2119497

Patunah, S., Herman, T., & Hasanah, A. (2020). The Enhancement of Mathematical Problem-Solving Skills among Junior High School Students Using Problem-based Learning. *Jurnal Pendidikan MIPA*, *25*(3), 1067–1079. https://dx.doi.org/10.23960/jpmipa/v25i3.pp1067-1079

Peralta, L. M. (2020). Between The Boundaries Of Knowledge: Theorizing An Etic-Emic Approach To Mathematics Education. *Mathematics Education Across Cultures: Proceedings of the 42nd Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, 476–484. https:/doi.org/10.51272/pmena.42.2020

Plomp, T., & Nieveen, N. (2013). Educational Design Research Educational Design Research. *Netherlands Institute for Curriculum Development: SLO*, 1–206. http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ815766

Portana, H. V., Fronda, J. G., Policarpio, D. G. T., Rigat, K. A. R. C., & A. Llames, G. (2021). Effectiveness and Acceptability of Instructional Materials in the Enhancement of Students' Academic Achievement. *International Journal of Advanced Engineering, Management and Science*, *7*(1), 12–15. https://doi.org/10.22161/ijaems.71.2

Purwanty, R., & Fredy. (2020). Etnomatematika Malind-Papua: Integrasi Budaya dalam Kompetensi Dasar Matematika di Sekolah Dasar. *AL-MUDARRIS: Journal of Education*, *3*(2), 202–214. https://doi.org/10.32478/al-mudarris.v3i2.521

Rashaad Shabab, C. (2024). Understanding mathematics anxiety: loss aversion and student engagement. *Teaching Mathematics and Its Applications*, *43*(2), 107–124. https://doi.org/10.1093/teamat/hrad008

Ratnaningsih, D., Putra, N. N. B., Nathania, N., Mulya, U. T., Novitasari, D. A., & Fadilah, U. (2022). Penggunaan Media Pembelajaran Jaring-Jaring Bangun Ruang Untuk Peningkatan Minat Belajar Siswa Kelas 2 di SDN 03 Desa Kembang Tanjung. *Pengabdian Kepada Masyarakat Cendekia*, *1*(2), 79–88. https://doi.org/10.47637/pkmcendekia.v1i2.938

Rima, R., Muhyidin, A., Leksono, S. M., & Jamaludin, U. (2024). Exploring Culturally Responsive Teaching Practices in English Language Teaching at High Schools in Banten Province: Perceptions, Strategies, Challenges, and Opportunities. *Edukatif : Jurnal Ilmu Pendidikan*, *6*(3), 2145–2155. https://doi.org/10.31004/edukatif.v6i3.6620

Rosa, M., D'Ambrósio, U., Orey, D. C., Shirley, L., Alangui, W. V., Palhares, P., & Gavarrete, M. E. (2016). *Current and future perspectives of ethnomathematics as a program*.

Rosa, M., & Orey, D. C. (2020). Principles of Culturally Relevant Education in an Ethnomathematical Perspective. *Revista De Educação Matemática*, *17*(32), 1–24. https://doi.org/doi.org/10.37001/remat25269062v17id306

Sakti, S. A., Endraswara, S., & Rohman, A. (2024). Revitalizing local wisdom within character education through ethnopedagogy apporach: A case study on a preschool in Yogyakarta. *Heliyon*, *10*(10), e31370. https://doi.org/10.1016/j.heliyon.2024.e31370

Schorcht, S., Peters, F., & Kriegel, J. (2025). Communicative AI Agents in Mathematical Task Design : A Qualitative Study of GPT Network Acting as a Multi - professional Team. In *Digital Experiences in Mathematics Education*. Springer International Publishing. https://doi.org/10.1007/s40751-024-00161-w

Shahidayanti, T., Charitas, R., Prahmana, I., & Fran, F. A. (2024). *Integrating Ethno-Realistic Mathematics Education in developing three-dimensional instructional module*. *7*(December), 379–400. https://doi.org/10.30862/jhm.v7i3.698

Shultz, M., Close, E., Nissen, J., & Van Dusen, B. (2024). Enacting Culturally Relevant Pedagogy when "Mathematics Has No Color": Epistemological Contradictions. *International Journal of Research in Undergraduate Mathematics Education*, *10*(2), 486–515. https://doi.org/10.1007/s40753-023-00219-x

Suastra, I. W., Suma, K., Agung, A. A. I., & Sudiatmika, R. (2024). Expert Validation of Ethnoscience-Based Teaching Materials to Develop Student Competence in Critical Thinking and Caring Attitudes. *Kappa Journal*, *8*(1), 85–90. https://doi.org/10.29408/kpj.v8i1.25656

Supriadi, N., Jamaluddin Z, W., & Suherman, S. (2024). The role of learning anxiety and mathematical reasoning as predictor of promoting learning motivation: The mediating role of mathematical problem solving. *Thinking Skills and Creativity*, *52*(February), 101497. https://doi.org/10.1016/j.tsc.2024.101497

Tarng, W., Huang, J. K., & Ou, K. L. (2024). Improving Elementary Students' Geometric Understanding Through Augmented Reality and Its Performance Evaluation. *Systems*, *12*(11). https://doi.org/10.3390/systems12110493

Teise, K. L. (2025). Place-based Mathematics Education: An Education for Sustainable Development Pedagogy to Enhance Mathematics Teacher Training. *ERRCD Forum*, 72–87. https://doi.org/10.38140/obp3-2025-05

Thiagarajan, S. (1974). *Instructional development for training teachers of exceptional children: A sourcebook*. https://eric.ed.gov/?id=ED090725

Yu, M. V. B., Liu, Y., Soto-Lara, S., Puente, K., Carranza, P., Pantano, A., & Simpkins, S. D. (2021). Culturally responsive practices: Insights from a high-quality math afterschool program serving underprivileged Latinx youth. *American Journal of Community Psychology*, *68*. https://doi.org/10.1002/ajcp.12518

Yunitasari, F., Sintawati, M., & Mastul, A.-R. H. (2023). The Application of Contextual Teaching and Learning for Increasing Learning Outcomes and Reducing Anxiety in Elementary School Mathematics. *International Journal of Learning Reformation in Elementary Education*, *2*(02), 77–85. https://doi.org/10.56741/ijlree.v2i02.283