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Integrating Ethnomathematics in Geometry Learning to Enhance Primary Students' Numeracy Skills: A Systematic Literature Review

Putri Sarah Zainovi *
Department of Master's Basic Education, State University of Surabaya, Surabaya, Indonesia

Neni Mariana
Department of Master's Basic Education, State University of Surabaya, Surabaya, Indonesia

Nurul Istiq'faroh
Department of Master's Basic Education, State University of Surabaya, Surabaya, Indonesia

Wiryanto
Department of Master's Basic Education, State University of Surabaya, Surabaya, Indonesia

Hitta Alfi Muhimmah
Department of Master's Basic Education, State University of Surabaya, Surabaya, Indonesia

***Corresponding Author:** putri.23052@mhs.unesa.ac.id

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Abstract
This study presents a systematic literature review aiming to explore the integration of ethnomathematics in the teaching of plane geometry as a means to enhance numeracy skills among primary school students. Ethnomathematics, which connects mathematical concepts with local cultural practices, offers a contextual and meaningful learning experience that aligns with students' everyday lives. The review was conducted by analyzing ten peer-reviewed studies published between 2021 and 2024, sourced from credible academic databases such as Google Scholar, DOAJ, ERIC, and Garuda. The inclusion criteria focused on empirical studies involving primary students, with interventions integrating ethnomathematics in geometry learning, while non-empirical papers and studies focusing on secondary or tertiary education were excluded. The findings indicate that embedding cultural elements into geometry instruction—such as traditional motifs, crafts, and architecture—not only improves students' conceptual understanding but also promotes critical thinking, collaboration, and motivation to learn. Instructional tools developed using ethnomathematical approaches, including modules, multimedia, animated videos, and augmented reality, were reported to be valid, practical, and effective in classroom implementation. Moreover, this culturally responsive pedagogy supports the development of a more inclusive and identity-affirming mathematics education. However, the review is limited by the relatively small number of studies and the dominance of quasi-experimental designs, which may affect the generalizability of the findings. The review highlights the pedagogical value of ethnomathematics and recommends its wider adoption in mathematics curricula, teacher training, and educational policy. Future research should focus on experimental designs and cross-cultural implementations to further validate the long-term impact of ethnomathematics on student learning outcomes.

INTRODUCTION

Numeracy skills are a very important basic competency in mathematics learning from the elementary school level. Numeracy is not only related to numeracy skills, but also includes logical thinking skills, understanding quantitative information, and solving problems in real life (Laksana, 2024). In the context of 21st century education, these abilities are an integral part of the basic literacy that every individual must possess (Campilla & Castañaga, 2021). Effective numeracy learning will equip students with a solid foundation to learn mathematics at a higher level. Unfortunately, the mathematics learning process in elementary school still tends to focus on memorizing mechanistic formulas and procedures. This causes students to have difficulty in relating mathematical concepts to

real-life situations. Therefore, it is necessary to design a learning approach that is contextual and relevant to students' daily experiences. One approach that can meet these needs is an approach based on local culture, such as ethnomathematics.

The results of international surveys such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) show that the numeracy ability of Indonesian students is still low. The 2018 PISA report noted that Indonesia ranks lower in terms of mathematics literacy, which reflects the weak understanding of basic mathematical concepts among students (O.E.C.D., 2019). In the 2019 TIMSS study, Indonesian students also showed unsatisfactory results in context-based mathematical problem solving. This low achievement shows that mathematics learning in Indonesia is not fully effective in building students' critical thinking and numeracy skills. One of the main causes is a learning approach that is not fully contextual and irrelevant to students' daily lives (Alvira et al., 2022). This phenomenon is also reported in other developing countries, where formal mathematics is often taught abstractly without meaningful connection to students' cultural backgrounds, indicating a global relevance of the problem. Geometry topics, especially flat building materials, are often presented in the abstract without being associated with the cultural or environmental realities of the student. Therefore, there is a need for an alternative approach that is able to bridge the gap between formal concepts of mathematics and students' real experiences. The ethnomathematical approach is believed to be one of the potential solutions to overcome this problem.

Ethnomathematics is an approach that brings together formal mathematics and local cultural knowledge in the learning process. This approach according to Sultan (2023) is a way to understand how certain cultural groups use and develop mathematical concepts in their lives. By linking mathematics to cultural contexts, ethnomathematics provides opportunities for students to understand mathematical concepts through familiar experiences. This helps students build the meaning of concepts more deeply and increases their motivation to learn. In the context of Indonesia, which is rich in cultural diversity, ethnomathematics has great potential to be applied in various regions by adapting local cultural elements. For example, batik motifs, wood carvings, traditional games, and local architecture can be used as a medium to explain geometric concepts, including flat builds (Susiliastini & Sujana, 2022). Thus, learning mathematics becomes more lively, relevant, and fun for students. Ethnomathematics can also strengthen students' cultural identities while developing their cognitive abilities.

In flat building materials, concepts such as squares, triangles, and circles can be found in various forms of local art and culture. The application of ethnomathematics in this topic allows students to identify geometric shapes in their surroundings, such as in weaving motifs, batik, or traditional house ornaments (Astriandini et al., 2021). For example, the traditional lantern of Damar Kurung from Gresik contains geometric patterns that can be used as teaching materials in understanding the nature and types of flat buildings. By making cultural objects a learning medium, students not only learn about the shape, size, and nature of flat buildings, but also learn to appreciate and understand their own cultural heritage (Solihin & Rahmawati, 2024). This creates a strong emotional and cognitive connection between the student and the material being studied. In addition, students are also trained to think critically and creatively through the analysis of the forms they encounter in the local culture. This kind of learning is much more meaningful than conventional methods that are abstract and separate from the context of students' lives. Therefore, the application of ethnomathematics in flat building learning has great potential in improving the quality of mathematics learning in elementary schools.

Research by Solihin & Habibie (2024) shows that ethnomathematical approaches can increase student involvement in the learning process as well as significantly increase understanding of mathematical concepts. In addition, this approach has been proven to be effective in improving students' numeracy skills through learning activities that are contextual and rooted in their culture (Laksana, 2024). The use of local media and cultural contexts in flat learning not only makes it easier

to understand concepts, but also stimulates students' logical and analytical thinking skills. Through cultural integration, students are encouraged to develop applicative and meaningful problem-solving skills. Ethnomathematics-based learning also supports the development of social and communication skills as it often involves collaborative activities and group discussions. This is especially important in the development of 21st-century competencies, which emphasize the importance of critical thinking, communication, collaboration, and creativity (Rahaju et al., 2021). Teachers who apply this approach also report increased student learning motivation and a more dynamic classroom atmosphere. Thus, ethnomathematics can be a strategic alternative in improving the numeracy achievement of elementary school students.

Based on these considerations, this study aims to answer the following research questions: (1) How has ethnomathematics been applied in the learning of plane geometry in primary education? (2) What learning models and strategies have been found effective in integrating ethnomathematics to improve numeracy skills? (3) What are the common challenges and opportunities in implementing ethnomathematics in classroom settings?. Through this literature study, it is hoped that various models, strategies, and best practices can be compiled in the application of ethnomathematics, especially in flat building learning. A review of the relevant literature allows the identification of potentials, challenges, and opportunities for the development of this approach in the context of Indonesian education (Khairunnisa et al., 2022). In addition, the results of this study can also be the basis for teachers and curriculum developers in designing learning that is more contextual, creative, and responsive to student needs. In the midst of the demands of Merdeka Belajar, learning that is relevant to the local context is very important to foster students' independence and reasoning power (Rambung et al., 2023). Therefore, the ethnomathematics approach has strategic value in realizing meaningful learning that is in line with the vision of national education. This study also contributes to the development of culture-based mathematics learning theories and character strengthening through education based on local wisdom. By integrating culture in mathematics, students are not only academically competent but also have an awareness of their cultural identity and values. The novelty of this study lies in its systematic synthesis of recent empirical studies, highlighting practical applications and policy implications of ethnomathematics in primary geometry learning. Therefore, it is important for education stakeholders to support the application of ethnomathematics as part of learning innovation in elementary schools.

METHODS

This study uses a literature review approach with a qualitative descriptive method. The main objective of this study is to identify, classify, and analyze the findings of previous research related to the application of ethnomathematics in flat learning and its effect on improving the numeracy skills of elementary school students. This approach was chosen because it is able to provide a comprehensive picture of research trends, application models, and gaps that still exist in the field (Snyder, 2019). The focus of the study lies on the incorporation of local cultural values in contextual and meaningful mathematics learning. This study does not aim to test hypotheses, but rather places more emphasis on narrative synthesis and exploration of conceptual ideas and learning practices that have been previously reported. Thus, the results of the study are expected to contribute to the development of culture-based learning theories and innovative learning practices at the elementary school level.

The literature analyzed in this study was selected through a systematic selection process and based on inclusion criteria. The sources used are scientific publications published in the last three years (2021–2024), with the main topics directly related to ethnomathematics, numeracy, flat building, and mathematics learning at the elementary school level. These sources come from national and international accredited journals, scientific proceedings, and repositories of trusted academic institutions. The inclusion criteria are (1) empirical studies using qualitative, quantitative, or mixed-method approaches; (2) focus on elementary or primary school levels (grades 1-6); (3) interventions or discussions directly involving ethnomathematical approaches in geometry learning; (4) articles

written in English or Indonesian; and (5) publications from peer-reviewed journals or reputable conference proceedings. The exclusion criteria include (1) conceptual or opinion papers without empirical data; (2) studies focusing on secondary or tertiary education; (3) unrelated topics such as purely theoretical mathematics or non-mathematics cultural studies; and (4) duplicate publications. The validity of the literature is reviewed through abstract reading, methodological analysis, and conceptual contribution to the study topic. The search process was carried out with the help of scientific databases such as Google Scholar, DOAJ, Garuda, and ERIC using keywords: "ethnomathematics in elementary school", "ethnomathematics in primary school", "numeracy and flat building", and "cultural-based geometry learning". In addition, the snowballing technique is also used by browsing the bibliography of the main articles to obtain additional relevant literature.

The stages of data analysis are carried out through content analysis techniques, namely by reviewing each literature based on the research theme, objectives, methods, results, and learning implications. Each article was analyzed to identify the relationship between local cultural elements and mathematical concepts, particularly flat geometry, as well as the extent of its contribution to improving students' numeracy. Findings from various sources are then arranged narratively to build a comprehensive synthesis that describes general patterns, approaches used, and the effectiveness of the application of ethnomathematics in the context of elementary learning. The results of this process are expected to contribute to the development of contextual and culture-based mathematics learning strategies, as well as become a practical reference for teachers and curriculum developers in designing more meaningful learning and significantly improving students' numeracy skills.

RESULTS AND DISCUSSION

Research Results

Based on the results of the literature review conducted, ten relevant studies were found that discussed the application of the ethnomathematical approach in mathematics learning, especially in flat building materials at the elementary school level. These studies show that the ethnomathematical approach has been applied in various forms of learning media such as modules, animated videos, multimedia, student worksheets (LKPD), to augmented reality-based media. In addition, this approach has also been proven to be able to improve various aspects of student competence, ranging from understanding geometry concepts, critical thinking, collaborative, metacognitive, to comprehensive numeracy literacy. Findings from previous research show that the integration of local cultures in mathematics learning contributes greatly to increased student engagement and understanding. The ethnomathematical approach not only strengthens the connection between mathematical concepts and cultural contexts that are close to students, but also encourages the birth of learning media innovations that are contextual, creative, and pedagogically valid. Thus, this approach is believed to have great potential to be adopted more widely in the primary school curriculum to support the meaningful and sustainable improvement of students' numeracy skills.

Table 1 summarizes the ten studies analyzed in this study, including information about the researcher and the year, the title of the study, the methods used, the variables measured, as well as the main findings of each study. All of these studies are focused on the implementation of ethnomathematical approaches in flat learning at the elementary school level, both in the form of media development and the implementation of learning strategies.

The ten studies summarized in Table 1 demonstrate promising outcomes regarding the application of ethnomathematics in enhancing students' numeracy skills. However, a critical analysis reveals several strengths and limitations that must be acknowledged to provide a balanced interpretation of these findings. In terms of study quality, most of the research utilizes recognized educational research methods, such as Research and Development (R&D) models like ADDIE and 4D, qualitative descriptive methods, and quantitative experimental designs. The frequent use of ADDIE and 4D models (Studies 2, 5, 7, 8, 10) is a strength as these methods ensure systematic product development and validation processes. Furthermore, the inclusion of true experimental research

(Study 6) adds credibility through causal inference regarding the effectiveness of the ethnomathematics approach on numeracy literacy. The presence of a Systematic Literature Review (Study 9) strengthens the theoretical grounding and synthesis of broader trends. Nevertheless, some limitations are apparent. First, the majority of studies (7 out of 10) focus on media development rather than large-scale classroom implementation, making generalization across diverse student populations limited. Second, only one study (Study 6) employs a true experimental design with rigorous control of variables, while others primarily use R&D or descriptive approaches, which tend to lack control groups and statistical rigor in measuring effectiveness. Third, the sample sizes across the studies are not consistently reported, and in studies where sample sizes are disclosed, they tend to be small-scale, classroom-based trials, reducing external validity.

Table 1. Summary of Research Results Related to the Use of Ethnomathematics in Flat Building Learning in Elementary Schools

No.	Researcher(s) & Year	Research Method	Measured Variables	Research Findings
1	(Mailani et al., 2024)	Descriptive qualitative	Understanding of plane figure concepts	Ethnomathematics helps overcome difficulties in understanding plane figures by relating the material to local culture.
2	(Febriyanti & Ain, 2021)	Research and Development (ADDIE)	Module validity and practicality	The module is highly valid and practical for classroom use.
3	(Yuniari, 2025)	Quantitative	Critical thinking and metacognitive skills	Ethnomathematics-based animation effectively enhances students' critical thinking and metacognitive abilities.
4	(Aditya & Fiantika, 2024)	Qualitative	Students' collaborative skills	The ethnomathematics approach enhances students' collaborative skills in learning plane figures.
5	(Setyoningrum & Pangestika, 2022)	Research and Development (ADDIE)	Multimedia feasibility, conceptual understanding	The multimedia is highly valid, practical, and effective in improving students' understanding of plane figure concepts.
6	(Husna et al., 2024)	True experimental	Numeracy literacy skills	Ethnomathematics-based learning significantly improves students' numeracy literacy.
7	(Wiryanto & Dewi, 2022)	Research and Development (ADDIE)	Media feasibility, learning motivation, conceptual understanding	ARLOGY media is feasible to use, increases students' motivation, and supports understanding of plane and solid figures.
8	(Nopianda, 2023)	Research and Development (ADDIE)	Worksheet validity, critical thinking skills	The worksheets are highly valid, practical, and effectively improve students' critical thinking skills.
9	(Ramadhani et al., 2024)	Systematic Literature Review	Understanding of mathematical concepts	Ethnomathematics-based learning media effectively improves students' mathematical understanding through contextual approaches.
10	(Nelawati et al., 2018)	Research and Development (4D)	Teaching material feasibility	The Komering ethnomathematics-based materials are highly feasible and engaging for teaching plane figures in primary school.

From a methodological perspective, there is also a notable absence of longitudinal research. None of the reviewed studies investigate the long-term impact of ethnomathematics integration on students' learning outcomes, raising questions about sustainability. Additionally, most studies (especially Studies 1, 4, 9) use qualitative methods, which provide in-depth insights but are susceptible to subjective interpretation bias and lack statistical generalizability. In terms of

geographical coverage, all studies are conducted within the Indonesian context, predominantly focusing on specific local cultures (e.g., Komering, batik, Damar Kurung). This offers cultural depth but limits cross-cultural applicability. There is minimal comparison with international practices of ethnomathematics, reducing the potential to generalize findings beyond the Indonesian educational system. Lastly, although the studies report positive outcomes, there is a lack of critical examination of possible challenges, such as teacher readiness, curricular alignment, and assessment standardization when implementing ethnomathematical approaches in real classrooms. In summary, while the reviewed studies collectively indicate the effectiveness of ethnomathematics in primary geometry learning, the dominance of media development research, limited experimental rigor, small-scale samples, absence of longitudinal data, and contextual limitations should be carefully considered. Future studies are recommended to employ more robust experimental designs, larger and more diverse samples, and explore long-term impacts and implementation challenges to strengthen the evidence base for the adoption of ethnomathematics in elementary education.

Discussion

The ethnomathematical approach in mathematics learning has been shown to be effective in overcoming students' difficulties in understanding geometry concepts, especially flat buildings. This can be seen from the research of Mailani et al. (2024) which shows that the relationship between flat building materials and local culture is able to clarify previously abstract concepts. When students learn through symbols and cultural forms that they are familiar with, understanding becomes more concrete and contextual. Culture-based learning also strengthens the connection between math and students' real lives. In the context of elementary school, cultural experience-based understanding has great potential in improving mathematical literacy. Ethnomathematics as a learning approach is able to overcome the gap between formal concepts and student experience. This approach also contributes to minimizing the gap in understanding between students from different social backgrounds. In line with the view of Muzakkir (2021), mathematics should be taught in a cultural context to make it more meaningful. Therefore, teachers need to explore the richness of local culture as a teaching resource in learning to build flat. This strategy is relevant to be applied in the context of Indonesia, which is rich in cultural diversity.

The use of ethnomathematics-based learning media also shows high effectiveness in increasing student motivation and understanding. Research by Febriyanti & Ain (2021) proves that modules and multimedia developed through the ADDIE model are very valid and practical to be used in learning. The validity of this instrument indicates that the materials packaged are not only in accordance with the curriculum, but also relevant to the student's cultural experience. Interactive multimedia allows students to visually and dynamically observe and explore flat building shapes. In addition, students become more enthusiastic and actively involved in learning because the material presented feels closer to their lives. As stated by Andriliani et al. (2022), ethnomathematical approaches can effectively integrate cultural aspects with educational technology. This media also supports differentiated learning because it can be adjusted to the characteristics and learning styles of students. This kind of culture-based innovation plays an important role in creating more meaningful and inclusive learning. Therefore, teachers are advised to utilize technology in the development of ethnomathematics-based teaching materials. This step not only improves the quality of learning, but also enriches the student learning experience.

The ethnomathematical approach has also been shown to be able to improve higher-level thinking skills, such as critical and metacognitive thinking. Yuniari (2025) in his research uses culture-based animation videos as a medium to teach flat building. The results showed a significant improvement in students' critical thinking and metacognitive abilities after participating in the learning. This ability is especially important in the context of 21st century education, where students are required to be able to analyze, evaluate, and reflect on their learning process. Learning that is based on cultural context helps students form a deeper and more meaningful understanding. In addition,

ethnomathematics also encourages students to be more active in asking questions and solving problems creatively (Rizky & Nasution, 2024). By using mathematical symbols and structures derived from their own culture, students feel more confident in arguing and conveying ideas. This approach strengthens the connection between students and learning materials emotionally and cognitively. Therefore, the application of local culture-based media such as animation needs to be encouraged in mathematics learning. This integration allows students not only to master the material, but also to develop more complex thinking skills.

Research by Hartanti & Ramlah (2021) shows that ethnomathematics also has a positive influence on the development of students' social skills. Aditya & Fiantika (2024) revealed that the use of Madura batik motifs in learning to build flat improves students' collaborative skills. Collaboration occurs when students work together in identifying the shapes, patterns, and symmetry of the batik motif. This activity stimulates discussion, exchange of ideas, and group problem-solving. Collaborative activities like this are very important in fostering mutual respect and cooperation among students. In addition, learning becomes more lively because students are active in the process of exploration and meaning. When students are socially involved in learning, motivation and a sense of responsibility for the learning process also increase (Solihin et al., 2025). This is in line with the social constructivist approach that emphasizes the importance of social interaction in building understanding. Therefore, the use of ethnomathematics not only has an impact on cognitive aspects, but also affective and social aspects. This approach is very suitable to be applied in project-based learning or group work.

The application of ethnomathematics has also been proven to be significant in improving students' numeracy literacy. Lesmana et al. (2024) through experimental research showed that students who received ethnomathematics-based learning had higher numeracy scores than the control group. This learning is designed by associating the concept of mathematics, especially building flat, with the context of the local culture of Aceh. This allows students to understand numerical concepts in a more real and familiar context. Numeracy literacy includes the ability to understand, interpret, and use mathematics in daily life (Fadhilah, 2024). By using culture as a context, students not only learn to count, but also understand the meaning of numbers and shapes in real-life situations. Culture-based learning also creates a strong emotional engagement between students and the material being studied. These results show that the ethnomathematics approach has great potential to answer the challenge of low numeracy literacy in Indonesia. Therefore, this learning strategy needs to be applied and researched more in various regions. Moreover, strengthening numeracy since basic education is very important as a foundation for further learning.

In terms of learning media innovation, research by Wiryanto & Dewi (2022) shows that the development of ethnomathematics-based ARLOGY media is feasible and effective in learning to build flat and space. This media utilizes augmented reality technology to display geometric objects in a three-dimensional form that is integrated with local cultural elements. The use of technology like this allows students to explore geometric concepts in an interactive and fun way. In addition, students become more motivated because learning feels more engaging and different from conventional methods. High motivation to learn contributes to the increase in deeper understanding of concepts (Riki & Kusno, 2023). ARLOGY also encourages students to learn independently and reflectively through visual exploration and hands-on experience. This merger of technology and culture is a form of pedagogical innovation that answers the challenges of learning in the digital era. This kind of media can also reach a variety of student learning styles, especially visual and kinesthetic. Therefore, the use of culture-based technology in mathematics learning needs to be expanded and further developed. This approach promises relevant, engaging, and effective learning.

Meanwhile, research by Ramadhani et al. (2024) shows the consistency of the effectiveness of ethnomathematics-based learning media in improving students' understanding of mathematical concepts. This study strengthens the findings of various previous studies by presenting evidence that contextual media that utilize local culture are able to bridge students' understanding of abstract mathematical concepts. This approach is very much in line with the characteristics of elementary

school students who are still thinking concretely. By providing a meaningful learning experience, students more easily absorb and apply the concepts learned. In addition, culture-based media also encourages active involvement of students in the learning process. This study confirms the importance of the role of culture in effective learning design. In line with the opinion of Solihin et al. (2024), mathematics should be understood as a cultural construct, not merely an abstract science. Therefore, teachers need to be facilitators in connecting formal mathematics with the cultural realities of students. The results of this study support the importance of collaboration between educators, researchers, and curriculum developers in designing ethnomathematics-based learning.

Finally, the development of teaching materials such as LKPD and ethnomathematics-based modules showed very positive results in flat wake learning. Research by Nopianda (2023) proves that teaching materials developed based on the peculiarities of local culture are not only valid in terms of content, but also interesting and effective in improving students' critical thinking skills. The LKPD and this module are designed by inserting cultural values, symbols, and the context of local people's lives into math tasks. Students are invited to observe, analyze, and solve problems related to their daily lives. This strategy makes learning more relevant and grounded. When students feel that mathematics has benefits in their lives, motivation and learning outcomes increase (Adawiyah & Kowiyah, 2021). This kind of learning supports a student-centered learning approach that puts students' experiences and backgrounds as the starting point for learning. Therefore, the development of teaching materials based on local culture needs to continue to be encouraged in the context of the Merdeka Learning curriculum. This approach is able to create an authentic learning experience and empower students as active learners.

CONCLUSION

Based on the results of the literature study that has been conducted, it can be concluded that the ethnomathematical approach in flat learning in elementary school has a significant contribution to improving students' numeracy skills. Through the integration of local culture into math materials, it is easier for students to understand geometric concepts that were previously abstract to become more concrete and meaningful. This approach has also been proven to be able to improve students' critical thinking, collaborative, and learning motivation. Various media and teaching materials developed culturally based such as modules, animated videos, multimedia, and augmented reality, have shown their validity and effectiveness in supporting the learning process. In addition, ethnomathematics is a means to strengthen students' cultural identities and build an emotional connection with the material studied. As such, this approach is relevant and appropriate to the characteristics of learning in primary schools that emphasize contextualization, active participation, and enjoyable learning experiences.

Based on these findings, it is recommended that teachers in elementary schools be more active in integrating elements of local culture in mathematics learning, especially flat building materials. The government and curriculum developers also need to encourage the use of ethnomathematical approaches as part of the implementation of a curriculum that is contextual and based on local wisdom. Training and professional development for teachers in designing ethnomathematics teaching media and materials are needed to ensure that their application takes place optimally. In addition, follow-up research with experimental approaches and case studies in different regions can provide a broader picture of the effectiveness of this approach in various cultural contexts. By prioritizing ethnomathematics, mathematics education is not only an academic tool, but also a medium for cultural preservation and the formation of the character of students who think critically, creatively, and respect local heritage.

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