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Integrating local wisdoms for improving students' mathematical literacy: The promising context in learning whole numbers

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Abstract

The gap in the decline in PISA scores is likely due to an abstract and contextually irrelevant approach to teaching mathematics, which often fails to connect everyday experiences that utilize the potential of local wisdom to make learning more engaging and culturally relevant. This research aimed to develop mathematics learning materials that integrate local wisdom to improve students' mathematical literacy skills. The study employed the Research and Development (R&D) method with the ADDIE development model. The developed learning materials incorporated elements of Timor local culture, including traditional houses, handwoven fabrics, and traditional games, as contextual tools to enrich the learning experience. The quality of the developed product was evaluated for three aspects: validity, practicality, and effectiveness. The validation results showed an average score of 93.1%, which is included in the very valid category. Product implementation showed a significant increase in trial results, with all students meeting the minimum competency criteria after using the learning materials. The final score of students' responses after using this developed product is 96.93%, categorized as very practical. The average N-Gain score of 0.76 significantly increased students' mathematical literacy skills. Feedback from students highlighted that learning materials inspired by local wisdom made the learning process more engaging and relatable. Teachers appreciated the inclusion of cultural elements, noting that they facilitated a deeper connection between mathematical concepts and students' everyday experiences. The research underscores the transformative potential of a culture-based approach in mathematics education.

Keywords:
Literacy skills, Local wisdom, Mathematics learning, Whole number

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1. INTRODUCTION

Mathematical literacy is one of the important indicators in assessing the quality of a country's education. Mathematical literacy is not only related to students' ability to solve math problems in class, but also includes their understanding of how to use mathematical

concepts in everyday life. Referring to data from the Organization for Economic Co-operation and Development (OECD) which released the results of the Program for international Student Assessment (PISA) test in 2022, shows a decrease in reading, mathematics and science scores. Reading skills dropped from 371 to 359; math skills also decreased from 379 to 366 (OECD, 2023; Wijaya et al., 2024). In general, the average mathematics performance of Indonesian students is still low when compared to other countries such as Singapore, Japan, Korea, and others.

Countries such as Singapore, Japan, and Korea have implemented specific practices and policies that can inspire improvements in Indonesia. For example, Singapore emphasizes a problem-solving approach that integrates real-world applications into the mathematics curriculum, ensuring that students develop conceptual understanding and practical skills. Japan incorporates lesson study as a professional development practice, where teachers collaboratively plan, observe, and refine lessons, leading to more effective teaching strategies. Korea, on the other hand, has invested in integrating technology into the classroom and promoting personalized learning pathways for students (Nurlaili et al., 2022). These practices not only improve mathematics literacy but also equip students with the critical thinking and problem-solving skills needed for the 21st century.

The PISA test results also show how well the education system in Indonesia prepares students to face real-life challenges and future success (Rizki & Priatna, 2019). The decline in the scores of students in Indonesia indicates the low competence of 15-year-old students in 21st century skills which include critical thinking, problem solving, and other higher-order thinking skills (HOTS) that are still not adequately achieved (Bilad et al., 2024; Rahmawati et al., 2022) even though one of the components needed to build 21st century skills is mathematical (Hasanah et al., 2022). This shows that there is a gap between the learning of mathematics taught at school and the application of mathematics in everyday life.

One of the causes of low mathematical literacy skills is the learning approach that often tends to be abstract and unrelated to students' daily lives. Although mathematics learning in schools generally focuses on formal mathematical concepts, there is variation across schools and programs. Some institutions have attempted to connect mathematics to real-life contexts through project-based learning or contextualized problem-solving tasks. However, these efforts are not always widespread or implemented consistently due to various constraints, such as lack of teacher training, inadequate resources, or rigid adherence to traditional curricula (Sumirattana et al., 2017). This inconsistent application can cause many students to have difficulty understanding the relevance of mathematics, causing them to experience a gap between mathematical concepts and their practical application in everyday life.

Additionally, the implementation of the formal curriculum in schools often ignores the local context that can provide a deeper understanding of mathematical concepts (François & Van Kerkhove, 2010). Therefore, we argue that mathematics learning needs to be elaborated with real contexts. To address this, mathematics instruction should be designed to incorporate real-world contexts, including elements of local wisdom. Teachers can create lesson plans that incorporate local traditions, crafts, or technologies, offering students varied

and engaging learning experiences for solving mathematics problems. For example, traditional weaving patterns, such as those found in local textiles, can be used to teach geometry, symmetry, and spatial reasoning. Indigenous measurement systems, such as those used in traditional construction or agricultural practices, can provide a foundation for understanding ratios, proportions, and units of measurement. Similarly, the architectural design of a traditional house can illustrate the use of angles, shapes, and calculations of area and volume.

Local wisdom is the embodiment of mathematical ideas, thoughts, and practices that are rooted in a particular cultural context (Fouze & Amit, 2018). By combining these cultural elements, mathematics learning can bridge the gap between abstract concepts and practical applications, making learning more meaningful for students. For example, traditional games such as congklak can be used to explore integer arithmetic operations in a culturally relevant way. Integrating local wisdom, supported by appropriate technology and various activities, offers a promising strategy to improve students' mathematical literacy. This helps them not only understand mathematical concepts but also appreciate their relevance to everyday life, thereby fostering a deeper connection with their cultural heritage (Cai et al., 2014; d'Entremont, 2015).

The implementation of an independent curriculum that provides opportunities for schools to develop learning creates enough space for teachers to innovate. One such innovation is the integration of local wisdom into mathematics learning. Local wisdom serves as an effective medium for explaining abstract mathematical concepts (Fouze & Amit, 2023) because it is closely related to students' daily experiences (Abdullah, 2017). For example, traditional weaving patterns can be used to teach concepts such as symmetry, geometry, and fractions, while indigenous architectural designs, such as traditional houses, can illustrate the principles of area, volume, and angles.

Mathematics learning based on local wisdom can help students understand abstract concepts better by connecting them to real-world examples encountered in their environment (Knijnik, 2002; Machromah et al., 2020). For example, traditional agricultural practices that rely on local calendars can serve as a basis for teaching time, sequence, and probability. Likewise, cultural artifacts such as musical instruments can demonstrate the concepts of measurement, ratio, and proportional reasoning. Integration of local wisdom also makes learning more meaningful by personalizing and contextualizing it with students' cultural backgrounds (Fouze & Amit, 2018).

Local wisdom encompasses various aspects of life, including number systems, measurement techniques, and patterns, which often have a mathematical basis (Kusuma et al., 2024). For example, using traditional games such as congklak can introduce basic arithmetic and counting strategies, while learning the mathematics behind indigenous navigation methods can provide insights into coordinate geometry and spatial reasoning. This integration not only offers hands-on mathematics learning experiences but also familiarizes students with diverse cultural traditions, fostering an appreciation for local values and ensuring their preservation for future generations.

Integrating local wisdom into learning can be an effective medium for explaining abstract mathematical concepts by grounding them in real-life contexts that are familiar and

meaningful to students. For example, the use of traditional weaving patterns can help students understand symmetry, geometry, and fractions, while indigenous measurement systems, such as those used in traditional markets, can clarify concepts of length, area, and volume. These cultural connections make mathematics more relevant, allowing students to see its relevance in everyday life and community practices. In addition, incorporating local wisdom fosters a deeper appreciation of cultural heritage while enhancing students' problem-solving skills by encouraging them to apply mathematical concepts to solve practical challenges in their environment.

Several previous studies have shown that the integration of local wisdom in mathematics learning can improve students' understanding and motivation in learning mathematics (Arion, 2024; Deda et al., 2024; Sukadari et al., 2023; Umbara et al., 2023). Arion (2024) conducted a systematic review of ethnomathematics, found that ethnomathematics could increase learning motivation, mathematical concepts understanding, and problemsolving skills, so he suggested the next researchers to use ethnomathematics in mathematics learning to preserve local wisdoms and cultural values. Complemented this finding, the result from Deda et al's research shows that there has been a very significant increase in the number of ethnomathematics studies in the period 2012 – 2022. Based on this finding, they suggest conducting research related to literacy, numeracy, and mathematical abilities for the next researchers. These studies collectively provide a strong foundation for future research in the field of ethnomathematics education in Indonesia, especially in the areas of literacy, numeracy and mathematical abilities.

In Indonesia, there is still room to further explore how local wisdom in various regions can be effectively integrated into mathematics learning. In the Timor-East Nusa Tenggara region, for example, traditional practices such as weaving tenun cloth, which involves intricate geometric patterns, can be used to teach concepts such as symmetry, area, and transformation. In addition, the unique architectural designs of traditional Timorese houses, such as the lopo, provide opportunities to explore three-dimensional shapes, proportions, and spatial reasoning. Indigenous measurement systems used in traditional farming or trading activities can also be used to teach units, conversions, and arithmetic operations. These culturally rooted practices not only make abstract mathematical concepts more relevant but also provide meaningful contexts for students to apply their mathematical knowledge to real-life situations. By integrating these elements, educators can foster mathematical literacy and cultural preservation, helping students connect their learning to their heritage while developing critical thinking and problem-solving skills.

Lorontuan Atambua Junior High School, as one of the schools located in the Indonesia-Timor Leste border area, faces various challenges in improving students' mathematical literacy skills. Based on initial observations and interviews with several teachers, it was found that students at Lorotuan Atambua Junior High School have diverse mathematical literacy skills with most students still at a low level in understanding and applying basic mathematical concepts. The researcher suspects that this is due to limited infrastructure, limited access to educational resources and socio-economic conditions that affect the learning process in schools as well as limited access to learning resources, lack of teacher training and lack of support from parents.

This study specifically develops local wisdom-based teaching materials on integers to improve students' mathematical literacy skills in border schools, such as SMP Lorotuan Atambua, which is still rarely done. The teaching materials contain activities and examples taken from local cultural practices, such as using traditional games to perform and understand the concept of integer operations, as well as solving problems based on traditional trading systems. These activities are designed to bridge the gap between abstract mathematical concepts and real-life applications, making mathematics more accessible and interesting for students. The teaching materials include story problems contextualized in local traditions, interactive exercises involving exploration of geometric patterns in local crafts, and collaborative projects that encourage students to apply integer operations in culturally relevant scenarios. By addressing specific gaps in mathematical literacy, these teaching materials aim to provide students with meaningful learning experiences that not only improve their mathematical skills but also deepen their appreciation of local wisdom and its practical applications.

Through this development method, it is expected to be an alternative solution to overcome the low mathematical literacy skills of students in Indonesia, by linking mathematics learning with a more meaningful local context. This study aims to develop mathematics teaching materials that integrate local wisdom to improve students' mathematical literacy skills. In addition to being able to provide more effective recommendations for improving mathematical literacy skills, the results of this study are also expected to be able to contribute to the development of a more inclusive curriculum based on local culture. A curriculum that considers local wisdom can provide space for students to recognize and appreciate their own culture, while improving mathematical literacy skills for their cognitive development. This learning approach is expected to be an alternative solution to overcome the low mathematical literacy skills of students and also improve their understanding of the rich and diverse cultural heritage that exists throughout Indonesia.

2. METHOD

Using Research and Development (R&D) method, this reseach aims to produce a learning material that intergrates local wisdoms in mathematics learning to improve students’ mathematical literacy skills. Located in SMP Negeri Lorotuan, Atambua, Subject of this research were 7th grade students in 2024/2025 academic year.

The quality of developed product was determined by using Nieveen theory (Kurniawan et al., 2019), which consists of three aspects namely: validity, practicality, and effectiveness. In this research, validity score was determined by two experts, who evaluate the quality of developed learning material before implementation. Practicality score was determined by teacher and students’ feedbacks after they used this developed product. Effectiviness score was determined by students’ post-test result and comparing it with pre-test result; the developed product would be classified as an effective product if at least more than 80% students could pass the minimum competency criteria. The determination of the 80% criteria in this study is based on the classical learning completion standards commonly used in the context of education in Indonesia, where learning in class is said to have passed

classically if 75% of the class successfully exceeds the Minimum Completion Criteria (Nurlaili et al., 2022).

Before use, the tests instrument were tested for validity and reliability. The improvement score after using this product would be determined by comparing the pretest and posttest result. These tests were created by using three mathematical literacy skills indicators, including: (1) using mathematics to solve problems in various contexts of daily life; (2) analyze information displayed in various forms (graphs, tables, sections, diagrams and so on); (3) Interpret the results of the analysis to predict and make decisions (Ferdianto et al., 2022; Sari et al., 2021).

This research uses interviews, questionnaires, and tests for data collection. Interviews with teacher and students was conducted to understand their problems in class. Questionnaires were used to validate product design from experts, and to collect feedbacks from teacher and students after using research product. Tests were used to collect effectiveness data from students before and after using developed product.

This research uses ADDIE development model that consists of 5 steps, including: analysis, design, development, implementation, and evaluation. The explanation of each step could be seen on Table 1.

Table 1. ADDIE development model steps used in this research

ADDIE Development Model	**Description**
Analysis	Based on observation and interview with teacher, researcher analyzed the suitable components for enhancing students' mathematical literacy skills, student's profile, and the learning materials.
Design	Researcher prepared everything needed to develop the product, consisted of: reference books, product design, and learning materials, including: learning concepts, local wisdoms materials, exercises, and quizzes.
Development	Researcher developed product based on previously created design. This process included product validity process by the experts. Using formula $P = \frac{f}{N} \times 100\%$, with P as the result score from an expert, f as total scores from each component, and N as the maximum score, validation score was determined by the average score from two experts, that is valid if the average score is at least 75%.
Implementation	After being declared valid, the developed product was given to teacher to be used with students in learning process. After using it, students were asked to do the posttest in order to measure their achievement, and filled the questionnaire for feedback. Besides the students, teacher was asked to fill the questionnaire too about their judgement and suggestion after using this developed product. Using formula $P = \frac{f}{N} \times 100\%$, with P as the result score from teacher/students, f as total scores from each component, and N as the maximum score, the developed product is practical if the average score is at least 75%.

ADDIE Development Model	Description
Evaluation	Based on posttest result, the developed product would be classified as an effective product if at least more than 80% students could pass the minimum competency criteria. Minimum competency criteria refer to specific standards or benchmarks determined by schools that students must meet to demonstrate essential skills and knowledge in a subject area. These criteria are often set to ensure that all students achieve the basic level of understanding necessary for academic progress or graduation. The level of improvement would be determined by using N-Gain formula: $Normal\ Gain = \frac{Pretest\ Score - Posttest\ Score}{Maximum\ Score - Pretest\ Score}$ Criteria: - N-Gain Score < 0.3: Low improvement - 0.3 ≤ N-Gain Score < 0.7: Moderate improvement - 0.7 ≤ N-Gain Score ≤ 1: High improvement

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Analysis Phase

In this phase, three kinds of analyses were conducted, namely: analysis of identified competencies, analysis of students' profile, and analysis of learning materials.

Analysis of Identified Components

Han et al. (2017) stated that numerical literacy has six components, including: 1) estimating and calculating with integers; 2) using fractions, decimals, percents, and ratio; 3) recognizing and using patterns and relations; 4) using spatial reasonings; 5) using measurements; and 6) interpreting statistical information. The relationship between these components and curriculum could be seen in Table 2.

Table 2. The relationship between numerical literacy components and curriculum

Numerical literacy Components	Curriculum
Estimating and calculating with integers	Numbers
Using fractions, decimals, percents, and ratio	Numbers
Recognizing and using patterns and relations	Numbers and Algebra
Using spatial reasonings	Geometry and Measurements
Using measurements	Geometry and Measurements
Interpreting statistical information	Data Processing

This research would be conducted on integer section. According to Table 2, numerical literacy components that suitable with integers materials is the first component: estimating and calculating with integers.

Analysis of Students' Profile

The mathematical literacy test was given to 28 seventh grade students as the pretest. The presentation of students' answers to the test questions given can be seen in Table 3.

Table 3. Students answer persentations

Question Number	Problem 1	Problem 2	Problem 3	Mean
% correct answer	28.57	32.14	21.43	27.38

Based on Table 3, we could see that there was no single question could be anwered correctly by at least 80% of total students at seventh grade. Based on interviews with students, researchers found that students had limited understanding about basic concepts of mathematics, including: reading diagram/graph, comparison, and integer problems. Besides that, analyzing several information given in the question and relating them to solve the problems or to make decisions also seemed to be difficult for them. Despite demonstrating strong mathematical abilities, many students struggled with contextual or word problems during the interview. This was not due to a lack of ability, but rather a lack of experience in solving such problems. Actually, some students showed a natural aptitude for logical reasoning, even when their approaches lacked a formal analytical basis. These findings highlight the importance of developing problem-solving skills through purposeful learning experiences. Lack of ability to analyze information and connect information with statements is the main factor that causes most of them to be unable to understand the problems given.

Analysis of Learning Materials

Lorotuan Senior High School has applied Independent Curriculum which emphasizes on the development of students' mathematical literacy skills. Supporting these requirement, they use books for teachers and students based on Independent Curriculum that is published by Curriculum and Book Center, Research and Development and Book Agency of the Ministry of Education, Culture, Research, and Technology (Tosho, 2021). In these books, all the learning materials have been arranged systematically according to National Education Standard that aims to develop students competencies on mathematical literacy. Related to D-Phase of Independent Curriculum especially for integers, learning materials structured in these books will help students in reading, writing, and comparing integers. Using these materials, students could learn about integers (positive, nol, and negative numbers), counting operations (addition, substraction, multiplication, and division of integers, including commutative, assosiative, adn distributive properties), and how to apply them to solve daily life problems. Overall, according to the books, by learning these materials, students are expected to able to: 1) understand integers concept comprehensively; 2) do integers counting operation fluently and approprietelly; 3) apply integers concept in problem solving; and 4) develop logical and analytical thinking skills.

3.1.2. Design Phase

Acording to analysis phase results, design phase was started by preparing and conceptualizing the product. There are four things should be considered in design phase,

including: 1) the product should be focused on estimating and calculating integers; 2) the product should use contextual problems; 3) the problems should be familiar to students; and 4) students need to learn how to use graph to solve contextual problems. Ensuring that the problems are familiar to students, it would be developed from students' local wisdom that they have faced or used in daily life. Based on these several points, researcher determined to design and develop a learning material to help students in developing their mathematical literacy skills.

In order to produce a good learning material, researcher conducted literature reviews, including: 1) ethnomathematics and local culture studies, to find the appropriate local wisdoms that could be used in this research; and 2) educational studies, to find the proper components of developed teaching material. Based on this step, researcher determined seven main components in this learning material, including: 1) introduction, it contains an illustration about how integers could be found in local wisdoms; 2) Pancasila students profiles, it contains Pancasila's values that could be formed by students after learning with this product in the class; 3) learning purposes, it contains the purposes of learning with this product; 4) starter questions, it contains some questions to stimulate students' thinking and develop active participation; 5) content map, it contains a map of knowledge that is used to help students build their understanding of integers by connecting new knowledge with their prior knowledge; 6) materials of learning, it contains all the materials, accompanied by illustrations from local wisdoms, that should be learned by students; and 7) assessment, it contains group of questions that should be answered by students to train their mathematical literacy skills particularly about integers. Design of this product could be seen Figures 1 to 7.

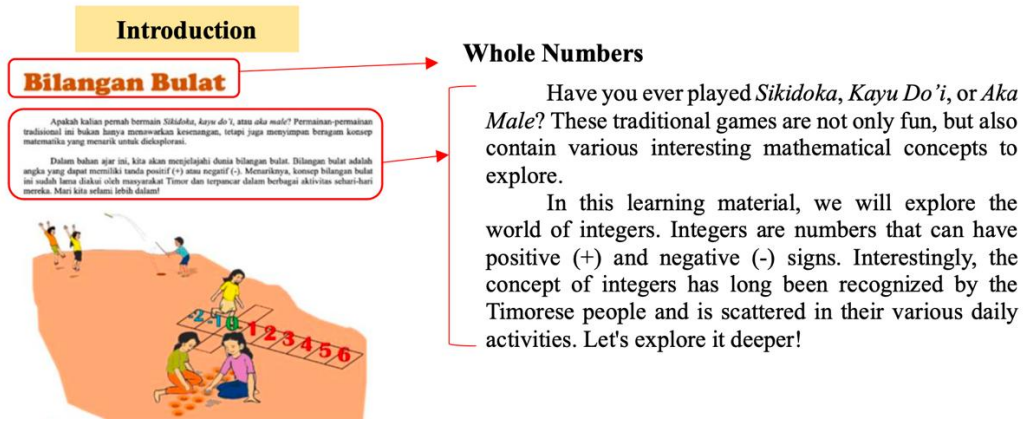

Figure 1. Introduction part of learning material

Figure 1 shows a part of the introduction part of learning material. This part contains an illustration about three traditional games from Timor called Sikidoka, Kayu Do'i, and Aka Male. This part is used for introducing the concept of integers through local wisdoms.

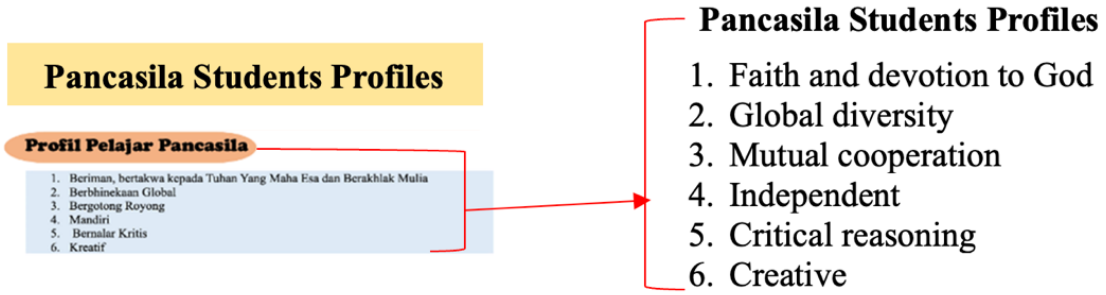

Figure 2. Pancasila students profiles

Figure 2 shows the Pancasila Students Profiles describes the profile of Pancasila which is expected to be developed through the use of this learning material. These profiles include: 1) faith and devotion to God; 2) global diversity; 3) mutual cooperation; 4) independent; 5) critical reasoning; and 6) creative. It emphasizes the broader educational goals that are aligned with the values of Pancasila, the Indonesian state philosophy.

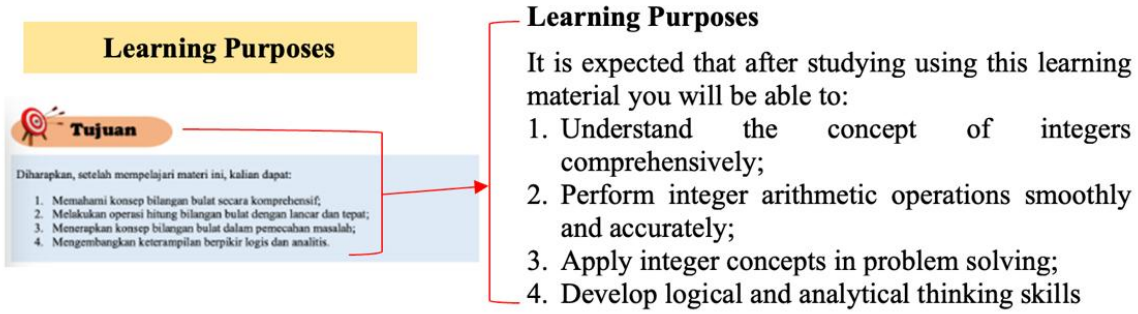

Figure 3. Learning purposes

Figure 3 contains the learning purposes of using this developed learning materials. These are: 1) understand the concept of integers comprehensively; 2) perform integer arithmetic operations smoothly and accurately; 3) apply integer concepts in problem solving; and 4) develop logical and analytical thinking skills. By integrating these goals, the learning materials aim to provide a balanced approach that combines cognitive, practical, and reflective aspects of mathematics learning, making it both meaningful and effective for students.

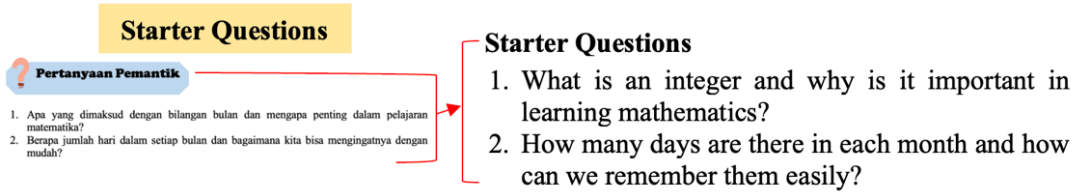

Figure 4. Starter questions

Figure 4 shows the starter questions used in this learning materials. These are: 1) what is an integer and why is it important in learning materials? 2) How many days are there in each month and how can we remember them easily? These starter questions aim to create

an interactive and culturally enriched learning environment, enabling students to connect abstract mathematical concepts with tangible experiences.

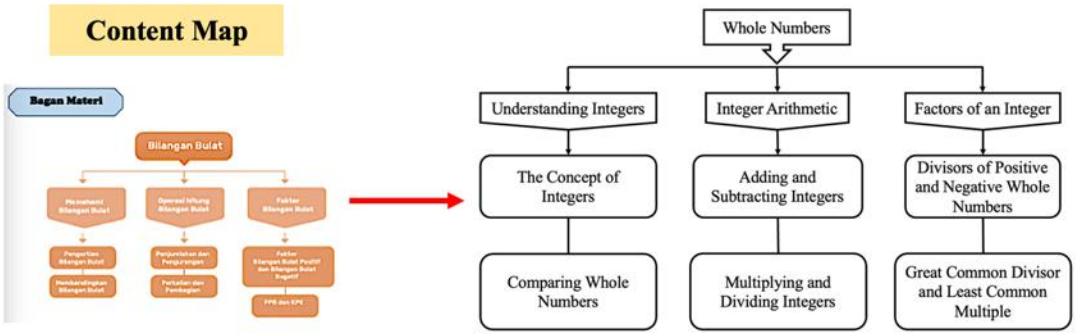

Figure 5. Concept map

Figure 5 shows the concept map is used to visualize information about the concept of integers studied in this learning materials to make it easier to remember and understand. It highlights the connecting between different concepts of integers, revealing underlying patterns and structures.

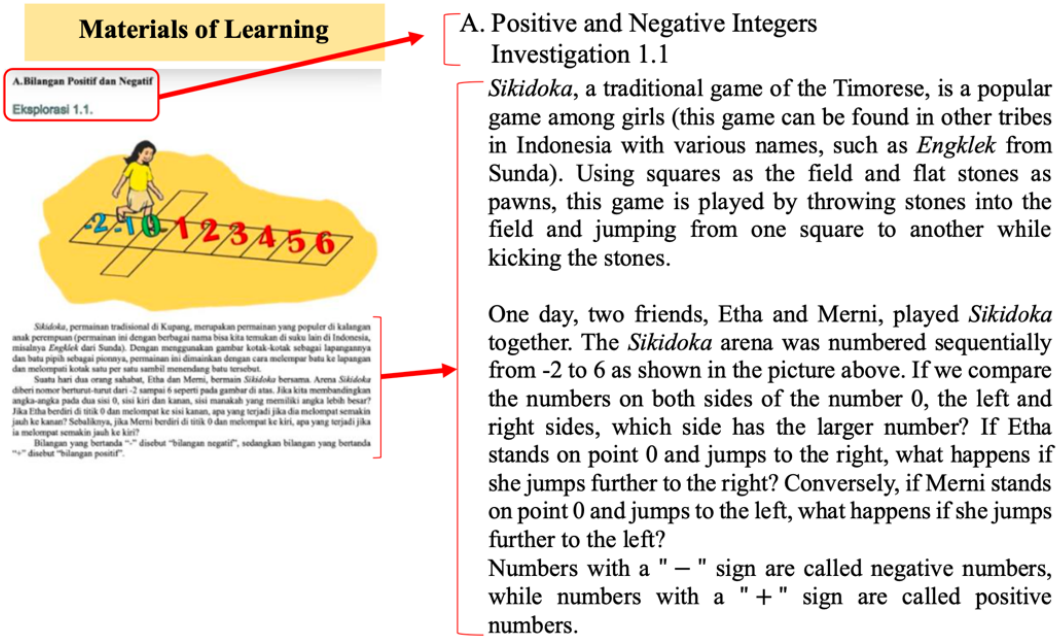

Figure 6. Materials of learning

Figure 6 shows the part of learning contents used in this learning materials. This learning content contain the name of every subsection, followed by an illustration picture and narrative that explains the picture equipped with the critical questions to directs students' thinking. This format not only facilitates active learning but also ensures that students engage critically with the material. By incorporating cultural elements into the content, the learning materials provide a meaningful context that enhances students' appreciation of mathematics and their cultural heritage.

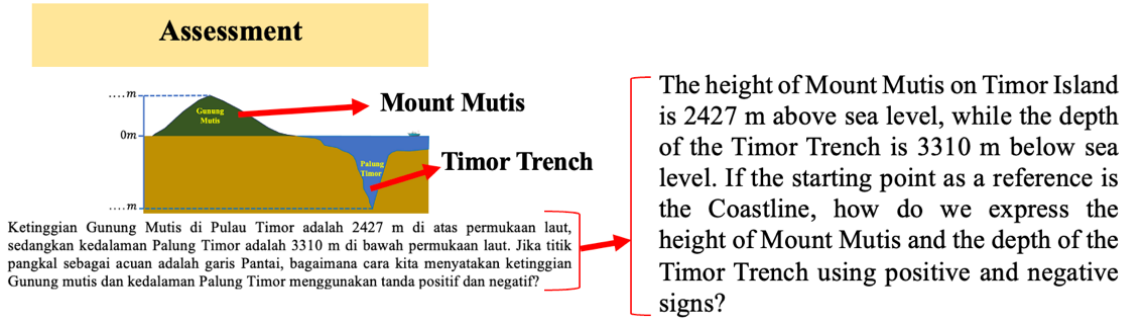

Figure 7. Assessment

Figure 7 shows assessment part used in this learning material. The assessment contains critical and creative questions that encourage students to develop their thinking after learning the materials. By combining critical and creative elements, the assessment ensures a holistic evaluation of students' mathematical literacy skills. It fosters not only understanding and application but also innovation and self-reflection, which are essential for 21st century learning. The assessment aims to prepare students to solve real-life problems while increasing cultural awareness and appreciation.

Figures 1 to 7 showed a sample part of the developed product. This product was designed to be used by students in the class through teacher's guidance. The illustration used in Figure 1 is Sikidoka, a popular traditional game from Kupang, East Nusa Tenggara (for Sundanese People, it is called by *Engklek*). Using checkered pattern as the playing field and flat stones as pawns, this game is played by throwing stones onto the playing field and jumping over the squares one by one while kicking the stones. In this product, this illustration is used as introduction to learn about positive and negative integers. Besides that, the questions used in this product consist of critical and creative thinking questions that are designed to stimulate students' mathematical literacy skills.

3.1.3. Development Phase

At this phase, validation process of the product was carried out. Two parts of the product were validated, including: 1) the learning material part; and 2) the assessment part. The final score of these two parts would determine the final result of product validation.

First, the validation process for learning material part, it was conducted to ensuring the suitability of the product with independent curriculum and mathematical literacy indicators. The validation scores of the developed product could be seen in Table 4.

Table 4. Final result of developed learning material part validation

No	Indicators	Max. Score	Validation Scores	
			1st Validator	2nd Validator
1.	Conformity with curriculum	10	10	9
2.	Integration of materials	10	9	10
3.	Readibility and Easy for understanding	10	10	9
4.	Evaluation	10	9	10
5.	Accesibility	10	9	10

No	Indicators	Max. Score	Validation Scores	
			1st Validator	2nd Validator
6.	Conformity with mathematical literacy indicators	15	14	14
	Total	65	61	62
	Mean		61.5	
	Final Score		94.6%	
	Criteria		**Very Valid**	

Based on Table 4, the final score of learning material validation is 94.6%, which is categorized as very valid. It means that the learning material part could be used in the class. Second, the validation score of the assessment part could be seen in Table 5.

Table 5. Final result of the asessment part validation

No	Indicators	Max. Score	Validation Scores	
			1st Validator	2nd Validator
A.	**The conformity with literacy abilities indicators**			
1.	Using mathematics to solve problems in various contexts of daily life	5	5	5
2.	Analyze information displayed in various forms (graphs, tables, sections, diagrams and so on	5	5	4
3.	Interpret the results of the analysis to predict and make decisions	5	4	4
B.	**The conformity with students' level of knowledge**			
1.	The appropriateness of data understanding and analysis problems for VII grade students	5	5	5
2.	The appropriateness of application of mathematics in real life context for VII grade students	5	4	5
3.	The appropriateness of critical and logical thinking skills level of VII grade students	5	5	4
	Total	30	28	27
	Mean		27.5	
	Final Score		91.6%	
	Criteria		**Very Valid**	

Based on Table 5, the final score for assessment part validation is 91.6%, which is categorized as very valid. It means that the asessment part could be used for data collection. Overall, based on previous results, the final scores for product validation could be seen in Table 6.

Table 6. Final result of product validation

Validation Score		Mean	Criteria
Learning Material Part	**Asessment Part**		
94.6%	91.6%	93.1%	Very Valid

Based on Table 6, the average of validation score is 91.6%, which is categorized as very valid. It means that the developed product is suitable with independent curriculum and mathematical literacy indicators, and it could be used for this research.

3.1.4. Implementation Phase

In this phase, the valid product was implemented in learning class to evaluate the practicality and effectivity of the product in order to achieve the predetermined learning purposes. Using this product, teacher guided his students in learning class to develop their mathematical literacy skills. Responses from teacher and students after using this product were collected and analyzed by researcher to ensure that the developed product is truly of high quality and can provide benefits for students.

Analysis result of students' responses after using this developed product could be seen in Table 7.

Table 7. Final result of students' responses after using the developed product

No	Indicators	Max. Score	Scores Obtained
1.	Student's interest in developed teaching material	280	280
2.	Improved students' conceptual understanding	420	420
3.	Relevancy of teaching materials to local wisdoms	280	280
4.	Suitability of the level of difficulty of teaching materials	280	244
5.	Sufficient example questions and exercises	280	256
6.	Effectiveness of teaching materials in improving mathematical literacy skills	420	420
	Total	1960	1900
	Final Score	96.93%	
	Criteria	**Very Practical**	

Based on Table 7, the final score of students' responses after using this developed product is 96.93% which is categorized as very practical. According to some notes given by students in the last part of the quistionaire, some of them revealed that the developed product could help them in learning because of the conformity with their daily life. One of them said, "pictures in this material are interesting and helped me more in understanding problems." It is related to the basic skill to solve real life problems. The others said, "this material helped me learn integers better". By using this product, students could learn about how to construct their knowledge particularly in integers problem solving. Besides its adventages, some students expressed that they were not used to working on real-life problems, so they had to struggle more in studying. It could be seen in Table 7 that "suitability of the level of difficulty

of teaching materials" has the lowest score than others. Besides that, researcher also analyzed teacher's responses after using this product. The analysis result could be seen in Table 8.

Table 8. Final result of teacher's responses after using the developed product

No	Indicators	Max. Score	Scores Obtained
1.	Learning preparation	10	10
2.	Delivery of materials	10	10
3.	Students' interction	10	10
4.	Practice and aplication	10	9
5.	Learning evaluation	10	9
Total		50	48
Final Score		96%	
Criteria		**Very Practical**	

Based on Table 8, the final score of teacher's responses after using this developed product is 96% which is categorized as very practical. According to some notes given by teacher in the last part of the quistionaire, he appreciated the ability of the product to encourage students active learning especially in solving mathematical literacy problems in integers. He said, "The adventages of using this produk are it relates with students' daily life, and it could help in cultural preservation". It shows another benefit of using this product that it could be used to preserve our local wisdom to the young generation.

3.1.5. Evaluation Phase

In this phase, researcher did effectiveness test to evaluate the positive impact of local wisdoms integration particularly in mathematical literacy skills development. The comparison of pretest and posttest result of the research subjects according to their mathematical literacy skills could be seen in Figure 8.

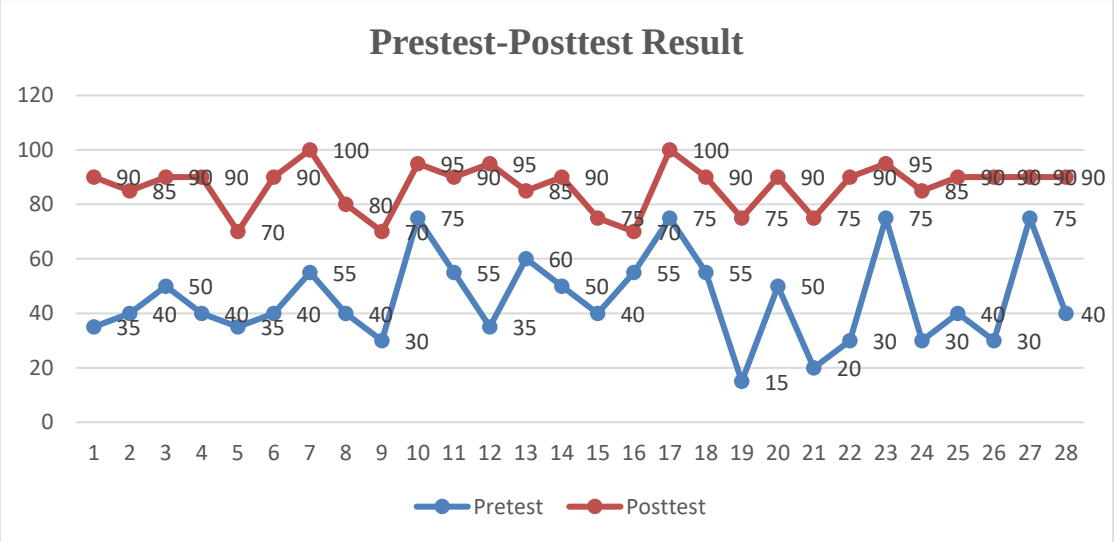

Figure 8. The comparison of pretest-posttest result

Based on Figure 8, we can see that there was an improvement in outcomes for all research subjects. In pretest, there were only 4 students could pass the Minimum Competency Criteria (70 pints), but after using the developed product, all students could pass the criteria so that the developed product could be classified as an effective product to improves students' mathematical literacy skills. Besides that, the result of effectiveness test by using N-Gain score could be seen in Figure 9.

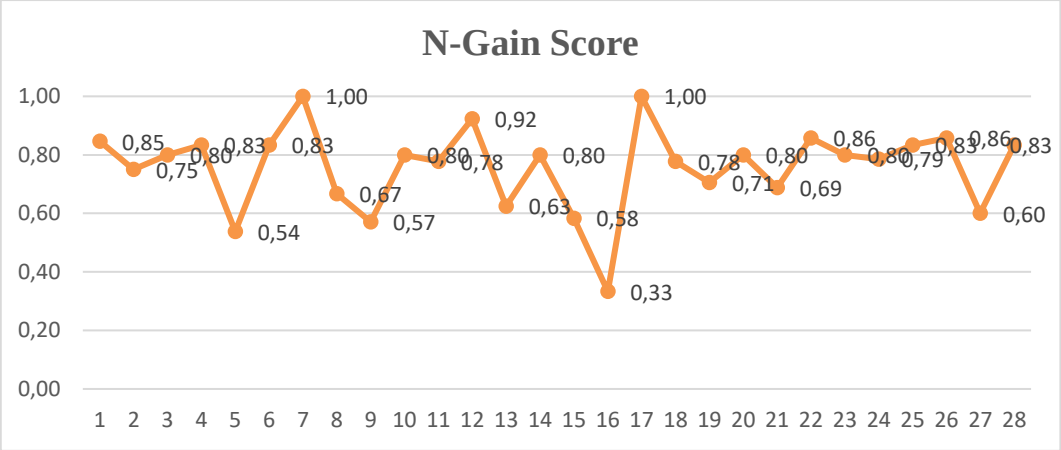

Figure 9. N-gain score after implementing the product

Based on Figure 9, it can be seen that research subjects who succeeded in obtaining a high improvement of mathematical literacy skills were more (20 students) than the rest who obtained the moderate improvement. None of the research subject obtained the low improvement. Furthermore, according to those data, the average of pretest and posttest results respectively were 45.36 and 86.61, so that the final N-Gain score was 0.76, which is qualified as high improvement.

3.2. Discussion

The final result of this research showed the importance of local wisdom integration in learning mathematics particularly in developing students' mathematical literacy skills. The significant improvement on test results (from 45.36 to 86.61) described the effectiveness of contextual learning experience (Asrizal et al., 2018). The high score of N-Gain (0.76) showed that not only students' understanding has been improved after using this learning product but also their engagements with the material, that suggesting that learning applied to familiar contexts enhances retention and cognitive application.

Relation to Local Wisdoms

The integration of local wisdoms into learning materials was very impactful. From the results, the according to students' responses, contextual problems drawn from their daily life facilitated deeper understanding of mathematics concepts. From the results, based on students' responses, contextual problems taken from their daily lives facilitate a deeper understanding of mathematical concepts. This can be seen from the maximum score given by students (420 out of 420) for the indicator of improving students' conceptual understanding in filling out the student response questionnaire. The previous research from

Dosinaeng, Lakapu, Jagom, et al. (2020) has highlighted the importance of cultural integration into mathematics education in order to enhance students' relevance and engagement. It is in line with ethnomathematics framework, which states that mathematics could be more easily understood when it is linked to cultural practices and experiences (D'Ambrosio, 1985; Dosinaeng, Lakapu, & Leton, 2020). Traditional games, like sikidoka, which is used as illustration in learning material, not only serves as a relevant entry point, but also as connecting bridge between culture and mathematics education (Deda & Disnawati, 2024; Wulansari & Dwiyanti, 2021).

Problem Solving Skills Improvement

The result of pretest – posttest analysis showed the improvement of students' ability in solving real life problems. Before using this product, many students struggled with world problems that reflected their lack experience with contextual issues (Vessonen et al., 2024). This difficulty reflects a gap between their understanding of abstract mathematical concepts and their application in practical scenarios. But, after using the learning materials, their problem-solving skills have been improved. It could be seen in their tests results, where there is a high improvement of posttest (86.61) according to pretest (45.36) in result.

The integration of real-life scenarios into the learning materials plays a vital role in bridging the gap between theory and application. By contextualizing mathematical problems to reflect real-world situations, students are able to understand the material more effectively, which facilitates deeper understanding and engagement. This connection not only improves their ability to solve mathematical problems but also increases their confidence in using mathematics as a tool to address real-life challenges. Posttest results showed that all students met or exceeded the minimum competency criteria, underscoring the effectiveness of this approach (Jade et al., 2023; Melaibari & Ismail, 2023).

This finding is in line with previous studies, such as those conducted by Surya et al. (2017), which showed that contextual learning methods improve problem-solving skills and increase students' confidence in their mathematical abilities. By emphasizing practical applications through real-life scenarios, the learning materials effectively address gaps in students' prior experiences, providing a meaningful and engaging pathway to mathematical literacy.

Students' Engagement and Active Learning

The practicality of the developed product, as demonstrated by feedback from students and teachers, highlights the importance of engaging students in meaningful and contextually relevant learning processes. One of the practical exercises carried out involves solving mathematical problems rooted in local cultural contexts, such as calculating the amount of corn harvest, or the proceeds from sales at the market using traditional counting techniques. These exercises are designed to connect mathematical concepts to students' everyday experiences, making abstract ideas more tangible and relevant. In addition, the use of active learning strategies, such as group discussions, collaborative problem solving, and exploratory activities, encourage students to actively participate and take ownership of their learning. For example, directing students to compete in teams to solve addition and

subtraction problems of integers using the sikidoka game as found in this teaching material will encourage students to develop their understanding of addition and subtraction of positive and negative integers in an active and fun way.

Besides it catered for different learning styles, using this strategy could motivate students to engage with the content, leading to more dynamic learning environment (Al Shloul et al., 2024; Munna & Kalam, 2021). It is supported by research result from Maemunah et al. (2024), which explained that active learning strategy improves students' engagement and academic performance. Furthermore, collaborative learning atmosphere resulted from the use of local wisdoms as the learning material has been admitted as one of the most important aspects for effective learning (Dewi et al., 2021; Nurdiansah et al., 2019).

Overcoming Challenges

Although the developed product has been categorized as an effective product, some students appeared to have difficulty in using this learning materials. This suggests the need for different learning strategy to accommodate varying level of mathematical proficiency among students. Adjusting learning experience to meet diverse need could increase students' understanding and ensure that all students get benefits from learning materials (Ahmad et al., 2024). Developing this product in the future could be done by adopting several approaches to help students who may have difficulty with certain concepts. It is in line with study from Kalinowski et al (Kalinowski et al., 2024) that emphasized on the importance of differentiation to maximize students' learning outcomes. Furthermore, (Muktamar et al., 2024) also emphasized that differentiated learning provides space for each student to develop according to their needs and potential. Thus, efforts to continue developing differentiation-based teaching materials can increase product effectiveness and provide an inclusive learning experience for all students.

Implications for Curriculum Development

The findings of this study have significant implications for curriculum development in mathematics education. By integrating local wisdom into the curriculum, educators can create more meaningful and contextually relevant learning experiences that align with students' everyday lives. Such an approach not only enhances students' understanding of abstract mathematical concepts but also fosters a deeper appreciation for their cultural heritage, which promotes cultural preservation alongside academic growth. Furthermore, the findings emphasize the importance of adopting active and collaborative learning strategies, which can enhance student engagement and accommodate diverse learning styles. These insights can guide policymakers and curriculum developers in designing more inclusive and adaptive mathematics curricula that address the varying levels of mathematics proficiency among students. By aligning mathematics education with the local context, this study highlights pathways to improving mathematical literacy and ensuring a more equitable learning environment for all students.

As previous studies have shown, by integrating indigenous knowledge into the learning process, educators can create more inclusive and effective learning environments (Sukadari et al., 2023). Furthermore, the emphasis on mathematical literacy as an essential

competency underscores the importance of equipping students with the skills to navigate an increasingly complex world. Research from Acharya et al. (2021) also supports the integration of culturally relevant pedagogy in mathematics, suggesting that such an approach can enhance students' understanding and engagement in mathematics learning.

4. CONCLUSION

This study successfully proved the effectiveness of integrating local wisdom into mathematics teaching materials to improve students' mathematical literacy skills. Using the ADDIE development model and focusing on grade 7 students of SMP Negeri Lorotuan, this study highlighted a comprehensive approach that included the analysis, design, development, implementation, and evaluation phases.

The main results showed that the developed teaching materials obtained very high validity and practicality scores, with an overall validation score of 93.1%. Feedback from students and teachers showed that the teaching materials not only attracted students' interest but also significantly improved their understanding of mathematical concepts, especially in the field of integers.

The pretest and posttest results showed a significant increase in students' abilities, with all students exceeding the minimum competency criteria after using the developed teaching materials. The high N-Gain score of 0.76 indicated substantial progress in students' mathematical literacy skills, which was largely due to the contextual learning approach drawn from their cultural experiences.

Furthermore, this study emphasized the importance of engaging students through familiar contexts, encouraging active participation, and fostering a collaborative learning environment. Although some challenges were noted, particularly related to varying levels of mathematics proficiency, the overall findings support the integration of local knowledge into mathematics education as a means to create more inclusive and effective learning environments. In conclusion, this study not only contributes to the field of mathematics education but also offers practical implications for curriculum development, demonstrating that culturally relevant pedagogy can enhance student engagement and understanding. Future iterations of the learning materials can further refine strategies to meet the diverse needs of students, ensuring equitable access to improved educational outcomes.

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Declarations

Author Contribution : SIL: Conceptualization, Supervision, and Writing - review & editing; ML: Data curation, Formal analysis, Methodology, Resources, and Writing - original draft; WBND: Investigation, Visualization, Writing - original draft, and Writing - review & editing; NF: Funding acquisition, Investigation, and Validation.

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