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Enhancing students' mathematical thinking through culturally responsive algebra instruction using interactive Google Slides

Wilfridus Beda Nuba Dosinaeng*, Samuel Igo Leton, Kristoforus Djawa Djong, Irmina Veronika Uskono, Yohanes Ovaritus Jagom, Meryani Lakapu

Widya Mandira Catholic University, East Nusa Tenggara, Indonesia

* Correspondence: wilfridusdosinaeng@unwira.ac.id

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Abstract

Algebra plays a vital role in developing students' higher-order thinking skills; however, in many junior high schools, algebra instruction remains focused on mechanical procedures rather than conceptual understanding and contextual problem solving. This approach limits students' ability to engage meaningfully with mathematical content, particularly in culturally diverse classrooms where learning materials often lack relevance to students' lived experiences. To address this gap, this study presents the development of culturally grounded algebra learning materials using Google Slides, chosen for its accessibility, interactivity, and collaborative features, which offer distinct advantages over conventional static media. The study employed the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model within a Research and Development (R&D) framework to systematically design and evaluate the learning materials. Conducted with seventh-grade students at SMP Lorotuan using a pretest-posttest design, the results revealed a significant increase in student achievement, with scores improving from 45.36 to 86.61 and an N-Gain value of 0.42, classified as moderate by Hake's standard. Observations and survey data confirmed the materials' practicality and strong cultural relevance, with students awarding a perfect cultural relevance score (560/560) and reporting increased appreciation for their local culture. This study concludes that integrating local wisdom into interactive algebra instruction can effectively enhance students' mathematical understanding and cultural identity. The findings support the continued development of culturally responsive digital learning tools that address diverse student needs and promote equitable mathematics education.

Keywords: ADDIE model, algebra learning, interactive learning, local wisdom, mathematical understanding.

Introduction

Algebra serves as a foundational component of mathematics education at the junior high school level, playing a critical role in the development of students' mathematical reasoning and understanding. As a central domain encompassing variables, expressions, equations, and functions, algebra cultivates students' problem-solving abilities and logical thinking (Komang & Ariyana, 2022; Kusuma et al., 2021). Mastery of algebra supports the enhancement of higher order thinking skills, enabling students to analyze relationships, formulate hypotheses, and construct solutions through the manipulation of algebraic expressions and equations. Despite its recognized importance, student performance in algebra often reveals persistent challenges, particularly in applying conceptual understanding to real-world contexts.

An analysis of Grade VII students at SMP Negeri Lorotuan revealed a substantial gap between procedural fluency and contextual application of algebraic concepts. While students were able to address routine tasks, they struggled significantly with non-routine and contextually embedded problems. Pretest data from 28 students indicated that 67.86% demonstrated the ability to formulate basic mathematical statements using variables. However, only 46.43% could model real-life situations algebraically, and a mere 10.71% successfully applied operational laws such as commutative, associative, and distributive properties to construct equivalent expressions. These findings underscore a disconnect between students' symbolic manipulation skills and their ability to apply algebraic reasoning in meaningful contexts.

To further investigate these challenges, semi-structured interviews were conducted with two mathematics teachers at SMP Negeri Lorotuan. The findings highlighted several key issues: the abstract nature of algebraic concepts, limited pedagogical strategies emphasizing contextual learning, and a predominant reliance on repetitive, procedural exercises. The teachers noted that a lack of interactive and culturally grounded learning media further impeded students' comprehension and engagement, exacerbating the difficulty of bridging algebraic concepts with real-life applications.

Addressing this disconnect necessitates an innovative instructional approach that contextualizes algebra within students' lived experiences. Integrating local wisdom into mathematics instruction has emerged as a promising strategy to enhance relevance and accessibility (Fouze & Amit, 2023). Local wisdom refers to culturally embedded knowledge, practices, and values that can serve as a conduit for contextualizing mathematical content (Fouze & Amit, 2018). Through culturally relevant pedagogy, abstract algebraic principles can be made more tangible and relatable. For instance, the weaving practices of the Timorese community in East Nusa Tenggara offer authentic contexts for exploring operational properties such as commutativity, associativity, and distributivity by constructing patterns that parallel the structure of equivalent algebraic expressions. This cultural linkage not only enhances conceptual understanding but also fosters cultural appreciation and identity development.

Recent studies have explored diverse strategies for incorporating local wisdom into instructional design. Nuryadi et al. (2020) and Sastrawati and Budiono (2024) emphasized its integration through classroom media to increase student motivation and engagement, while

Husna (2017) and Novelita et al. (2024) embedded local contexts into instructional tasks to promote critical thinking and creativity. Despite these contributions, most research has focused narrowly on media and assessment development, leaving a gap in the holistic integration of local wisdom across the entire instructional cycle including planning, delivery, and evaluation. Furthermore, as highlighted by Pugu et al. (2024), the implementation of culturally responsive instruction in rural schools faces significant barriers such as limited resources, insufficient teacher preparation, resistance to pedagogical change, and inadequate documentation of local knowledge.

To overcome these limitations, the integration of digital technology presents an opportunity to enhance instructional effectiveness while addressing implementation barriers. Among various digital tools, Google Slides offers a flexible, interactive, and widely accessible platform for designing culturally enriched mathematics instruction. Its potential lies in supporting both visual representation and interactivity, enabling the integration of local cultural elements into algebraic content. This aligns with the perspectives of Bukhatwa et al. (2022) and Engelbrecht & Borba (2024), who emphasize the transformative role of digital technology in facilitating student-centered, culturally responsive learning environments.

Empirical studies further affirm the pedagogical value of Google Slides in mathematics education. Rosmiati et al. (2021) demonstrated that Google Slides-based media improved students' engagement and comprehension of abstract mathematical concepts through visual and dynamic representations. Similarly, Umardiyah et al. (2023) found that the interactive features of Google Slides positively influenced students' motivation and learning outcomes. These findings position Google Slides as a versatile tool not only for delivering algebra content, but also for integrating cultural narratives that render mathematics instruction more meaningful and contextually grounded.

Despite the growing interest in culturally responsive mathematics education, previous studies have yet to comprehensively address the integration of local wisdom throughout the entire instructional process. Additionally, limited research has explored the convergence of digital technology particularly Google Slides with culturally contextualized algebra instruction. This study seeks to address these gaps by developing interactive, accessible, and culturally relevant learning materials that incorporate local wisdom using Google Slides. The innovation of this research lies in its holistic approach to instructional design encompassing planning, implementation, and evaluation and its emphasis on bridging traditional knowledge with modern pedagogical tools. By situating this approach in the rural context of SMP Negeri Lorotuan, the study aims to offer scalable and context-sensitive solutions for mathematics education in similar settings.

Methods

This study employed a Research and Development (R&D) approach to create an innovative educational product in the domain of mathematics learning. The R&D method was deemed appropriate as it facilitates the systematic design, development, and empirical evaluation of

instructional tools in this case, interactive learning materials for algebra that incorporate elements of local wisdom and are delivered through Google Slides. Unlike methodologies that emphasize solely implementation or outcome evaluation, the R&D framework supports iterative refinement across distinct phases: needs analysis, product design, expert validation, limited trials, and revision. This process ensures that the resulting product is both theoretically grounded and empirically validated for effectiveness and feasibility in authentic classroom settings.

The research was conducted at SMP Negeri Lorotuan, selected purposively due to the observed instructional challenges in teaching algebra and the institution's potential for implementing innovative, culturally responsive materials. The participants consisted of Grade VII students enrolled in the 2024/2025 academic year, while the research object was a Google Slides-based digital learning material encompassing: (1) algebraic content presented through interactive human avatars with synchronized teacher voiceovers, (2) animations depicting cultural elements from Timor, (3) a user manual, (4) practice exercises, (5) formative quizzes, and (6) feedback questionnaires.

Initial data collection involved classroom observations and semi-structured interviews with two mathematics teachers and nine Grade VII students. These instruments aimed to identify students' motivational levels and interest in algebra, as well as teachers' perspectives on integrating local culture into mathematics instruction. The qualitative data were analyzed thematically to determine common issues and instructional needs, which directly informed the development of the learning materials.

To assess students' understanding of algebraic concepts before and after using the developed product, a pretest–posttest design was adopted. The test instruments underwent a rigorous content validation process involving two subject-matter experts: (1) a mathematics education lecturer with a doctoral degree and over five years of curriculum development experience in teacher education, and (2) a junior high school mathematics teacher with more than ten years of classroom experience and active participation in national teacher professional development programs. The validation process assessed the alignment of the content with Grade VII algebra competencies, cognitive suitability for the target learners, and the linguistic clarity, neutrality, and readability of the instructional content.

The development of the algebra learning materials was guided by the ADDIE model Analysis, Design, Development, Implementation, and Evaluation. The model was selected over alternatives such as Dick and Carey or ASSURE due to its demonstrated effectiveness in educational product development, adaptability to iterative feedback, and its alignment with Nieveen's quality criteria encompassing validity, practicality, and effectiveness. ADDIE's cyclical design facilitated continuous refinement throughout the development process, with the analysis phase supporting a robust needs assessment and the evaluation phase enabling rigorous empirical validation—features essential for the development of culturally responsive instructional materials.

The validity of the product was established through expert judgment, focusing on both content fidelity (curriculum alignment) and presentation quality (language, structure, and

graphics). Practicality was measured through teacher and student feedback following implementation, while effectiveness was determined through post-test performance. A scoring rubric was employed during validation, with percentage scores computed using the formula:

$$P = \frac{f}{N} \times 100\%$$

where P represents the component score, f the total score achieved, and N the maximum possible score. The average of both expert scores was taken to determine overall validity, with a minimum threshold of 75% considered acceptable.

After validation, the materials were implemented in a classroom trial involving 28 purposively selected Grade VII students, chosen based on their prior exposure to foundational algebra concepts and availability during the research period. A pretest was administered to determine students' baseline understanding. During the trial, student engagement with the materials was observed, and feedback was solicited from both students and teachers regarding the strengths and areas for improvement. Practicality was also assessed using the same scoring formula, with a minimum benchmark of 75% indicating adequate practicality.

To evaluate the effectiveness of the learning materials, a post-test was administered, and results were analyzed. The materials were deemed effective if at least 80% of students achieved the minimum competency criteria, consistent with Indonesia's national standard for classroom-level learning completeness (Nurlaili et al., 2022). The degree of learning improvement was quantified using the normalized gain (N-Gain) formula:

$$Normal\ Gain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$

This improvement category is divided into three: N-Gain score < 0.3 indicates low improvement, 0.3 ≤ N-Gain < 0.7 indicates moderate improvement, and 0.7 ≤ N-Gain ≤ 1 indicates high improvement. A learning product was categorized as effective if most students achieved moderate to high N-Gain classifications.

To test the statistical significance of the intervention's effect, a paired sample t-test was conducted using the following hypotheses:

Ho: *There is no significant difference between the pretest and post-test scores after the implementation of Google Slides-based learning materials incorporating local wisdom.*

Ha: *There is a significant difference between the pretest and post-test scores after the implementation of Google Slides-based learning materials incorporating local wisdom.*

Prior to the t-test, data normality was assessed using the Kolmogorov–Smirnov test. As the data were normally distributed, a paired t-test was conducted at a significance level of $\alpha = 0.05$. The analysis was performed using SPSS software. If the resulting t-value exceeded the critical t-value from the t-distribution table or the p-value was less than 0.05, the null hypothesis

was rejected, indicating a statistically significant effect of the learning materials on students' algebra learning outcomes.

Results and Discussion

This study employs the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) instructional design model to systematically develop learning materials incorporating local wisdom, delivered through the Google Slides platform. The structured nature of the ADDIE model enables a comprehensive analysis of students' learning needs, the design and development of contextually relevant materials, and the iterative implementation and evaluation of the instructional tools to ensure pedagogical effectiveness.

Analysis Phase

The analysis phase, as the foundational stage of the ADDIE model, involved three core areas: (1) an analysis of the targeted competencies based on curriculum standards, (2) an assessment of students' initial algebra competencies, and (3) an evaluation of teachers' instructional capacities in algebra.

Analysis of Identified Competencies

Referring to the Decree of the Head of the Curriculum Standards and Education Assessment Agency, Ministry of Education, Culture, Research, and Technology of Indonesia (No. 008 of 2022), the learning outcomes for Algebra within the Independent Curriculum span from informal representations such as pictorial symbols to formal algebraic notation utilizing letter variables. Key content includes equations and inequalities, patterns and relationships, and the concepts of ratio and proportion.

This study focuses specifically on Phase D of the curriculum, corresponding to Grades VII and VIII, which represents a critical transition from concrete arithmetic reasoning to abstract algebraic thinking. Accordingly, instructional materials at this phase must scaffold students' understanding from intuitive pattern recognition to the use of symbolic notation and algebraic generalization. The expected competencies at this level include: (1) recognizing, predicting, and generalizing number patterns and object arrangements; (2) expressing mathematical relationships in algebraic form; and (3) applying the commutative, associative, and distributive properties to derive equivalent algebraic expressions.

The selection of Phase D as the development focus is underpinned by the cognitive readiness of students to initiate formal engagement with algebraic concepts. As emphasized in the official teacher and student handbooks issued by the Curriculum and Book Centre (Tosho, 2021), constructing mathematical expressions using variables is a foundational competency at this stage. Therefore, aligning instructional materials with these competencies is imperative for facilitating meaningful algebra learning at the junior high school level.

Moreover, in accordance with Regulation No. 37 of 2018 issued by the Minister of Education and Culture of the Republic of Indonesia, the core competency for knowledge (KI.3) at the Grade VII level includes acquiring factual, conceptual, and procedural understanding

rooted in scientific curiosity and observation. Relevant basic competencies (KD 3.5) include explaining algebraic forms and performing the four fundamental operations on algebraic expressions. For skills (KI.4), students are expected to engage in both concrete and abstract learning activities, such as composing, modifying, calculating, drawing, and solving algebraic problems. The corresponding basic skill competency (KD 4.5) involves solving contextual problems related to algebraic expressions. These competencies form the curricular basis for developing the local wisdom-based learning materials.

Analysis of Students' Competencies

A pretest was administered to assess students' preliminary algebraic knowledge and identify instructional needs. The test was designed to measure Grade VII learning outcomes in algebra, specifically: (1) formulating mathematical statements involving numbers and variables, (2) translating verbal conditions into algebraic expressions, and (3) applying algebraic properties (commutative, associative, and distributive) to construct equivalent expressions. To ensure content validity, the pretest was evaluated by two subject-matter experts. Table 1 presents the validation outcomes.

Table 1. Pretest Validation Results

No.	Indicators	Max. Score	Validation Scores	
			1st Validator	2nd Validator
1.	The conformity with the learning achievements of algebra for grade VII junior high school	15	13	13
2.	The conformity with students' level of ability of grade VII junior high school students	15	14	13
3.	Clarity of language used	15	14	14
Total		**45**	**41**	**40**
Mean			**40,5**	
Final Score			**90%**	
Criteria			**Very Valid**	

The final validation score of 90% categorizes the pretest as very valid, indicating its appropriateness for assessing student competencies in algebra. Following validation, the pretest was administered to 28 Grade VII students. The results are summarized in Table 2.

Table 2. Pretest results of student algebra competencies

Indicators	Percentage
Being able to construct statements about the relationship between numbers and mathematical sentences using letters or variables	67,86%
Stating a condition in algebraic form	46,43%
Using the properties of operations (commutative, associative, and distributive) to produce equivalent algebraic forms	10,71%

The results indicate varying levels of student competency. While approximately two-thirds (67.86%) could formulate algebraic expressions using variables, a lower proportion (46.43%) were able to translate verbal conditions into algebraic form suggesting difficulty in representing contextual problems algebraically. Notably, only 10.71% demonstrated proficiency in applying algebraic properties to simplify expressions, underscoring the need for instructional strategies that reinforce conceptual understanding over procedural memorization.

Analysis of Teachers' Competencies

Teacher competency analysis focused on four domains: algebraic content knowledge, pedagogical strategies, technological integration skills, and the incorporation of local wisdom in teaching practices.

Observational and interview data indicate that teachers possessed adequate foundational knowledge of algebra aligned with curriculum standards. However, challenges emerged in presenting abstract algebraic concepts in ways that are accessible and meaningful to students. For example, teachers often remained at the level of symbolic manipulation without connecting variables to real-world quantities, causing students to misinterpret variables as arbitrary symbols rather than as representations of unknown values.

Teachers also reported difficulties in guiding students from identifying numerical patterns to expressing them using general algebraic rules. This gap in conceptual bridging impeded students' ability to recognize underlying mathematical structures and apply them in novel situations. Consequently, student engagement tended to rely heavily on rote learning rather than conceptual reasoning.

In terms of instructional strategies, while active learning was employed, the absence of engaging and culturally contextualized materials limited the effectiveness of algebra instruction. The predominant use of textbook examples constrained students' opportunities to explore mathematical ideas through meaningful contexts.

Regarding technological competencies, most teachers were proficient in using basic digital presentation tools such as PowerPoint and Google Slides. However, they lacked familiarity with more advanced features—such as animations, hyperlinks, and multimedia integrations—that could enhance interactivity and engagement. Teachers expressed a desire for professional development in digital content creation tailored to students' learning characteristics.

Finally, the integration of local cultural elements into algebra instruction remains a challenge. Although teachers acknowledged the pedagogical potential of connecting mathematical concepts with cultural contexts, they highlighted the absence of structured guidance and instructional resources. This lack of concrete examples and training has hindered the incorporation of ethnomathematical perspectives into classroom practice.

Design Phase

Following the results of the preliminary analysis, the design phase commenced with the preparation and conceptualization of the instructional product. Four primary considerations guided the development process: (1) the instructional content was centered on algebraic topics aligned with predetermined learning objectives; (2) contextualized problems rooted in local wisdom were integrated to support culturally relevant pedagogy; (3) problem contexts were deliberately selected based on their familiarity to students; and (4) Google Slides was employed as the principal digital learning platform. The contextual problems were derived from students' lived experiences and local cultural practices to enhance relevance and engagement.

Google Slides was selected as the preferred instructional medium due to its pedagogical affordances in facilitating interactive learning environments. First, the platform supports the integration of diverse visual representations such as images, diagrams, and animations—that aid in concretizing abstract algebraic concepts. Second, its interactive elements and hyperlink functionalities enable students to navigate content autonomously, thereby fostering learner agency. Third, the platform promotes collaborative learning by allowing real-time interaction between teachers and students within both face-to-face and online modalities. Educators can provide immediate feedback by commenting directly on students' work, thereby enhancing the formative assessment process. Lastly, as a cloud-based application, Google Slides ensures accessibility across various devices including laptops, tablets, and smartphones which allows students to access learning materials flexibly and at their own pace. Considering these advantages, the instructional product was intentionally developed using Google Slides to ensure that algebra learning was not only informative, but also interactive, contextualized, and accessible.

To ensure the pedagogical robustness and contextual relevance of the learning material, a comprehensive literature review was conducted. This review encompassed: (1) studies on local wisdom to identify culturally pertinent contexts suitable for integration into the learning content; and (2) educational research to determine the essential components of effective instructional design. Based on these findings, five core components were established for inclusion in the product: (1) Home a landing page providing navigational access to all sections; (2) Materials a sequenced presentation of algebraic concepts enriched with illustrations grounded in local wisdom; (3) Practice Questions a series of exercises scaffolded from basic to applied levels, delivered through Google Forms quizzes to provide immediate feedback; (4) Response Questionnaire an evaluative instrument designed to capture student perceptions and experiences with the instructional product; and (5) Instructions a user guide for both teachers and students detailing how to utilize the features and navigate the digital environment.

Figure 1 illustrates the five core components integrated into the developed instructional product. The Home section functions as the main navigation hub, providing access to all other features within the product. The Materials section offers structured explanations of algebraic concepts, which are presented in a sequential manner and enriched with illustrations derived from local cultural contexts.

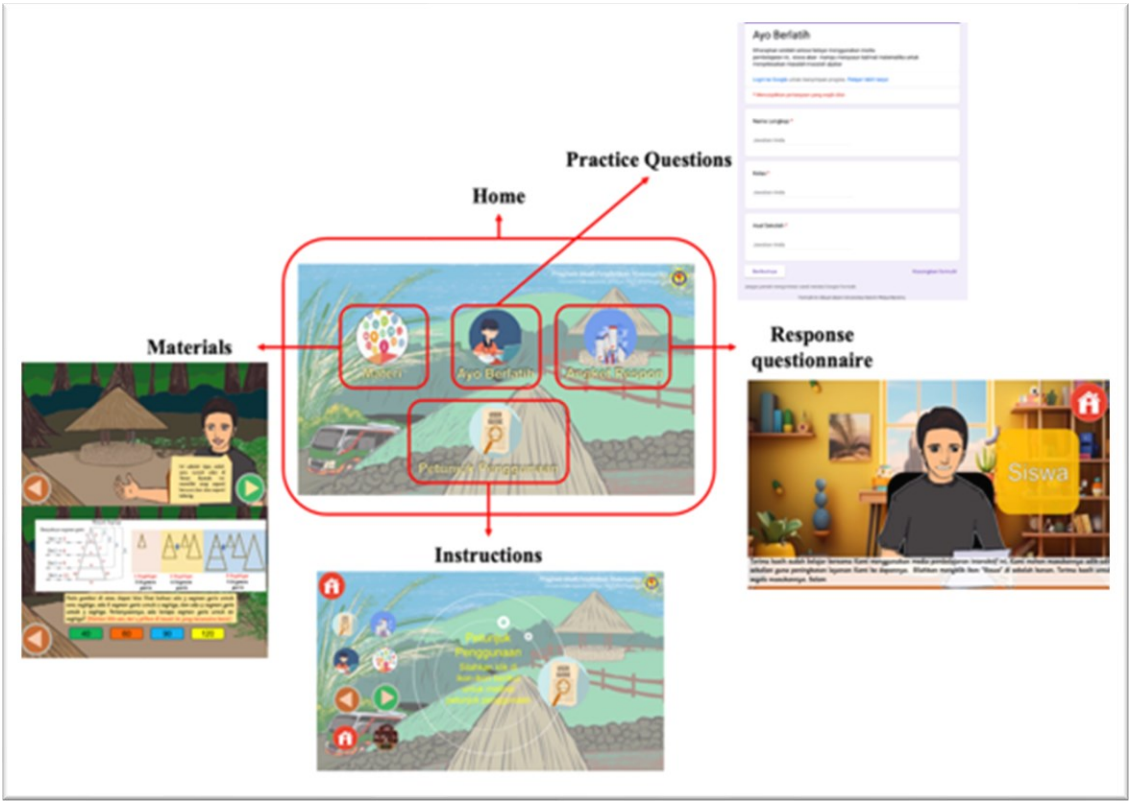

Figure 1. Components of the developed product

The Practice Questions section comprises a set of exercises designed to enhance students' comprehension of algebraic principles, progressing from foundational questions to those involving real-world applications. These exercises are implemented through Google Forms in quiz format, enabling immediate feedback upon completion. The Response Questionnaire section includes an instrument for collecting students' perceptions and reflections following their interaction with the learning product. Finally, the Instructions section provides detailed guidance for both teachers and students on how to navigate the product, access instructional content, complete practice tasks, and effectively utilize the interactive features offered through Google Slides.

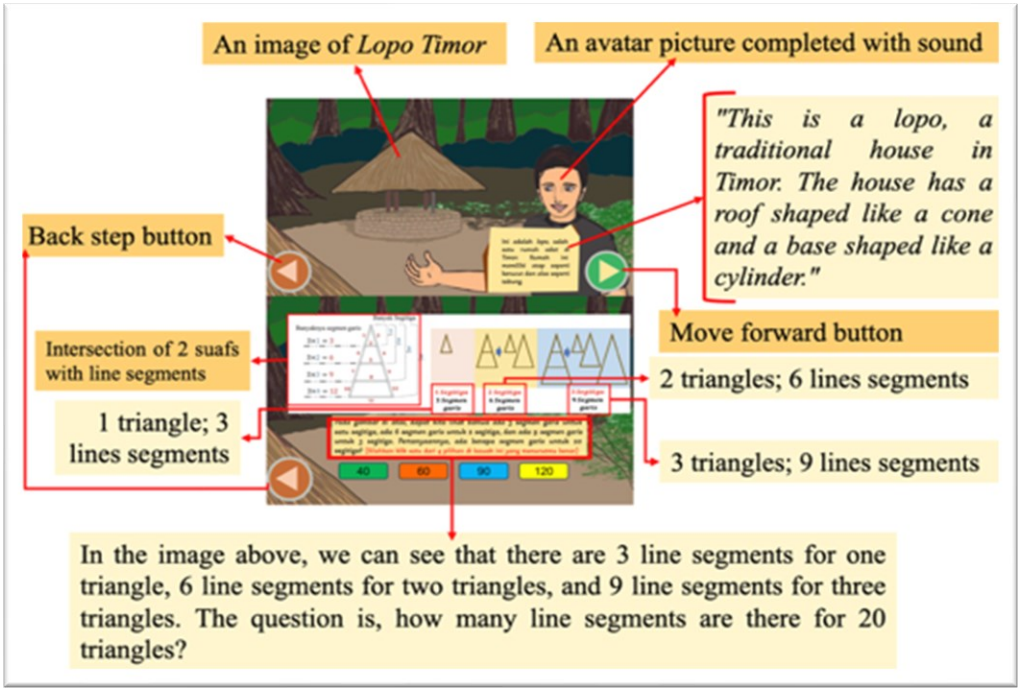

Figure 2. Illustration of a local wisdom-based algebra task in google slides

Figure 2 exemplifies a segment of the learning product incorporating local cultural contexts in this instance, the *Lopo* traditional house of Timor. The slide features an interactive avatar equipped with audio narration, which introduces the *Lopo* house's architectural structure, characterized by a conical roof and cylindrical base. The avatar provides a cultural background, explaining that the roof is constructed using natural materials such as palm leaves and grass, tied to a wooden framework referred to as *Suaf*. The explanation proceeds to describe how intersecting *Suaf* lines on the roof form triangular patterns, which serve as the foundation for an algebraic task.

At the bottom of the slide, a pattern is visually represented: 1 triangle corresponds to 3 line segments, 2 triangles to 6 segments, and 3 triangles to 9 segments. Students are then prompted to extrapolate this pattern and determine the number of line segments for 20 triangles. This is posed as a multiple-choice question (40, 60, 90, or 120), designed to activate algebraic reasoning and pattern recognition skills. This problem exemplifies the use of contextualized algebra tasks that align with students' cultural knowledge and experiences.

Navigation is facilitated via "*Back*" and "*Forward*" buttons located on either side of the screen, allowing students to move through the instructional sequence. Correct responses trigger audio-based positive reinforcement, such as "*Yes, your answer is correct. Congratulations!*", accompanied by a brief explanation linking the result to algebraic expressions. Conversely, incorrect answers prompt constructive feedback "*The answer is not correct, try again!*" along with visual scaffolds to guide students in reconstructing their understanding. Students also have the option to revisit prior slides, reinforcing opportunities for review and self-paced learning.

Development Phase

In this phase, the product underwent a validation process to evaluate its alignment with the Independent Curriculum and its relevance to the algebra learning objectives for Grade VII of junior high school. The validation was conducted by two expert validators, and the results are presented in Table 3.

Table 3. The validation result of the developed product

No	Indicators	Max. Score	Validation Scores	
			1st Validator	2nd Validator
1.	Conformity with Independent Curriculum	10	9	9
2.	Integration of materials	10	10	10
3.	Readability and Easy for understanding	10	10	9
4.	Evaluation	10	9	9
5.	Accessibility	10	9	9
6.	Conformity with the learning achievements of algebra for grade VII junior high school	15	14	14
	Total	**65**	**61**	**60**
	Mean		**60.5**	
	Final Score		**93,07%**	
	Criteria		**Very Valid**	

As shown in Table 3, the final validation score was 93.07%, which falls under the "Very Valid" category. This indicates that the developed learning material is appropriate for implementation in the classroom setting and meets the required curricular and content standards for algebra instruction.

Implementation Phase

The implementation phase focused on evaluating the practicality and effectiveness of the validated learning product when applied in a classroom context. The product was utilized by a mathematics teacher to facilitate students' conceptual understanding and skills in algebra. The instructional sessions followed a structured sequence involving interactive Google Slides, culturally contextualized examples, and embedded learning activities.

During each session, instruction began with a review of prior knowledge using multimedia features such as animations and interactive quizzes. The teacher presented new algebraic concepts through the provided slides, which included examples and scaffolded problem-solving exercises. Embedded worksheets supported guided practice, while peer-to-peer discussion was encouraged. Students also engaged with dynamic simulations that allowed manipulation of algebraic variables, enhancing visual and conceptual understanding. Additionally, the product linked to external digital resources (e.g., calculators and videos), catering to diverse learning preferences. Cultural relevance was emphasized through localized problem contexts that incorporated elements of local wisdom.

Students participated in both individual and collaborative tasks during the sessions. Table 4 summarizes the analysis of student responses following implementation.

Table 4. Student responses to the learning product

No.	Indicators	Max. Score	Scores Obtained
1.	Interest and motivation to learn algebra	280	264
2.	Easy of use	560	551
3.	Relevance to local culture	560	560
4.	Understanding of concepts	560	487
5.	Adequacy of example and practice questions	280	242
6.	Suitability of the level of difficulty of the learning material	560	435
	Total	**2800**	**2539**
	Final Score	**90,68%**	
	Criteria	**Very Practical**	

Based on Table 4, the students' responses yielded a final score of 90.68%, classified as "*Very Practical*." Qualitative feedback indicated that students found the material accessible and relevant. One student remarked, "*This material is easier to understand because it is accompanied by interesting illustrations*," underscoring the role of visuals in enhancing algebraic comprehension. Another student shared, "*I understand algebraic forms and operations faster with this material than before*," highlighting its effectiveness in promoting conceptual learning.

Nevertheless, a few students reported difficulty engaging with real-life context-based problems, as they were unaccustomed to such applications. This is reflected in the lower score for the indicator on the appropriateness of the difficulty level. Furthermore, teachers' feedback was also analyzed, as shown in Table 5.

Table 5. Teacher' Responses after product implementation

No.	Indicators	Max. Score	Scores Obtained
1.	Lesson preparation	10	10
2.	Material presentation	10	10
3.	Students' engagement	10	10
4.	Practice and application	10	9
5.	Learning assessment	10	9
	Total	**50**	**48**
	Final Score	**96%**	
	Criteria	**Very Practical**	

The teacher assigned a final score of 96%, categorizing the product as "*Very Practical*." In their comments, the teacher emphasized the product's alignment with students' everyday experiences and its contribution to preserving local wisdom. The teacher stated, "*This product is very helpful because it is relevant to students' daily lives and at the same time plays a role in*

maintaining local wisdom," affirming its value in fostering active learning and contextualized mathematical problem-solving.

Evaluation Phase

The final phase assessed the effectiveness of the developed learning product in enhancing students' algebraic competence. A post-test was administered using items aligned with the pre-test to allow for comparative analysis. The results, presented in Figure 3, demonstrate notable improvement.

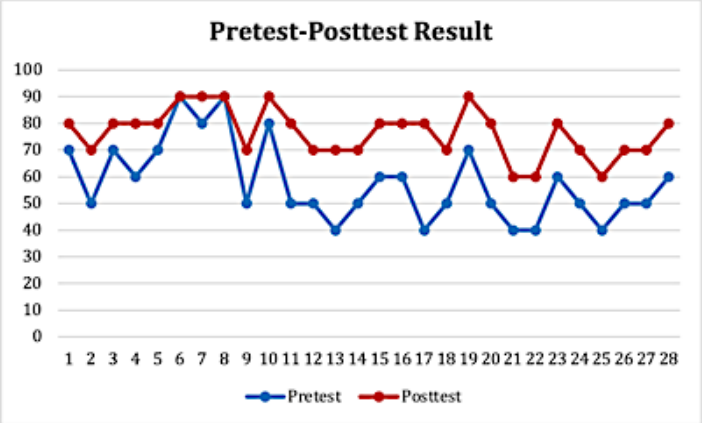

Figure 3. The comparison of pretest-post-test result

As depicted in Figure 3, a notable improvement is evident across all research subjects. Initially, only 8 out of 28 students achieved the Minimum Completion Criteria known as KKM of 70 points in the pretest. However, following the implementation of the developed product, 25 students successfully met the criterion. This suggests that the developed product significantly contributed to enhancing students' mathematical literacy skills.

Furthermore, the results of the effectiveness test, assessed through the N-Gain score, are shown in Figure 4.

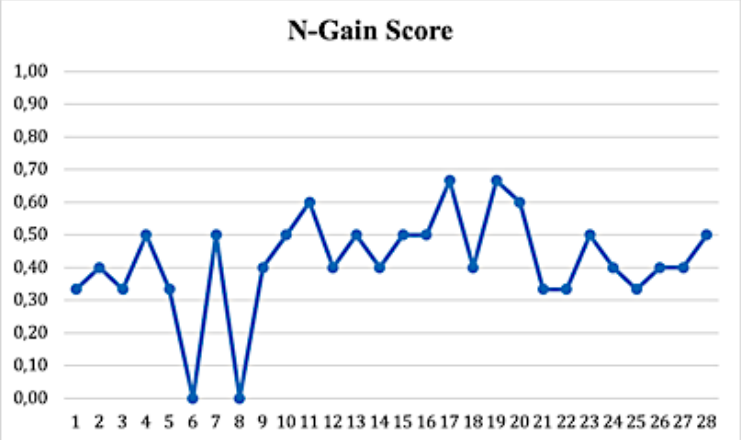

Figure 4. N-gain scores following product implementation

As shown in Figure 4, 26 students demonstrated a moderate increase in mathematical literacy skills, with an N-Gain score ranging from 0.3 to 0.7. The remaining 2 students showed no improvement, as their scores remained unchanged. The average N-Gain score, calculated by comparing the pretest and post-test results, was 0.42, indicating a moderate level of improvement.

Subsequently, a significance test was performed using the t-test. The first step involved conducting a classical assumption test to assess the normality of both the pretest and post-test data. The results of this normality test, analyzed using SPSS 26 software, are presented in Figure 5.

One-Sample Kolmogorov-Smirnov Test

		Pretest
N		28
Normal Parameters[a,b]	Mean	5.79
	Std. Deviation	1.475
Most Extreme Differences	Absolute	.239
	Positive	.239
	Negative	-.119
Test Statistic		.239
Asymp. Sig. (2-tailed)		.000[c]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

One-Sample Kolmogorov-Smirnov Test

		Posttest
N		28
Normal Parameters[a,b]	Mean	7.64
	Std. Deviation	.911
Most Extreme Differences	Absolute	.224
	Positive	.188
	Negative	-.224
Test Statistic		.224
Asymp. Sig. (2-tailed)		.001[c]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

Figure 5. Normality test results (SPSS 26 output)

As shown in Figure 5, the Asymp. Sig. (2-tailed) value for the pretest is 0.000, which is less than the significance level of 0.05, and for the post-test, the value is 0.001, also below 0.05. Since both values are less than the 0.05 threshold, it can be concluded that the data for both the pretest and post-test follow a normal distribution.

Following this, a significance test was performed to assess the impact of the developed learning materials on the algebraic competencies of grade VII students at SMP Lorotuan. The results of this test are presented in Figure 6.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Posttest & Pretest	28	.850	.000

Figure 6. Paired-sample t-test results (SPSS 26 output)

As shown in Figure 6, the significance value (Sig.) is 0.000, which is less than the 0.05 threshold. Therefore, the null hypothesis (Ho) is rejected, and the alternative hypothesis (Ha) is accepted. This indicates that there is a statistically significant difference between the pretest

and post-test results following the implementation of the local wisdom-based learning materials delivered through Google Slides. Finally, these findings provide strong evidence of the positive impact of the local wisdom-based materials on students' mastery of algebraic concepts, highlighting the effectiveness of the Google Slides-based instructional approach in enhancing students' understanding of algebra.

The results of this study affirm that the integration of local wisdom-based learning materials, supported by interactive media such as Google Slides, positively influences seventh-grade students' understanding of algebraic concepts. These findings hold significant implications for the educational field, particularly in terms of the efficacy of culturally enriched learning approaches, the incorporation of technology in education, and the adoption of student-centered learning strategies.

Local Wisdom-Based Learning in the Context of Education

The incorporation of local wisdom into mathematics instruction not only enhances students' conceptual understanding but also reinforces their cultural identity. Ethnomathematics, which has been explored as an approach that connects mathematical concepts with students' everyday experiences, underpins this study's approach (Machaba & Dhlamini, 2021). The indicators used to assess algebraic conceptual understanding in this study encompassed students' ability to represent problems mathematically, articulate their reasoning, and relate algebraic operations to culturally significant real-life contexts. A comparative analysis of pretest and post-test scores demonstrated significant improvement in student performance, with the average score rising from 45.36 in the pretest to 86.61 in the post-test, yielding an N-Gain score of 0.42, indicative of moderate conceptual gains. Qualitative feedback from student questionnaires and interviews corroborated this, with students affirming the relevance and enjoyment of the learning process. This was reflected in the perfect score (560/560) given to the cultural relevance section, as well as student comments that emphasized the helpfulness of real-life examples in fostering a deeper understanding of algebraic concepts. These results align with Vygotsky's socio-cultural theory, which posits that when mathematical concepts are connected to students' lived experiences, they become more meaningful and engaging.

Despite the advantages, some challenges emerged in the learning process. This was evident in the post-test results, where three out of the 28 students did not meet the minimum completion criteria. Further analysis of student feedback indicated that the indicator related to the "suitability of the level of difficulty of the learning material" received the lowest score among six assessed indicators. This suggests that students accustomed to conventional learning methods may require more time to adapt to the local wisdom-based approach (Nurlaeli et al., 2018).

Utilization of Technology in Education

In the digital age, the integration of technology into learning is becoming increasingly essential. The use of Google Slides in this study exemplifies how technology can enhance learning experiences by providing more interactive and engaging educational content. A primary benefit

of employing Google Slides is its ability to visualize abstract mathematical concepts. The animations, color-coded visuals, and step-by-step representations facilitated a clearer understanding of algebraic topics, making them more accessible and intuitive. Student feedback confirmed this, with many reporting that the attractive visuals, animations, and clear layout significantly improved their understanding of previously challenging topics. One student noted that the dynamic illustrations helped them visualize the interactions of variables in equations. These findings are consistent with those of Susilowati et al. (2023), which suggest that Google Slides can make learning more interactive and engaging, motivating students to actively participate in their learning.

Additionally, post-test analysis showed a significant improvement in students' understanding of algebraic concepts following the use of interactive learning materials. The average post-test score increased to 86.61, compared to the pre-test score of 45.36. This improvement was confirmed through a paired sample t-test, which revealed a statistically significant difference ($p < 0.05$). The N-Gain score of 0.42 further supports the conclusion that the learning intervention resulted in a moderate gain in conceptual understanding. This also indicates an enhancement in students' critical and analytical thinking skills when solving mathematical problems. The use of multimedia, interactive simulations, and digital exercises allowed students to explore various problem-solving strategies and engage deeply with mathematical reasoning. These results align with Harianto and Sudatha's (2024) findings, which highlight the effectiveness of interactive multimedia-based learning in improving students' problem-solving skills.

Students' Engagement and Active Learning

The practicality of the developed learning materials, as evidenced by feedback from both students and teachers, underscores the importance of engaging students in a meaningful, contextually relevant learning experience. Practical exercises, such as solving mathematical problems grounded in local cultural contexts such as calculating the number of threads needed in weaving or identifying patterns in cultural artifacts like traditional houses enabled students to connect algebraic concepts with their daily lives. This approach made abstract mathematical ideas more tangible and relevant. Danoebroto et al. (2024) assert that such activities help to develop students' reasoning, critical thinking, and creativity, providing a solution for teachers aiming to support these cognitive skills. This approach is consistent with the principles of student-centered learning, wherein students actively engage in the learning process and construct their own knowledge. Furthermore, the collaborative learning environment fostered by integrating local wisdom into the curriculum was identified as a key element that supports effective learning. This method not only improves academic performance but also fosters a positive attitude toward mathematics and prepares students to face real-world challenges.

Overcoming Challenges

Although the developed product was deemed effective, some students, particularly those with lower mathematical proficiency, encountered difficulties in engaging with the interactive

learning materials. This suggests the need for more targeted and adaptive learning approaches tailored to students' diverse levels of understanding. The study identified differentiation strategies, such as tiered assignments and scaffolded tasks, as potential solutions. For instance, exercises of increasing complexity ranging from basic conceptual questions to more advanced problem-solving tasks allowed students to engage with the material at their own pace. Unlike traditional differentiation methods, which often group students by ability, this approach emphasizes flexibility and autonomy, aligning with the personalized learning model advocated by Muktamar et al. (2024). Additionally, teachers recommended incorporating interactive guidance within Google Slides, such as embedded hints or optional video explanations, to assist students who require extra support. Building on these findings, further product development could involve designing modular content with varying difficulty levels, embedding formative assessments that direct students to appropriate remedial resources, and offering students greater control over the pace and path of their learning. These strategies resonate with the work of Ahmad et al. (2024) and Kalinowski et al. (2024), who emphasize the need for individualized learning pathways to optimize student outcomes. Ultimately, refining the product within a structured differentiation framework will ensure a more inclusive and effective learning experience for all students.

Conclusion

This study demonstrates the substantial impact of local wisdom-based learning materials, augmented with interactive media such as Google Slides, on enhancing seventh-grade students' understanding of algebraic concepts. The integration of cultural context into mathematics education, specifically through the ethnomathematics approach, not only fosters deeper conceptual understanding but also reinforces students' cultural identity, making the learning process more engaging and relevant. By linking abstract mathematical concepts to students' everyday experiences, this approach facilitates a more meaningful connection to the material, enabling students to apply algebraic principles more effectively. The results from the post-test revealed a significant improvement in students' performance, with an average score increase from 45.36 (pre-test) to 86.61 (post-test), alongside an N-Gain of 0.42, reflecting moderate gains in both conceptual understanding and critical thinking skills.

While the findings are promising, the study also identified certain limitations that warrant consideration. Although the overall results were positive, three of the 28 students in the study did not meet the minimum completion criteria, suggesting that some students faced challenges in adapting to the local wisdom-based learning method, particularly those accustomed to traditional teaching approaches. This highlights the need for further adaptation of the teaching materials to better accommodate diverse learning paces and proficiency levels. Additionally, the indicator of "suitability of the level of difficulty" emerged as the lowest-rated aspect in the student feedback, indicating that further calibration of the learning materials' complexity is required to meet the varying needs of students with different academic backgrounds.

For future research, several recommendations can be made to build upon the findings of this study. First, it is crucial to develop more differentiated learning materials that cater to

students' varying levels of mathematical proficiency, with particular emphasis on scaffolding tasks and providing tailored support for students who face difficulties with the content. Furthermore, teacher training programs should focus on optimizing the use of digital tools such as Google Slides, ensuring that educators can effectively incorporate technology into their teaching practices. Finally, future studies should explore the scalability of this approach in diverse educational settings and its impact on students' long-term retention of mathematical concepts. Expanding access to technology in schools and investigating the potential of blended learning environments could help ensure more equitable learning opportunities for all students, fostering greater engagement and improved learning outcomes in mathematics education.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been covered completely by the authors.

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