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Exploration of a Contextual Approach Using Areca Nut Media to Optimize Students' Understanding of Mixed Arithmetic Operations in Elementary Schools

Makhali[1], Beti Istanti Suwandayani[2*], Agus Tinus[3]
[1,2,3]Universitas Muhammadiyah Malang, Malang, Indonesia

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ABSTRACT

Purpose: This study explored the implementation of a Contextual Teaching and Learning (CTL) approach assisted by areca nut media to improve fourth-grade students' understanding of mixed arithmetic operations at SD Negeri 2 Waisai during the 2025 academic year in a coastal 3T area where local cultural traditions remain preserved. **Methods:** This study employed an exploratory qualitative approach involving 28 fourth-grade students, one classroom teacher, and one school principal. Data were collected through classroom observations, interviews, and documentation, then analyzed using the interactive model of Miles, Huberman, and Saldaña through data reduction, data display, and conclusion drawing. **Findings:** The findings revealed that areca nut media improved students' conceptual and procedural understanding of mixed arithmetic operations, particularly in identifying operational sequences and explaining calculation processes. Students became more active in discussions, collaboration, and problem-solving activities, while their intrinsic motivation toward mathematics increased. The use of familiar local objects enabled students to connect abstract mathematical concepts with daily experiences, making learning more meaningful and engaging. School support through flexible policies and encouragement of local culture-based innovation strengthened the implementation of contextual learning. **Research Implications:** This study implies that local culture-based media can support meaningful and student-centered mathematics learning, particularly in remote elementary school contexts. However, the findings are limited to one school and one mathematical topic, requiring further studies in broader educational settings. **Originality:** This study highlights the integration of local wisdom through areca nut media within the CTL approach to support mathematics learning in coastal and remote 3T elementary school contexts.

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INTRODUCTION

Mathematics is a fundamental discipline that plays an essential role in developing students' logical, systematic, and critical thinking skills from the elementary school level. In elementary mathematics learning, students are expected not only to master computational skills but also to understand mathematical concepts meaningfully and apply them in everyday life (Jannah & Hayati, 2024). Conceptual understanding is considered a crucial foundation because it enables students to connect mathematical ideas with real situations and solve problems systematically (Rendrayana et al., 2020). One of the essential competencies for fourth-grade students is understanding mixed arithmetic operations, which require students to apply addition, subtraction, multiplication, and division according to the correct order of operations. However, many elementary school students still experience difficulties in understanding mixed arithmetic operations conceptually, particularly in determining operational priorities and interpreting mathematical symbols within contextual situations (Asriningtyas et al., 2024). Similar findings have also been reported in international studies indicating that elementary students frequently struggle to connect procedural calculation with conceptual understanding in mathematics learning (Žakelj et al., 2025).

Preliminary observations conducted at SD Negeri 2 Waisai revealed that students tended to memorize procedural steps without fully understanding the underlying mathematical concepts. As a result, students often encountered difficulties when solving problems presented in forms different from the examples provided by the teacher. Previous

studies similarly reported that elementary school students commonly experience difficulties in mathematical concept comprehension due to learning approaches emphasizing memorization and repetitive exercises (Netson & Ain, 2022). This condition indicates that mathematics learning remains dominated by conventional approaches centered on lectures, textbooks, and routine tasks, which provide limited opportunities for students to actively construct their own understanding. Such learning conditions become more challenging in remote and coastal areas where educational facilities and learning resources are often limited (Igo et al., 2024).

To address these issues, the *Contextual Teaching and Learning* (CTL) approach offers an alternative learning strategy that connects academic content with students' real-life experiences. CTL encourages students to construct knowledge actively through direct experiences, inquiry, problem-solving activities, and social interaction (Nababan & Sipayung, 2023). This approach aligns with constructivist learning theory and Edgar Dale's Cone of Experience, which emphasizes that students learn more effectively through concrete and meaningful experiences. Previous studies have demonstrated that CTL can improve students' mathematical understanding, participation, self-confidence, and learning outcomes in elementary mathematics instruction (Rosdianwinata & Aprilianti, 2022). International research also suggests that contextual and student-centered learning environments contribute significantly to students' conceptual understanding and engagement in mathematics learning (Agustina et al., 2025).

In addition to contextual learning approaches, the use of concrete and manipulative learning media plays an important role in supporting students' conceptual understanding of mathematics. Elementary school students are still in the concrete operational stage; therefore, they require learning experiences involving real objects that can be directly observed and manipulated (Azizah et al., 2024). This perspective is consistent with the cognitive development theory proposed by Jean Piaget, which emphasizes that children at the concrete operational stage understand concepts more effectively through direct interaction with concrete objects. Several studies have reported that concrete learning media help students understand mathematical concepts more effectively because students become actively involved in the learning process (Ana et al., 2025). In mathematics learning, concrete media allow students to visualize numerical relationships, classify objects, perform grouping activities, and practice arithmetic operations directly, making abstract concepts easier to understand (Suwandayani & Anggraini, 2021).

Previous studies have demonstrated that contextual learning approaches effectively improve students' understanding of arithmetic operations, fractions, mathematical literacy, and problem-solving abilities in elementary mathematics learning (Manfreda Kolar & Hodnik, 2021). However, most previous studies focused on general or technology-based learning media, while limited attention has been given to the utilization of local wisdom-based media closely related to students' social and cultural environments. In the context of Waisai and the Raja Ampat Islands, areca nut is a local commodity familiar to students' daily lives and has strong potential to serve as a concrete learning medium in mathematics instruction. Its physical characteristics allow students to manipulate, group, divide, and count objects directly, making mathematical concepts more visible and meaningful. The integration of local culture into learning activities is also considered important because it can strengthen students' engagement, contextual understanding, and meaningful learning experiences (Cholily et al., 2022).

Despite its potential, empirical studies examining the use of areca nut as a contextual learning medium in mixed arithmetic operation learning remain very limited, particularly in coastal and remote elementary school contexts. Existing studies have rarely explored how local wisdom-based media can support conceptual understanding, student participation, and contextual mathematics learning experiences simultaneously. This gap highlights the need for further investigation into culturally relevant mathematics learning approaches that utilize local environmental resources as learning media.

Based on these problems and research gaps, this study seeks to answer the following research questions: (1) How is the implementation process of the Contextual Teaching and Learning (CTL) approach assisted by areca nut media in teaching mixed arithmetic operations to fourth-grade students at SD Negeri 2 Waisai? ; (2) How do students experience and construct mathematical understanding through the use of areca nut media in contextual learning activities?; (3) How does contextual learning assisted by areca nut media shape students' engagement, collaboration, and motivation in mathematics learning?; and (4) How does the school support the implementation of local wisdom-based contextual mathematics learning in a remote elementary school context?. Therefore, this study aims to explore the implementation of a *Contextual Teaching and Learning* (CTL) approach assisted by areca nut media in optimizing fourth-grade students' understanding of mixed arithmetic operation concepts at SD Negeri 2 Waisai. In addition, the study investigates the role of the school in supporting the implementation of contextual learning. The study is expected to contribute theoretically to the development of contextual mathematics learning and ethnomathematics studies, while practically providing alternative learning strategies that are adaptive, meaningful, and relevant to the characteristics of elementary school students in remote educational contexts (Waruwu, 2024).

METHOD

This study employed an exploratory qualitative design supported by descriptive data derived from observations, interviews, and documentation. The qualitative approach was selected to obtain an in-depth understanding of students' learning experiences and the implementation of contextual mathematics learning in a real educational setting. The exploratory qualitative design was used because the study focused on investigating the implementation of a contextual learning approach in teaching mixed arithmetic operations and examining the school's role in supporting the implementation of Contextual Teaching and Learning (CTL) assisted by local wisdom-based media. The exploratory qualitative approach also allowed the researcher to capture participants' experiences, perceptions, and interactions during the implementation of contextual mathematics learning in a natural setting.

The research was conducted at SD Negeri 2 Waisai during the 2025/2026 academic year, from September 1 to November 29, 2025. The school was selected because it represents the context of learning in remote island areas, shows indications of students' difficulties in understanding mixed arithmetic operations, and supports collaborative educational research and instructional innovation.

Participants were selected using purposive sampling because they were directly involved in the implementation of contextual mathematics learning assisted by areca nut media. The participants consisted of: (1) one fourth-grade classroom teacher as the main implementer of the CTL approach; (2) 28 fourth-grade students as the primary participants in the learning activities; and (3) one school principal as a triangulation informant regarding school policies and institutional support for contextual learning innovation based on local wisdom. The fourth-grade students had heterogeneous academic abilities and social backgrounds, enabling the researcher to obtain diverse perspectives and learning experiences during the implementation of contextual learning activities. Participant selection was based on the following criteria: (1) active involvement in the learning process; (2) direct experience with CTL-assisted learning activities using areca nut media; and (3) willingness to participate in interviews and observations throughout the research process. Data collection was conducted until the information obtained became repetitive and no new significant themes emerged, indicating that data saturation had been achieved.

The data sources were divided into primary and secondary data. Primary data were obtained through classroom observations, in-depth interviews, and documentation, while secondary data included school profiles, syllabi, lesson plans, and archived learning documents. The researcher acted as the primary research instrument supported by observation sheets, interview guidelines, and documentation formats. Observation instruments focused on teacher and student activities during contextual learning, while interview guidelines explored students' conceptual understanding, learning motivation, learning difficulties, teacher perceptions, and school support toward contextual learning implementation.

Data were collected through: (1) direct classroom observations to examine the implementation of CTL activities assisted by areca nut media; (2) in-depth interviews with students, teachers, and the principal to explore experiences, perceptions, and learning challenges; and (3) documentation, including lesson plans, students' work, photographs, and archived instructional documents. The collected data were analyzed using the interactive model of Miles, Huberman, and Saldaña, consisting of data reduction, data display, and conclusion drawing/verification. To ensure the trustworthiness of the findings, the study applied triangulation, member checking, audit trails, and peer discussions following Lincoln and Guba's validation framework. These validation techniques were applied to ensure the credibility, dependability, confirmability, and transferability of the research findings.

The research procedure consisted of three stages: preliminary, implementation, and final stages. The preliminary stage involved literature review, initial observation, and research design preparation. The implementation stage focused on collecting and analyzing qualitative data through interviews, observations, and documentation. The final stage involved report writing, data compilation, and drawing conclusions based on the research findings.

Table 1. Documentation Format.

Nu.	Type of Documentation	Description
1	Learning Activity Photographs	
2	Interview Photographs	
3	Learning Instructional Documents	

Table 2. Student and teacher activity observation sheet.

Nu.	Observation Aspect	Observed Indicators	Findings
1	Introduction	The teacher greets the students, explains the learning objectives.	
2	Contextualization of material	The teacher relates the material on arithmetic operations to real situations.	
3	Learning strategies	Teachers use CTL methods such as role play, group discussions, case studies.	
4	Student involvement	Students actively discuss, ask questions, and are involved in learning activities.	
5	Concept understanding	Students are able to explain concepts in their own language meaningfully.	
6	Authentic assessment	Teachers conduct contextual task-based assessments (real problems).	
7	Student reflection	Teachers give students the opportunity to express learning difficulties and solutions.	

Table 3. Student Interview Guidelines

Nu.	Observation Aspect	Indicator Questions
1	Understanding of Mathematical Concepts	Students are able to explain the mathematics material that has been learned. Students are able to provide examples of the application of mathematical concepts in daily life. Students are able to distinguish between types of arithmetic operations (addition, subtraction, multiplication, and division). Students demonstrate understanding of the order of operations in mixed arithmetic calculations.
2	Interest and Attitudes toward Mathematics	Students show interest or enthusiasm during mathematics lessons. Students have positive perceptions toward mathematics subjects. Students feel happy or challenged when solving mathematics problems. Students relate mathematics learning to their personal goals or interests.
3	Learning Strategies and Independence	Students actively ask questions or seek information when they do not understand the material. Students have study habits or review mathematics lessons at home.
4	Difficulties or Obstacles Faced	Students mention the types of problems or concepts they find most confusing. Students express their feelings when experiencing difficulties in learning mathematics.
5	Pleasant or Unpleasant Learning Experiences	Students describe their most enjoyable experiences during mathematics lessons. Students describe unpleasant or confusing experiences while learning mathematics. Students explain the mathematics learning activities or methods they prefer (for example role-playing, games, or using instructional media).
6	Perceptions of Teachers and the Learning Process	Students feel that the teacher explains mathematics lessons clearly or unclearly. Students feel comfortable asking the teacher questions when they do not understand the material.

Table 4. Teacher Interview Guidelines

Nu.	Observation Aspect	Indicator Questions
1	Teacher Perceptions toward Mathematics Learning	The teacher understands the importance of mastering basic mathematical concepts. The teacher understands students' characteristics in learning mathematics.
2	Learning Planning	The teacher prepares contextual lesson plans. The teacher adjusts learning materials according to students' needs and abilities.

Nu.	Observation Aspect	Indicator Questions
3	Teaching Strategies and Methods	The teacher uses various methods in teaching mathematics. The teacher applies active learning approaches (for example contextual learning and problem solving).
4	Assessment and Evaluation	The teacher conducts comprehensive evaluations of students' understanding. The teacher uses evaluation results as a basis for improving instruction.
5	Challenges and Obstacles	The teacher identifies challenges encountered in mathematics learning. The teacher has strategies to overcome students' learning difficulties.
6	Expectations and Recommendations	The teacher has expectations for improving mathematics learning.

Table 5. Principal Interview Guidelines

Nu.	Observation Aspect	Indicator Questions
1	Principal's Understanding	How do you understand the contextual approach in mathematics learning? In your opinion, how important is the use of concrete learning media in elementary mathematics learning?
2	School Support for Learning	Does the school support the use of contextual approaches in the learning process? What forms of support does the school provide to teachers in implementing contextual learning approaches?
3	Impact on Students	Based on your observations, how does the use of concrete media such as areca nuts affect students' learning motivation? Have there been changes in students' participation or understanding after learning through the contextual approach assisted by areca nut media?
4	Challenges and Solutions	What challenges might teachers face in implementing the contextual approach assisted by areca nut media? How does the school help teachers overcome these challenges?
5	Principal's Expectations	What are your expectations regarding the future implementation of contextual approaches in mathematics learning?

RESULTS

Based on the results of observations, interviews, and documentation, the findings of this study are presented according to the four research questions: (1) the implementation process of the Contextual Teaching and Learning (CTL) approach assisted by areca nut media; (2) students' construction of mathematical understanding through contextual learning activities; (3) students' engagement, collaboration, and motivation during learning; and (4) school support for the implementation of local wisdom-based contextual learning.

Figure 1. The students are used to consuming betel nuts.

Implementation Process of the CTL Approach Assisted by Areca Nut Media

This study was conducted at SD Negeri 2 Waisai, Raja Ampat Regency, Southwest Papua, which is located in a coastal and 3T area (*frontier, outermost, and disadvantaged region*). The social environment of the community remains closely connected to traditional activities such as grouping agricultural products, sharing harvests, and conducting simple daily transactions. These local activities provided relevant contexts for mathematics learning. One local commodity closely related to students' daily lives is areca nut. In the Waisai community, areca nuts are not only consumed but also hold social and cultural value. Students' familiarity with areca nuts made them suitable as concrete learning media in contextual mathematics learning.

Figure 2. Students are involved in contextual learning.

The implementation of CTL assisted by areca nut media was carried out by connecting mixed arithmetic operation concepts with activities familiar to students, such as grouping, dividing, and counting areca nuts. During learning activities, students directly manipulated areca nuts to represent arithmetic operations rather than only observing mathematical symbols in textbooks. At the beginning of the learning process, students tended to follow procedural steps without understanding the meaning behind the operations. However, after the introduction of areca nut media, students gradually became more active in exploring mathematical processes and relating operations to concrete objects. One student stated: *"Dulu sa sering salah urutan, tapi setelah pakai buah pinang sa mengerti banyak."* Another student explained: *"Awalnya sa babingung urutan hitung, tapi waktu pakai buah pinang sa lebih mengerti."* These findings indicate that the CTL approach assisted by areca nut media created more contextual and meaningful mathematics learning experiences for students.

Students' Construction of Mathematical Understanding through Areca Nut Media

The findings showed that students constructed mathematical understanding through direct interaction with areca nut media during contextual learning activities. The use of concrete objects enabled students to visualize quantities, identify operational sequences, and understand relationships among arithmetic operations more systematically. Observation data revealed that students gradually became able to determine the order of mixed arithmetic operations independently. Students also showed improvement in explaining calculation procedures using their own language.

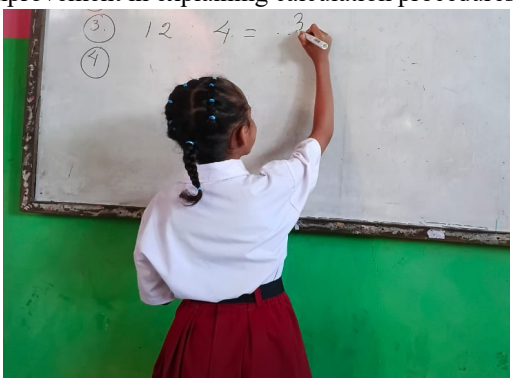

Figure 3. Students build mathematical understanding.

Students stated that learning mathematics through real objects was easier than learning only through abstract numbers and symbols. One student expressed: *"Belajar pakai buah pinang lebih seru, jadi sa cepat mengerti."* Another student mentioned: *"Menurut sa matematika jadi lebih gampang kalau ada contoh begitu (buah pinang)."*

From the teacher's perspective, the use of areca nut media helped students understand mathematical concepts more quickly because students could directly observe and manipulate the objects involved in the calculations. The classroom teacher stated: *"Siswa lebih mudah memahami matematika jika menggunakan benda konkret atau contoh yang dekat dengan kehidupan mereka sehari-hari seperti buah pinang."* These findings demonstrate that contextual learning assisted by local concrete media supported students' conceptual and procedural understanding of mixed arithmetic operations.

Students' Engagement, Collaboration, and Motivation in Mathematics Learning

The implementation of contextual learning assisted by areca nut media also influenced students' engagement, collaboration, and motivation during mathematics learning activities. Observation results showed that students became more active in discussions, asking questions, and participating in group activities. Initially, some students still depended on teacher guidance when using areca nuts as learning tools. However, during subsequent learning activities, students became more confident and independent in using the media to solve mathematical problems.

Figure 4. Students play drama in the learning process.

Students also demonstrated improved collaborative skills. They worked together in groups, shared responsibilities, and helped one another count and group areca nuts during problem-solving activities. Learning interactions became more communicative and socially active compared to previous classroom conditions. In addition, students showed positive emotional responses toward mathematics learning. Students considered learning with areca nuts more interesting and enjoyable than learning only with numbers and symbols. Their enthusiasm was reflected in their willingness to participate, experiment with problem-solving strategies, and engage in classroom discussions. These findings indicate that contextual learning connected to students' real-life experiences contributed not only to cognitive development but also to students' social interaction and intrinsic motivation in mathematics learning.

School Support for Local Wisdom-Based Contextual Learning

The findings revealed that the successful implementation of CTL assisted by areca nut media was influenced not only by teacher practices but also by institutional support from the school. The school principal explained that concrete learning media are important because elementary school students are still in the concrete operational stage of cognitive development. The principal stated: *"Media konkret sangat penting karena siswa sekolah dasar masih berada pada tahap berpikir konkret."*

The school also strongly supported the integration of local wisdom into mathematics learning activities. The principal further explained: *"Sekolah sangat mendukung karena pendekatan kontekstual berbantuan buah pinang nyata membantu siswa belajar lebih aktif dan memahami materi sesuai dengan lingkungan mereka."* Several forms of school support identified in this study included:

1. assistance in developing contextual teaching modules;
2. provision of learning facilities and resources;
3. strengthening teacher competence through Teacher Working Groups (KKG) and training programs;

4. support for school culture based on local wisdom;
5. classroom monitoring and supervision by the principal;
6. facilitation of teacher collaboration and reflection; and
7. support for low-cost instructional innovation using local resources.

These findings indicate that institutional support played an important role in strengthening the implementation of contextual mathematics learning in remote elementary school contexts.

Figure 5. Interview with the principal.

DISCUSSION

Contextual Learning Based on the Local Environment

The findings showed that the use of local contexts helped students understand mathematical concepts more meaningfully and contextually. Learning activities connected to students' daily experiences facilitated their understanding of mixed arithmetic operations through real-life situations and sociocultural environments (Nababan & Sipayung, 2023). The use of areca nuts as learning media created learning experiences closely related to the coastal community life in Waisai. This condition aligns with the principles of Contextual Teaching and Learning, emphasizing the relationship between instructional materials and students' real-life experiences (Zhakypova & Sydykova, 2021). Students gradually understood relationships among arithmetic operations when mathematical symbols were connected to activities such as grouping, dividing, and counting areca nuts directly. Contextual learning can create active and meaningful learning experiences through students' involvement in authentic situations (Muhartini et al., 2023). Therefore, the local context functioned as a cognitive bridge connecting concrete experiences with abstract mathematical concepts (Widodo & Astuti, 2024).

The use of the local environment also demonstrated the relevance of the ethnomathematics approach in elementary mathematics learning within coastal areas (Suhendri & Ningsih, 2023). Students appeared more enthusiastic when learning activities involved objects already familiar in their daily community lives. This condition indicates that cultural experiences strongly influenced the formation of students' mathematical conceptual understanding. The integration of local culture can strengthen cultural identity while simultaneously improving learning quality (Suwandayani & Anggraini, 2021). The findings revealed that mathematics should not be separated from the sociocultural realities surrounding students' lives. Therefore, contextual learning based on local environments can strengthen conceptual understanding while preserving local cultural values within the community.

The Role of Areca Nut Media in Constructing Mathematical Concepts

The use of areca nut media provided manipulative experiences that helped students understand mixed arithmetic operation structures concretely. Activities such as moving, grouping, and distributing areca nuts helped students construct mental representations of mathematical concepts. Most students appeared more active when learning used concrete media rather than only abstract mathematical symbols. Manipulative media have been proven to help students understand relationships among operations through direct learning experiences (Nurahlina & Aprilia, 2025). Similarly, concrete representations support the development of deeper conceptual understanding among elementary school students (Rendrayana et al., 2020). The findings indicated that students no longer memorized procedures mechanically but began understanding the reasons behind specific operations in solving mathematical problems. Thus, areca nuts functioned not merely as visual aids but also as media for constructing students' mathematical knowledge.

The findings also supported Jerome Bruner's representation theory regarding stages of learning from concrete experiences toward symbolic understanding. Students first manipulated areca nuts before translating those activities into abstract mathematical symbols. Enactive experiences helped students understand relationships among operations more systematically and conceptually. The use of concrete media gradually improves students' ability to understand mathematical concepts (Apriyanti et al., 2023). Concrete experiences also help students reduce misconceptions when solving mathematical problems (Zulaikhah & Kelana, 2022). Besides supporting conceptual understanding, the use of areca nut media also strengthened ethnomathematics approaches within elementary mathematics learning. Ethnomathematics approaches help students understand mathematics through local cultural contexts within their communities (Suhendri & Ningsih, 2023).

Students' Learning Motivation and Social Participation

The findings revealed that contextual learning assisted by areca nut media increased students' engagement during mathematics learning activities. Most students became more active in asking questions, participating in discussions, and solving problems collaboratively within groups. The use of familiar concrete media created more relaxed and less stressful classroom environments for students. Contextual learning can improve elementary students' learning interest and self-confidence (Rosdianwinata & Aprilianti, 2022). The findings also showed that students became more confident expressing opinions when learning involved concrete and collaborative activities. Teachers explained that almost all students actively participated during lessons assisted by areca nut media. Therefore, contextual learning helped create more participatory, communicative, and enjoyable learning environments for students.

Group activities during learning demonstrated that students constructed mathematical understanding through social interactions with classmates. Students helped one another count, group, and discuss mixed arithmetic problem-solving procedures collaboratively. This condition reflected the principles of social constructivism, positioning social interaction as an essential component of students' learning processes. Social engagement improves students' understanding in contextual mathematics learning at elementary schools (Anastasia et al., 2021). Active learning also increases creativity and students' participation in solving mathematical problems (Yayuk & As' ari, 2020). The findings indicated that students not only understood procedures but also explained reasons behind specific operations. Therefore, group collaboration played important roles in developing conceptual understanding while simultaneously improving students' mathematical communication skills.

School Support in Implementing Local Wisdom-Based CTL

The successful implementation of contextual learning assisted by areca nut media was influenced by school support toward innovative local culture-based learning development. The principal provided opportunities for teachers to utilize surrounding environments as contextual learning resources for elementary students. Such support helped teachers develop mathematics learning relevant to surrounding sociocultural community conditions. School culture strongly influences the reinforcement of character-based and contextual learning practices (Tinus & Wulandari, 2021). The findings demonstrated that school policies supported integrating local culture into elementary mathematics learning processes. The principal also emphasized that local media served as effective alternatives for schools with limited educational facilities. Therefore, institutional support became an important factor influencing successful implementation of contextual learning based on local wisdom.

Schools also supported learning implementation through continuous teacher competency development and professional collaboration activities. Teachers were provided opportunities to participate in training programs, seminars, and Teacher Working Group activities to improve pedagogical competencies. Strengthening teacher competencies improves the quality of innovative learning model implementation within elementary schools (Tinus & Wulandari, 2021). Likewise, school management plays important roles in supporting innovation within elementary education learning processes (Suwandayani & Anggraini, 2021). The findings showed that teachers became more creative utilizing local resources after receiving institutional support from schools. Furthermore, utilizing local media provided economical and easily implemented learning solutions for remote elementary schools. Therefore, local wisdom-based learning can become a strategic alternative for elementary schools within frontier, outermost, and disadvantaged regions.

Research Limitations and Implications

Although the findings demonstrated positive results, implementing contextual learning assisted by areca nut media still encountered several field limitations. Teachers required longer preparation time to design learning activities aligned with students' daily life conditions. Differences in students' abilities also influenced how quickly they understood relationships between concrete objects and abstract mathematical symbols. Differentiated learning approaches are

needed to accommodate students' diverse academic abilities and learning needs (Fauzia & Ramadan, 2023). In addition, limited school facilities also influenced the optimal implementation of contextual learning activities within several instructional sessions (Misqa et al., 2024). Nevertheless, the use of local media demonstrated strong potential as economical and contextually relevant learning solutions for remote schools.

This study provides theoretical implications for developing local context-based mathematics learning within remote elementary schools. The findings demonstrated that local media can function as cognitive bridges helping students understand abstract mathematical concepts. This condition reinforces social constructivist and contextual learning theories emphasizing the importance of authentic experiences within mathematics learning. Interpretive paradigms help explain students' meaning construction processes through social experiences in mathematics learning (Koskinen & Pitkäniemi, 2022). Practically, the study highlights the importance of teachers' creativity in utilizing surrounding environments as contextual mathematics learning resources. Furthermore, contextual approaches help improve elementary students' mathematical problem-solving abilities more meaningfully (Manfreda Kolar & Hodnik, 2021). Future studies are recommended to develop local media for different mathematical materials and examine CTL implementation through longitudinal studies across various elementary education contexts.

CONCLUSION

This study concludes that the implementation of the *Contextual Teaching and Learning* (CTL) approach assisted by areca nut media contributed significantly to enhancing students' understanding of mixed arithmetic operations among fourth-grade students at SD Negeri 2 Waisai. The integration of local-context learning media enabled students to connect abstract mathematical concepts with concrete experiences drawn from their daily lives. As a result, students demonstrated improved conceptual understanding, greater participation in classroom activities, stronger collaborative interaction, and increased intrinsic motivation toward mathematics learning.

The findings also indicate that contextual learning supported the development of mathematical reasoning through direct manipulation of concrete objects and collaborative problem-solving activities. The use of areca nut media encouraged students to actively construct knowledge through social interaction and contextual experiences, reflecting sociocultural and constructivist learning principles. In addition, support from teachers and school management played an important role in facilitating meaningful and engaging mathematics learning experiences, particularly in coastal and remote elementary school settings.

The originality of this study lies in integrating local wisdom through areca nut media within the CTL framework as a culturally relevant learning resource for elementary mathematics instruction. This study demonstrates that locally available materials can function not only as instructional aids but also as cognitive bridges that connect students' cultural experiences with abstract mathematical concepts. The findings contribute to the development of contextual and ethnomathematics-based learning practices, especially in underdeveloped and resource-limited educational contexts.

Despite these contributions, this study has several limitations. First, the research was conducted within a limited scope involving one elementary school and a relatively small number of participants, which may limit the broader generalizability of the findings. Second, the study focused primarily on qualitative exploration of learning experiences without incorporating quantitative measurement of learning outcomes. Third, the implementation period was relatively short, limiting observation of long-term impacts on students' mathematical achievement.

Based on these findings, teachers are encouraged to utilize local environmental resources as contextual learning media to create more meaningful mathematics learning experiences. Schools should support teachers through the provision of training and collaborative opportunities for developing innovative contextual learning strategies. Policymakers are expected to encourage the integration of local wisdom into elementary school curricula, particularly in remote and coastal regions. Future researchers are recommended to conduct mixed-method or experimental studies involving larger participant groups and longer implementation periods to further examine the effectiveness and sustainability of contextual learning assisted by local cultural media.

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AUTHOR CONTRIBUTION STATEMENT

MK was responsible for conceptualizing the study, designing the research framework, and drafting the initial manuscript. BI contributed to literature review, and the arrangement of research materials. AT assisted in data analysis, interpretation of findings, and refinement of the manuscript. All authorsreviewed and approved the final version of the article, ensuring accuracy and coherence in the presentation of the research.

AI DISCLOSURE STATEMENT

The author declares that, in the preparation of this manuscript, limited use has been made of artificial intelligence (AI), specifically for the improvement of grammar, sentence clarity and the neatness of the writing structure. The use of AI did not extend to the formulation of research ideas, data collection and analysis, or the drawing of conclusions. The author takes full responsibility for the entire content, accuracy, and scientific integrity of this manuscript.

Makhali
Master of Pedagogy,
University of Muhammadiyah Malang,
Jl. Raya Tlogomas No. 246, Babatan, Tlogomas, Lowokwaru District, Malang City, East Java, 65143, Indonesia
Email: makhali@webmail.umm.ac.id

***Beti Istanti Suwandayani (Corresponding Author)**
Master of Pedagogy,
University of Muhammadiyah Malang,
Jl. Raya Tlogomas No. 246, Babatan, Tlogomas, Lowokwaru District, Malang City, East Java, 65143, Indonesia
Email: beti@umm.ac.id

Agus Tinus
Master of Pedagogy,
University of Muhammadiyah Malang,
Jl. Raya Tlogomas No. 246, Babatan, Tlogomas, Lowokwaru District, Malang City, East Java, 65143, Indonesia
Email: agt.tns.umm@gmail.com