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Developing *Upak Nyamu* Ethnomathematics Learning Media through Design-Based Research to Improve Elementary Students' Critical Thinking

Rita[1], Gullham Hamdu*[1], Ika Fitri Apriani P[1], Krisma Natalia[2]
[1] Master's Program in Elementary School Teacher Education, Universitas Pendidikan Indonesia Tasikmalaya Campus, Tasikmalaya, 46115, Indonesia
[2] Elementary School Teacher Education Study Program, Faculty of Dharma Acarya, Institut Agama Hindu Negeri Tampung Penyang, Palangka Raya, 73112, Indonesia

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* *Corresponding author:*

E-mail: ghullamh2012@upi.edu

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A B S T R A C T

The limited integration of local cultural contexts into mathematics instruction remains a significant gap, particularly in elementary education, where learning often emphasizes abstract concepts that are not connected to students' real-life experiences. In addition, the availability of culturally based learning media that are both contextually relevant and empirically tested is still limited. This condition reduces student engagement and constrains the development of higher-order thinking skills. Therefore, this study aims to develop and examine the effectiveness of culturally based learning media using upak nyamu to enhance elementary students' critical thinking skills and support meaningful learning experiences. This study employed a Design-Based Research (DBR) approach involving 28 fourth-grade students. Data were collected through expert validation, observations, interviews, and pretest–posttest assessments. The results indicate that the developed media is valid and feasible, with a Content Validity Index exceeding 0.80 across all aspects. Students' mean scores increased from 9.71 to 17.04, while the N-Gain score (0.0799) remained in the low category due to the short implementation period and the need for sustained use of ethnomathematics-based media. The findings show that integrating local cultural elements into mathematics learning enhances students' understanding, engagement, and cultural awareness, and highlights the importance of culturally responsive pedagogy in creating meaningful and contextual learning environments.

1. Introduction

Mathematics learning in elementary schools continues to face challenges, particularly in helping students understand abstract concepts. Topics such as

multiplication are often taught using procedural and teacher-centered approaches, leading students to rely on memorization rather than conceptual understanding. As a result, students' engagement tends to be low, and their ability to connect mathematical concepts with real-life situations remains limited. This condition highlights the need for innovative learning approaches that can make mathematics more meaningful and relevant to students' experiences.

One promising approach is the integration of local culture into mathematics learning through ethnomathematics. Ethnomathematics views mathematics as a form of knowledge that is embedded in cultural practices and social activities within a community (D'Ambrosio, 1985). This perspective suggests that mathematical concepts can be explored through everyday cultural experiences, making learning more contextual and meaningful. By incorporating cultural elements into the classroom, students are encouraged not only to understand mathematical concepts but also to appreciate their cultural identity. Previous studies have shown that ethnomathematics-based learning can enhance students' conceptual understanding, engagement, and positive attitudes toward mathematics (Rosa & Orey, 2011; Pujastuti et al., 2024).

The integration of cultural context in learning is also aligned with the principles of contextual learning, which emphasize the connection between academic content and students' real-life environments. In a culturally diverse country such as Indonesia, local wisdom provides rich resources that can be utilized in the learning process. One such cultural element is *upak nyamu*, a traditional material used by the Dayak community. *Upak nyamu* has distinctive characteristics, including strength, flexibility, and durability, making it suitable as a manipulative learning medium. In addition to its physical properties, it carries cultural values that can enrich students' learning experiences.

Previous research has demonstrated that the use of manipulative media in mathematics learning can improve students' conceptual understanding and learning outcomes. Concrete media enable students to visualize abstract concepts, thereby facilitating deeper comprehension (Saragi et al., 2023; Suryani et al., 2023). Furthermore, studies that integrate cultural contexts into learning have shown that students become more active and are better able to relate mathematical concepts to their daily lives (Sari et al., 2024; Sanzania & Wati, 2026; Nailusaulakhah et al., 2026). Recent studies published in the *Journal of Educational Sciences* also highlight that interactive and problem-based learning media can significantly improve student engagement and critical thinking skills (Andriani et al., 2024).

In addition, the GASING method (Gampang, Asyik, dan Menyenangkan) has been recognized as an effective approach in mathematics learning. This method emphasizes step-by-step learning from concrete to abstract concepts through simple and enjoyable activities. The integration of the GASING method with culturally-based learning media has the potential to create a learning environment that is not only effective in improving cognitive outcomes but also meaningful and engaging for students. Despite these potentials, studies that specifically integrate local culture, ethnomathematics, and instructional methods such as GASING remain

limited. Previous research tends to examine these aspects separately, resulting in a lack of comprehensive understanding of how their integration can enhance mathematics learning. This gap indicates the need for research that develops and implements culturally-based learning media within an integrated pedagogical framework. Based on these considerations, this study aims to develop and examine the use of upak nyamu-based learning media in elementary mathematics learning through an ethnomathematics approach integrated with the GASING method. Specifically, this research seeks to investigate how the integration of local culture into learning media can support students' conceptual understanding and create more meaningful and contextual learning experiences in elementary school settings.

2. Methodology

Research Design

This study employed a Design-Based Research (DBR) approach to develop and examine ethnomathematics-based learning media using upak nyamu within a real classroom context. DBR was selected as it allows iterative processes of analysis, design, development, implementation, and reflection to produce valid, practical, and effective educational innovations. The research procedure followed the model proposed by McKenney and Reeves (2018), which consists of four main phases: analysis, design, development, and implementation.

In this study, each DBR phase was conducted systematically as follows: (1) the analysis phase involved classroom observations, teacher interviews, and document analysis to identify learning needs; (2) the design phase focused on developing conceptual and instructional designs of the media; (3) the development phase included prototype creation and expert validation; and (4) the implementation phase involved classroom trials using a one-group pretest-posttest design. The DBR process in this study was conducted through systematic and iterative cycles to ensure the validity, practicality, and effectiveness of the developed media. Each phase involved continuous refinement based on empirical findings and expert feedback.

Research Setting and Participants

he study was conducted at SDN 2 Kuala Kurun, Gunung Mas Regency, Central Kalimantan, where local Dayak cultural traditions are still strongly preserved. A total of 28 fourth-grade students participated in this study. The participants were selected based on their exposure to local cultural practices, making them relevant for ethnomathematics-based learning integration.

Instrument

Several instruments were used to collect both qualitative and quantitative data. First, a validation sheet was developed to assess the feasibility of the learning media. The instrument consisted of three main aspects: (1) mathematical content,

(2) media design and material characteristics of upak nyamu, and (3) instructional aspects. Each aspect included 5–8 indicators assessed using a Likert scale ranging from 1 (very poor) to 4 (very good).

Second, an observation sheet was used to examine students' engagement during the learning process. The observed indicators included active participation, interaction with the media, collaboration, exploration of materials, and responses to cultural contexts. Third, interview guidelines were designed in a semi-structured format to collect in-depth responses from teachers and students regarding their perceptions of the learning process and the use of upak nyamu-based media. Fourth, a test instrument in the form of pretest and posttest consisting of 10 open-ended questions was used to measure students' critical thinking skills in understanding multiplication concepts within a cultural context. The test items were designed based on indicators of critical thinking, including interpretation, analysis, and evaluation. The reliability of the test instrument was measured using Cronbach's Alpha, yielding a coefficient of 0.86, which indicates high reliability.

Data Collection

Data were collected through observation, interviews, documentation, and tests. Observations were conducted during the learning implementation phase in two classroom sessions to capture students' engagement, interaction patterns, and responses to the ethnomathematics-based media. Each observation was guided by a structured observation sheet. Interviews were conducted with one classroom teacher and six selected students representing different levels of academic ability. The interviews were carried out after the learning implementation to explore participants' perceptions of the learning experience and the integration of local culture. Documentation included photographs of classroom activities, students' worksheets, lesson plans, and learning materials used during the study. These documents were used to support and validate the findings obtained from observations and interviews. Quantitative data were collected through pretest and posttest administered before and after the implementation to measure students' critical thinking skills.

Data Analysis

Data analysis was conducted using both qualitative and quantitative approaches. Qualitative data were analyzed using an interactive model consisting of data reduction, data display, and conclusion drawing, as proposed by Miles et al. (2014). This analysis aimed to interpret students' engagement, cultural interactions, and learning experiences. Quantitative data were analyzed using descriptive statistics and inferential analysis. A paired sample t-test was applied to determine the significance of differences between pretest and posttest scores at a significance level of 0.05. In addition, the N-Gain score was calculated to measure the level of improvement in students' critical thinking skills using the following formula:

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

The N-Gain results were categorized into three levels: high (≥ 0.7), medium (0.3–0.7), and low (< 0.3). To ensure the validity of the developed media, content validity was analyzed using the Content Validity Index (CVI). A score of ≥ 0.80 indicated that the instrument and media were valid. Triangulation of data sources and methods was also applied to ensure the trustworthiness of the findings.

3. Results and Discussion

The data in this study were collected through four main techniques, namely observation, interviews, documentation, and tests, to ensure comprehensive and triangulated findings. Observations were conducted during the learning process to examine students' engagement, interaction with the upak nyamu-based media, and participation in group activities. Interviews were carried out using semi-structured guidelines involving both teachers and students to explore their perceptions, learning experiences, and responses to the integration of local culture in mathematics learning. Documentation included photographs of classroom activities, students' worksheets, and learning artifacts that supported the observation data. In addition, tests in the form of pretest and posttest were administered to measure students' critical thinking skills, particularly in interpreting, analyzing, and evaluating multiplication concepts within a cultural context. The integration of these data collection techniques allowed for a more in-depth understanding of both the learning process and outcomes.

Needs Analysis of Culturally Based Learning Media

The initial phase of this study identified critical issues in elementary mathematics learning, particularly in multiplication. Classroom observations revealed that instruction was still dominated by teacher-centered approaches, relying heavily on textbooks and procedural explanations. Students tended to memorize multiplication facts without understanding the underlying concepts. As a result, their engagement and conceptual comprehension remained low. Findings from interviews with teachers further confirmed that limited use of contextual and culturally relevant media contributed to students' difficulties. Approximately 78% of students experienced challenges in understanding multiplication as repeated addition. This condition aligns with previous studies published in the Journal of Educational Sciences, which highlight that abstract mathematical instruction without contextual support often leads to superficial understanding and low student engagement (Mustikazahra et al., 2025; Hastri et al., 2025).

Observation data showed that most students were passive during conventional instruction, with only a few actively responding to teacher questions. Students tended to wait for direct explanations rather than exploring problem-solving strategies independently. This finding was supported by documentation in the form of classroom activity records, which indicated limited student interaction and

minimal use of learning media. Furthermore, interview results revealed that teachers experienced difficulties in providing contextual examples that relate multiplication concepts to students' daily lives, highlighting the need for culturally relevant instructional media. The results of interviews with teachers and students are presented in Table 1 to provide a clearer overview of the identified learning problems.

Table 1. Summary of Interview Results

No	Aspect	Interview Question	Key Findings
1	Learning Process	How is mathematics learning usually conducted in the classroom?	Learning is teacher-centered and focuses on procedural explanation
2	Student Understanding	What difficulties do students face in learning multiplication?	Students have difficulty understanding multiplication as repeated addition
3	Learning Media	What media are used in teaching mathematics?	Limited use of manipulative and contextual learning media
4	Cultural Integration	Have local cultural elements been used in learning?	Cultural elements have not been optimally integrated
5	Student Engagement	How do students respond to current learning methods?	Students tend to be passive and less engaged
6	Learning Needs	What kind of learning media is needed?	Interactive, contextual, and culturally relevant media is needed

As shown in Table 1, the interview results indicate that the main challenges in mathematics learning are related to the lack of contextual and culturally relevant instructional media. Both teachers and students emphasized the need for more interactive and meaningful learning experiences. These findings strengthen the results of observations and documentation, confirming that the integration of culturally based learning media is necessary to improve students' conceptual understanding and engagement. These findings demonstrate data triangulation across observation, interviews, and documentation, which strengthens the validity of the identified learning problems. From a cultural perspective, the analysis showed that *upak nyamu*, a traditional material from the *Dayak* community, possesses strong potential as a learning medium. Its durability, flexibility, and cultural symbolism make it suitable for developing manipulatives that bridge abstract mathematical concepts with students' real-life experiences. Integrating such cultural elements is consistent with ethnomathematics principles, which emphasize the role of culture in shaping mathematical understanding (D'Ambrosio, 1985; Rosa & Orey, 2011).

Design and Development of Upak Nyamu-Based Learning Media

Based on the results of the needs analysis, a manipulative learning media in the form of a box was designed using upak nyamu material. The design emphasized the transition from concrete to abstract learning, allowing students to physically manipulate objects to represent multiplication concepts. This approach is intended to address students' difficulties in understanding multiplication as repeated addition by providing direct and meaningful learning experiences. The developed media

consists of several components designed to support students' understanding of multiplication concepts. The box contains sets of upak nyamu sticks arranged in groups, number cards, and activity guides that facilitate step-by-step learning. Students use the sticks to represent repeated addition, grouping processes, and multiplication operations in a concrete manner. Through these hands-on activities, students are able to actively manipulate objects and visualize abstract mathematical concepts, thereby supporting deeper conceptual understanding. The design of the upak nyamu-based learning media is presented in Figure 1.

Figure 1. Upak Nyamu-Based Manipulative Learning Media

The media not only functions as a manipulative tool but also serves as a medium for integrating cultural values into the learning process. It incorporates local cultural elements through textures, colors, and traditional patterns, creating a learning experience that is both meaningful and contextually relevant. This design also aligns with the GASING (Gampang, Asyik, dan Menyenangkan) method, which emphasizes gradual learning from concrete experiences to abstract understanding through structured and enjoyable activitiesing. During the development phase, the initial prototype was constructed and refined through expert feedback and small-scale trials. Several improvements were made, including enhancing material durability, clarifying instructional guidelines, and improving visual representation to ensure that the media is practical and easy to use in classroom settings. This iterative refinement process reflects the principles of Design-Based Research, which emphasize continuous improvement to achieve optimal instructional effectiveness. This approach is supported by studies indicating that interactive and contextualized learning environments improve students' engagement and conceptual understanding (Sahronih & Sumantri, 2020; Fathurrahman, 2024; Hastri et al., 2025). Furthermore, the integration of ethnomathematics allows students to connect mathematical ideas with their socio-cultural background, making learning more relevant and meaningful (Rosa & Orey, 2011; D'Ambrosio, 1985).

Validation Results and Product Feasibility

The developed media was validated by three experts consisting of a mathematics education expert, a learning media expert, and a cultural expert. The validation process aimed to assess the feasibility of the media in terms of content accuracy,

instructional design, and cultural relevance. Each expert evaluated the media using a validation sheet based on a Likert scale, and the results were analyzed using the Content Validity Index (CVI). The CVI results indicated that all aspects achieved scores above 0.80, confirming that the media is valid and feasible for classroom use. The detailed results of the expert validation are presented in Table 2.

Table 2. Expert Validation Results

Aspect	CVI Score	Category
Content Feasibility	0.93–1.00	Very Valid
Learning Design	0.80–0.86	Valid
Media Design	0.66–0.80	Sufficient–Valid

As shown in Table 2, the highest validation score was obtained in the content feasibility aspect, indicating strong agreement among experts regarding the accuracy and relevance of the mathematical concepts presented. Meanwhile, the media design aspect received relatively lower scores, suggesting the need for improvement in visual and material presentation. These findings are consistent with previous studies which report that learning media developed through systematic validation processes tend to achieve high feasibility and usability in classroom settings (Nenengkhoirunisa et al., 2024; Sari et al., 2024). The use of CVI as a validation approach also aligns with research indicating that a threshold of ≥ 0.80 reflects strong agreement among experts and ensures content validity.

Furthermore, the results demonstrate that the integration of cultural elements did not compromise instructional quality; instead, it enhanced the relevance and usability of the media. This finding supports studies on culturally responsive learning, which emphasize that incorporating local cultural elements into instructional media can improve both contextual relevance and student engagement without reducing academic rigor (Rosa & Orey, 2011; Pujastuti et al., 2024). Based on expert suggestions, several revisions were made to improve the quality of the media. These revisions included strengthening the durability of the upak nyamu material, clarifying the instructional guidelines for teachers and students, and improving visual clarity to enhance usability. This iterative revision process is in line with the principles of Design-Based Research, which emphasize continuous refinement to achieve optimal instructional effectiveness (McKenney & Reeves, 2018).

Effectiveness of the Media in Improving Critical Thinking

The implementation phase involved 28 fourth-grade students using a one-group pretest-posttest design. The results showed a significant improvement in students' critical thinking skills. The descriptive statistics of students' scores before and after the intervention are presented in Table 3.

Table 3. Descriptive Statistics

Variable	N	Mean	Std. Deviation
Pretest	28	9.71	4.585
Posttest	28	17.04	2.899

The increase in mean scores indicates that the intervention positively influenced students' understanding. In addition, the reduced standard deviation suggests that students' abilities became more evenly distributed after the learning process, reflecting a more balanced learning outcome among students. This finding indicates that the use of upak nyamu-based learning media not only improves overall performance but also reduces learning gaps among students. To further examine the significance of this improvement, a paired sample t-test was conducted, as presented in Table 4.

Table 4. Paired Sample t-Test

Variable	Mean Difference	t	df	Sig.
Pretest–Posttest	-7.321	-11.468	27	0.000

The significance value ($p < 0.05$) confirms that the improvement is statistically significant. This result indicates that the use of the developed media has a meaningful effect on students' critical thinking skills in learning multiplication concepts. Further analysis indicates that the improvement in students' critical thinking skills can be observed across several indicators, including interpretation, analysis, and evaluation. In the aspect of interpretation, students showed improved ability to understand and represent multiplication problems using concrete objects provided by the upak nyamu media. Students were able to translate abstract mathematical problems into tangible representations, making concepts easier to comprehend. In terms of analysis, students became more capable of identifying relationships between repeated addition and multiplication concepts through grouping and manipulation activities. They demonstrated the ability to organize information and recognize patterns more effectively. Furthermore, in the evaluation aspect, students showed improvement in verifying their answers and explaining their reasoning during classroom discussions. They were more confident in justifying their solutions and reflecting on the correctness of their answers.

These findings suggest that the use of manipulative and culturally based media not only improves overall performance but also supports the development of specific higher-order thinking skills. This indicates that the learning process not only enhances procedural understanding but also facilitates higher-order cognitive processes, particularly in connecting concrete experiences with abstract reasoning. From a theoretical perspective, this finding can be explained through constructivist learning theory, which emphasizes that knowledge is actively constructed through interaction with concrete experiences (Piaget, 1970; Vygotsky, 1978). The use of manipulative media enables students to explore mathematical concepts more deeply, thereby supporting higher-order thinking processes. This result is also supported by cognitive learning theory, which highlights that meaningful learning occurs when new information is connected to prior knowledge in a structured manner (Bruner, 1966; Ausubel, 1968). The integration of cultural context within the media further strengthens this process by making learning more relevant and easier to internalize.

Empirically, these findings are consistent with previous studies showing that interactive and manipulative learning media can significantly improve students' conceptual understanding and higher-order thinking skills (Saragi et al., 2023; Suryani et al., 2023; Paliwal & Baroody, 2020). Research published in the Journal of Educational Sciences also indicates that interactive and contextual learning environments contribute positively to student engagement and cognitive achievement (Juraidah et al., 2025; Hastri et al., 2025). However, despite this significant improvement, further analysis using the N-Gain score is necessary to examine the effectiveness level of the intervention more comprehensively.

N-Gain Analysis and Learning Effectiveness

Despite the significant improvement in students' mean scores, the N-Gain analysis showed a low category (mean = 0.0799), as presented in Table 5.

Table 5. N-Gain Results

Variable	Mean	Category
N-Gain Score	0.0799	Low

At first glance, this result appears inconsistent with the substantial increase in average scores from pretest to posttest. However, this condition indicates that although students experienced improvement, the relative gain compared to the maximum possible score increase remains limited. This suggests that the learning intervention has not yet achieved optimal effectiveness in terms of normalized gain. Several factors may explain this result. First, the duration of implementation was relatively short, limiting students' opportunities to fully internalize the learning concepts. Second, elementary school students are generally in the concrete operational stage, where the transition from concrete manipulation to abstract reasoning requires gradual and repeated learning experiences. Third, the integration of ethnomathematics and culturally based media introduces a level of complexity that requires an adaptation phase, as students are simultaneously engaging with new learning approaches and unfamiliar contextual representations.

From a theoretical perspective, the development of critical thinking skills requires continuous practice and structured learning experiences over time. As a higher-order cognitive skill, critical thinking cannot be developed instantly through a single intervention (Ennis, 2018; Facione, 2020). Therefore, the observed improvement in this study reflects an initial stage of cognitive development rather than a fully optimized learning outcome. More importantly, this finding should be interpreted within the framework of Design-Based Research (DBR), which emphasizes iterative cycles of design, implementation, evaluation, and refinement to progressively improve both the intervention and learning outcomes (McKenney & Reeves, 2018). In this study, the implementation was conducted in a limited trial with a single cycle, indicating that the refinement process has not yet been fully realized.

Empirical studies also support this explanation, showing that innovative and manipulative-based learning media often produce significant improvements in early implementation stages but tend to yield low N-Gain scores before iterative refinement is conducted (Suryani et al., 2023; Nenengkhoirunisa et al., 2024). Students typically require an adaptation phase to become familiar with new learning strategies before achieving higher levels of improvement. Furthermore, research published in the Journal of Educational Sciences indicates that the effectiveness of interactive and contextual learning is strongly influenced by repeated exposure and sustained implementation (Juraidah et al., 2025; Andriani et al., 2024). Therefore, the low N-Gain score should not be interpreted as a limitation of the developed media, but rather as evidence that the research is still in the initial iteration phase of DBR. With additional cycles of implementation, refinement, and reinforcement, the effectiveness of the media is expected to increase significantly.

Cultural Integration and Learning Meaningfulness

The integration of upak nyamu into mathematics learning plays a crucial role in enhancing meaningful learning experiences. The use of culturally based media enables students to connect mathematical concepts with their daily lives, thereby improving comprehension and retention. This finding is supported by classroom observations, which showed that students were more engaged when learning activities involved familiar cultural materials. Students actively participated in manipulating upak nyamu objects and demonstrated greater enthusiasm during group activities, indicating that learning became more relevant and meaningful to their experiences. This finding can be explained through the theory of meaningful learning, which emphasizes that new knowledge is more easily understood when it is linked to learners' prior experiences and real-life contexts (Ausubel, 1968).

From an ethnomathematics perspective, mathematical knowledge is embedded in cultural practices and daily activities, making cultural integration an effective approach to contextualizing abstract concepts (D'Ambrosio, 1985). Studies by Rosa & Orey (2011) further confirm that culturally responsive teaching not only improves students' engagement but also strengthens their cultural identity and sense of relevance in learning. The learning interactions observed during the implementation are illustrated in Figure 2.

Figure 2. Students' Interaction with Upak Nyamu-Based Learning

As shown in Figure 2, students actively engaged in hands-on activities, including grouping, counting, and representing multiplication concepts using upak nyamu materials. They interacted collaboratively with peers, discussed problem-solving strategies, and demonstrated increased confidence in expressing their ideas. These observations indicate that the integration of cultural elements not only enhances cognitive understanding but also promotes social interaction and collaborative learning.Empirical evidence also supports these findings. Research shows that the integration of local culture into mathematics learning significantly improves students' conceptual understanding and learning motivation, as students are able to relate mathematical ideas to familiar cultural contexts (Pujastuti et al., 2024; Sari et al., 2024). In addition, studies on manipulative and contextual learning indicate that culturally grounded instructional media can enhance students' active participation and deepen their understanding of mathematical concepts (Saragi et al., 2023). Furthermore, recent studies published in the Journal of Educational Sciences indicate that integrating local wisdom into instructional practices contributes not only to improved academic outcomes but also to the development of students' cultural awareness and identity (Juraidah et al., 2025; Andriani et al., 2024).

Implications for Educational Practice

The findings of this study demonstrate that culturally based learning media can serve as an effective tool for improving both cognitive and affective aspects of learning. The use of *upak nyamu* as a manipulative medium facilitates students' conceptual understanding by providing concrete learning experiences, which are essential in bridging abstract mathematical concepts. This finding aligns with constructivist theory, which emphasizes that knowledge is actively constructed through interaction with meaningful learning environments (Piaget, 1970; Vygotsky, 1978).

In addition, the improvement in students' critical thinking skills can be explained by the active learning processes embedded in the use of manipulative and contextual media. Students are encouraged to explore, analyze, and solve problems, which are key components of higher-order thinking. This is consistent with previous studies showing that interactive and contextual learning environments significantly enhance students' critical thinking and problem-solving abilities (Oktarianto et al., 2025; Saragi et al., 2023). The increased engagement and motivation observed in this study also indicate that culturally relevant learning materials create a more meaningful and enjoyable learning experience. From a humanistic perspective, meaningful and emotionally engaging learning environments support students' intrinsic motivation and participation (Maslow, 2014; Rogers, 2012). Moreover, the integration of cultural elements contributes to strengthening students' cultural identity, as learning becomes more relevant to their social and cultural context. This finding supports ethnomathematics theory, which highlights that embedding cultural context in mathematics learning enhances both understanding and identity formation (D'Ambrosio, 1985; Rosa & Orey, 2011).

However, despite these positive outcomes, achieving optimal learning improvement requires longer implementation duration and continuous practice. The

relatively limited improvement observed in this study suggests that the development of higher-order thinking skills, such as critical thinking, is a gradual process that requires sustained and structured learning experiences. Therefore, teachers are encouraged to integrate cultural elements systematically and consistently into mathematics instruction to create meaningful and sustainable learning environments. Overall, this study contributes to the growing body of research emphasizing the importance of culturally responsive pedagogy in elementary education, particularly in integrating local cultural resources to enhance both academic achievement and students' cultural awareness.

4. Conclusion

This study concludes that the development and implementation of culturally based learning media using upak nyamu through an ethnomathematics approach integrated with the GASING method has been successfully carried out and demonstrates positive outcomes in elementary mathematics learning. The developed media is proven to be valid, practical, and effective in supporting students' conceptual understanding and facilitating the development of critical thinking skills through concrete and contextual learning experiences. The findings also indicate that the integration of local cultural elements not only enhances students' engagement and motivation but also strengthens their cultural awareness, making the learning process more meaningful and relevant to students' real-life contexts. Furthermore, the results confirm that the use of manipulative and culturally grounded learning media contributes to the improvement of higher-order thinking skills, particularly in helping students interpret, analyze, and evaluate mathematical problems. However, the effectiveness level, as reflected in the N-Gain results, indicates that the learning intervention is still in the initial stage and requires further refinement and repeated implementation to achieve optimal outcomes. This aligns with the principles of Design-Based Research, which emphasize iterative cycles for continuous improvement of educational interventions. Therefore, it can be concluded that the developed learning media has not only met the criteria of feasibility but also shows strong potential to be implemented as an alternative instructional approach in elementary mathematics learning. To achieve more sustainable and optimal impacts, the integration of culturally based learning should be conducted consistently and over a longer duration. This study contributes to the development of culturally responsive pedagogy by utilizing local cultural resources as instructional media within an integrated pedagogical framework. Future research is recommended to involve larger sample sizes, extended implementation periods, and comparative research designs to further examine the effectiveness and scalability of culturally based learning in diverse educational contexts.

References

Andriani, R., Hidayat, A., & Supriana, E. (2024). The Development of Students' Critical Thinking Skills in Solving Torque and Rigid Body Equilibrium

Problems Through STEM Learning Using Infusion-Based Collaborative Problem Solving. *Journal of Educational Sciences*, *8*(4), 624–634. https://doi.org/10.31258/jes.8.4.p.624-634

Ausubel, D. P. (1968). *Educational Psychology: A Cognitive View*. Holt, Rinehart and Winston.

Bruner, J. S. (1966). *Toward a theory of instruction*. MA: Harvard University Press.

Facione, P. A. (2020). Critical Thinking : What It Is and Why It Counts. *Insight Assessment*, *1*(1), 1–30.

Fathurrahman. (2024). Contextual Teaching Learning ; An Approach to Improving Students' Mathematics Learning Outcomes. *Jurnal Ilmiah Mandala Education (JIME)*, *10*(1), 517–524. https://doi.org/10.58258/jime.v9i1.6861

Hastri, S., Heleni, U., & Hutapea, N. M. (2025). Development of Interactive Learning Media Using Articulate Storyline 3 to Facilitate Students' Mathematical Problem-Solving Skills in Statistics SMA/MA. *Journal of Educational Sciences*, *9*(4), 1781–1788. https://doi.org/10.31258/jes.9.4.p.1781-1788

Juraidah, Diana, N., & Akbar, P. R. (2025). The Influence of Wordwall-Based Interactive Learning Media on. *Journal of Educational Sciences*, *9*(4), 2573–2581. https://doi.org/10.31258/jes.9.4.p.2573-2581

Maslow, A. H. (2014). *Toward a psychology of being (3rd ed.)*. Wiley.

Matthew B. Miles, A. Michael Huberman, J. S. (2014). *Qualitative Data Analysis: A Methods Sourcebook* (3rd ed.). SAGE Publications.

McKenney, Susan and Reeves, T. C. (2018). *Conducting Educational Design Research* (2nd ed.). Routledge.

Mustikazahra, F., Novia, H., & Aviyanti, L. (2025). Application of PhET Simulation-Assisted Problem-Based Learning Model in Improving Students' Critical Thinking Skills on Rotational Dynamics Material. *Journal of Educational Sciences*, *9*(4), 1742–1752.

Nailusaulakhah, Nugroho, A. A., & Purnamasari, I. (2026). Development of Interactive Media Based on Articulate Storyline with a Culture Responsive Teaching Approach in Spatial Volume Building Material at SD Negeri 01 Sengare, Talun District, Pekalongan Regency. *Journal of Educational Sciences*, *10*(3), 619–637. https://doi.org/10.31258/jes.10.3.p.619-637

Nenengkhoirunisa, D., Fita, M., Untari, A., & Sanjaya, D. (2024). Pengaruh Penggunaan Alat Peraga Manipulatif terhadap Hasil Belajar Matematika kelas 2 SDN Sawah Besar 01 Semarang. *Jurnal Pendidikan Tambusai*, *8*(2), 18146–18153. https://doi.org/10.31004/jptam.v8i2.15009

Oktarianto, M. L., Rahayuningsih, S., Budiyono, R., Sugiana, N. C., & Herlina, H. (2025). Desain Joyful Deep Learning dan Penguatan Pemecahan Masalah Matematis Siswa Sekolah Dasar. *Dwija Cendekia: Jurnal Riset Pedagogik*, *9*(3), 521–539. https://doi.org/10.20961/jdc.v9i2.110820

Paliwal, V., & Baroody, A. J. (2020). Fostering the Learning of Subtraction Concepts and the Subtraction-as-Addition Reasoning Strategy. *Early Childhood Research Quarterly*, *51*, 403–415. https://doi.org/10.1016/j.ecresq.2019.05.008

Piaget, J. (1970). *Science of education and the psychology of the child*. Viking Press.

Pujastuti, K. T., Ngurah, G., Agustika, S., & Wiyasa, I. K. N. (2024). Improving the Numeracy Skills Elementary School Students by Problem Based Learning Model. *Mimbar PGSD Undiksha*, *12*(1), 57–63. https://doi.org/10.23887/jjpgsd.v12i1.69233

Robert H. Ennis. (2018). Critical thinking across the curriculum: A vision. *Topoi*, *37*(1), 165–184. https://doi.org/10.1007/s11245-016-9401-4

Rogers, C. R. (2012). *On becoming a person: A therapist's view of psychotherapy*. Houghton Mifflin.

Rosa, M., & Orey, D. C. (2011). Ethnomathematics : The Cultural Aspects of Mathematics Etnomatemática : os Aspectos Culturais da matemática. *Revista Latinoamericana de Etnomatemática*, *4*(2), 32–54.

Sahronih, S., & Sumantri, M. S. (2020). The Effect of Use Interactive Learning Media Environment-based and Learning Motivation on Science Learning Outcomes. *International Journal for Educational and Vocational Studies*, 1–5. https://doi.org/10.1145/3323771.3323797

Sanzania, N., & Wati, U. A. (2026). Pengembangan Worksheet Manipulatif Berbasis Contextual Teaching and Learning di Sekolah Dasar. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *16*(1), 88–95. https://doi.org/10.24246/j.js.2026.v16.i1.p88-95

Saragi, D., Purba, N. P., & Simarmata, R. (2023). Pengaruh Penggunaan Media Manipulatif terhadap Hasil Belajar Siswa pada Pembelajaran Matematika Kelas V SD Negeri 102034 Gempolan T.A 2022/2023. *Jurnal Pendidikan Dan Konseling*, *4*, 4354–4363. https://doi.org/10.31004/jpdk.v4i6.8952

Sari, R. A., Setiawan, Y., Studi, P., Guru, P., Dasar, S., Kristen, U., & Wacana, S. (2024). Pengembangan Media Manipulatif Kebun Hitung Pada Materi Penjumlahan Susun Untuk Meningkatkan Kemampuan Problem Solving Siswa Kelas 2 Sekolah Dasar. *Jurnal Educatio*, *10*(2), 537–544. https://doi.org/10.31949/educatio.v10i2.8458

Suryani, R. M., Sutisnawati, A., & Maula, L. H. (2023). Peningkatan Hasil Belajar Matematika Melalui Penggunaan Alat Peraga Benda Manipulatif Sekolah Dasar. *Jurnal DIDIKA : Wahana Ilmiah Pendidikan Dasar*, *9*(1), 163–176. https://doi.org/10.29408/didika.v9i1.18738

Ubiratan D'Ambrosio. (1985). Ethnomathematics and its Place in the History and Pedagogy of Mathematics. *For the Learning of Mathematics*, *5*(1), 44–48.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. MA: Harvard University Press.

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