Prima Magistra: Jurnal Ilmiah Kependidikan
Volume 7 – Number 4, October 2026, pp 828-840
https://doi.org/10.37478/jpm.v7i4.8571
Open Access: https://e-journal.uniflor.ac.id/index.php/JPM/article/view/8571

ISSN 2721-8112 (print)
ISSN 2722-4899 (online)

DEVELOPMENT OF AN INTERACTIVE ETHNOMATHEMATICS-BASED E-LKPD ON MAGETAN LOCAL ARCHITECTURE TO IMPROVE UNDERSTANDING OF SOLID GEOMETRY CONCEPTS

Vera Dewi Susanti[1*], Dirasti Novianti[2], Rika Wulandari[3], Syafina Putri Nurjanah[4]
[1,4]Universitas PGRI Madiun, Madiun, Indonesia
[2]UIN K. H. Abdurrahman Wahid, Pekalongan, Indonesia
[3]Universitas Trunojoyon Madura, Bangkalan, Indonesia
**Corresponding Author:* vera_mathedu@unipma.ac.id

Article History
Received : 07/08/2026
Revised : 26/10/2026
Accepted : 29/10/2026
Keywords:
Interactive E-LKPD, Ethnomathematics, Local architecture, Solid geometry, Conceptual understanding.

Abstract. Learning flat-sided solid geometry requires students to connect abstract mathematical concepts with visual representations and real-world objects. However, mathematics instruction at the junior high school level may still rely on conventional teaching methods, printed learning materials, and limited integration of local cultural contexts. This study aimed to develop and evaluate the validity, practicality, and effectiveness of an interactive mathematics electronic student worksheet (E-LKPD) based on the ethnomathematics of Magetan's local architecture. The study employed a Research and Development (R&D) approach using the ADDIE model. The participants were eighth-grade students at SMP Negeri 1 Kawedanan, selected through purposive sampling, comprising 10 students from Class VIII-B for the limited trial and 27 students from Class VIII-A for the field trial. Effectiveness was evaluated using a one-group pretest–posttest design without a control group. Data were collected through interviews, observations, questionnaires, and learning outcome tests and analyzed using descriptive statistics, the paired-samples t-test, the Wilcoxon signed-rank test, and N-Gain analysis. The E-LKPD achieved an overall validity score of 89.6% and practicality scores of 88.4% in the limited trial and 85.7% in the field trial. Mean scores increased from 77 to 88 in the limited trial and from 83.52 to 90.74 in the field trial. Both statistical tests indicated significant pretest–posttest differences ($p<.001$). The N-Gain values were 0.533 and 0.421, respectively, both in the moderate category, while classical mastery reached 90% and 100%. These findings indicate that the E-LKPD meets the study's criteria for validity, practicality, and effectiveness as an alternative learning resource for flat-sided solid geometry. Nevertheless, the absence of a control group limits conclusions about whether the observed improvements were attributable solely to the E-LKPD.

How to Cite: Susanti, V. D., Novianti, D., Wulandari, R., & Nurjanah, S. P. (2026). DEVELOPMENT OF AN INTERACTIVE ETHNOMATHEMATICS-BASED E-LKPD ON MAGETAN LOCAL ARCHITECTURE TO IMPROVE UNDERSTANDING OF SOLID GEOMETRY CONCEPTS. *Prima Magistra: Jurnal Ilmiah Kependidikan*, 7(4), 828-840. https://doi.org/10.37478/jpm.v7i4.8571

Correspondence address:
Jl. Setia Budi No. 85 Madiun, Jawa Timur, Indonesia.
vera_mathedu@unipma.ac.id

Publisher:
Program Studi PGSD Universitas Flores. Jln. Samratulangi, Kelurahan Paupire, Ende, Flores.
primagistrauniflor@gmail.com

INTRODUCTION

Mathematics is a core subject that plays a role in developing students' critical, systematic, and creative thinking patterns (Wahdiyah et al., 2025). One area is solid geometry, which requires spatial thinking skills. The PISA 2022 report emphasizes that understanding solid geometry is not limited to calculating formulas, but also includes the ability to visualize objects and comprehend spatial relationships as a whole (Susanti et al., 2026a). Indonesia's mathematics score in PISA 2022 was recorded at 366, far below the OECD country average of 472, indicating a fundamental gap in geometry learning in Indonesia (OECD, 2023). More specific evidence of these difficulties has been reported by Dintarini et al. (2022), who found that junior high school students experienced difficulties in spatial visualization, spatial orientation, and identifying relationships in geometric tasks. Similarly, Sudirman et al. (2023) identified students' epistemological obstacles in three-dimensional geometry, particularly in geometric representation, spatial structuring, and measurement. These findings highlight the importance of providing learning experiences that support students in visualizing three-dimensional objects and developing a conceptual understanding of their geometric properties.

In mathematics instruction at the junior high school level, such difficulties are also

evident when students solve problems involving three-dimensional shapes with flat faces both in terms of grasping the underlying concepts and in applying the necessary procedural steps (Suprayo et al., 2023). This difficulty mainly arises in forming three-dimensional visualizations and connecting two-dimensional representations with real objects (Nurhidayah et al., 2025). This is in line with the findings of Islamiyah et al. (2021), who reported that 45%–60% of junior high school students face challenges in recognizing the characteristics of solid shapes and drawing their nets. This condition is largely triggered by the scarcity of learning resources that connect abstract mathematical concepts with students' real-world contexts (Yana et al., 2025). It is also caused by learning that remains conventional, teacher-centered, and rarely relates the material to local culture or ethnomathematics in students' surrounding environment (Amilia et al., 2025).

The ethnomathematics approach offers an alternative by positioning mathematics as part of community culture, including local architecture. Fatimah et al. (2024) showed that learning that connects culture, such as traditional dance, can improve students' conceptual understanding and engagement, while Istiqomah (2024) stated that linking culture with learning also increases learning motivation. This approach needs to be supported by structured learning tools, one of which is the Student Worksheet (LKPD), which functions to facilitate students in discovering concepts independently (Juniarti & Utami, 2025). Technological development has driven the transformation of LKPD into an electronic form (E-LKPD) based on interactive multimedia, which enables virtual exploration of three-dimensional objects and has proven to increase students' independence and conceptual understanding compared to conventional methods (Silitonga & Purba, 2024).

Preliminary interviews with mathematics teachers and classroom observations at SMP Negeri 1 Kawedanan, Magetan Regency, East Java, indicated that the use of E-LKPDs in mathematics learning had not been fully optimized. The interviews focused on the learning resources used and the integration of local culture, while the observations examined the use of worksheets and the presentation of solid geometry concepts. The findings revealed that some teachers still used printed LKPDs and had not incorporated Magetan's local architecture into solid geometry instruction. These findings provided the basis for developing an interactive E-LKPD that integrates local architecture and three-dimensional visualization to help students understand geometric concepts through real-world objects.

Magetan is a regency in East Java with local cultural heritage that offers potential contexts for mathematics learning. Elements of traditional Javanese architecture, such as walls, floor plans, and roof structures, can be used to identify geometric shapes and explore the properties of flat-sided solid geometry. Therefore, Magetan's local architecture has the potential to serve as an ethnomathematical learning resource that connects abstract mathematical concepts with local cultural contexts.

Previous studies have demonstrated the potential of ethnomathematics-based learning resources. F. A. Widiyanto et al. (2025) developed an ethnomathematics-based LKPD on the Selogending Lumajang cultural heritage site and proved it to be valid, practical, and effective, although the resulting product was still in printed form. In addition, Wahyuningsih and Wibowo (2024) developed an ethnomathematics E-LKPD assisted by Live Worksheet, but at the elementary school level with cultural diversity material. These studies demonstrate the potential of ethnomathematics-based learning resources and interactive E-LKPDs, but they have addressed different educational levels, cultural contexts, and mathematical content. In particular, the study by F. A. Widiyanto et al. (2025) focused on a printed LKPD and the Selogending cultural heritage site, while Wahyuningsih and Wibowo (2024) developed an E-LKPD for elementary school cultural diversity material rather than junior high school solid geometry. Thus, previous studies have not specifically integrated local architectural ethnomathematics, interactive E-LKPD, and three-dimensional visualization to support the learning of flat-sided solid geometry among junior high school students.

The research gap addressed in this study extends beyond differences in local context, educational level, and mathematical content. Although previous studies have explored

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ethnomathematics-based worksheets and digital learning resources, the integration of local architectural heritage, interactive digital activities, and three-dimensional visualization within a single E-LKPD for teaching flat-sided solid geometry at the junior high school level remains insufficiently explored. In particular, there is a need for a learning design that transforms architectural elements from Magetan into interactive geometric representations, enabling students to connect real-world structures with abstract mathematical concepts and spatial relationships. Therefore, the novelty of this study lies in developing an interactive ethnomathematics-based E-LKPD that integrates Magetan's local architecture, interactive digital activities, and three-dimensional visualization to support students' understanding of flat-sided solid geometry. The pedagogical contribution of this study is to provide contextual and interactive learning experiences that connect local architectural heritage with abstract spatial concepts in junior high school mathematics. Meanwhile, its empirical contribution is to provide evidence regarding the validity, practicality, and effectiveness of the developed product. These evaluation results demonstrate the product's quality and potential educational value rather than serve as the primary basis for its novelty claim. Thus, this study not only produces a digital learning resource but also offers an integrated approach that combines local cultural contexts and spatial visualization within a learning resource specifically designed for flat-sided solid geometry.

Based on the above, the research problems are: (1) how valid is the interactive mathematics E-LKPD based on ethnomathematics of Magetan local architecture for solid geometry material for junior high school students; (2) how practical is it; and (3) how effective is it in improving junior high school students' understanding of solid geometry concepts. In line with these problems, this research aims to determine the validity, practicality, and effectiveness of the interactive mathematics E-LKPD based on ethnomathematics of Magetan local architecture to improve students' understanding of solid geometry concepts.

RESEARCH METHODS

This study employed a Research and Development (R&D) approach to develop an interactive mathematics E-LKPD based on ethnomathematics. According to Sugiyono (2019), R&D is a research method used to develop a specific product and evaluate its effectiveness. This study adopted the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Rustandi & Rismayanti, 2021), as shown in Figure 1. In the Analysis stage, the researchers identified students' learning needs, existing learning resources, and the challenges of teaching flat-sided solid geometry through preliminary interviews with mathematics teachers and classroom observations. The output was a needs analysis that informed the development of the E-LKPD. In the Design stage, the researchers developed the learning structure, activities, assessment instruments, and integration of Magetan's local architecture and three-dimensional visualization. The output was an initial design of the E-LKPD. In the Development stage, the design was transformed into an interactive digital product and evaluated by experts to assess its validity. Feedback from the experts was used to revise the content, presentation, and interactive features before implementation. In the Implementation stage, the revised E-LKPD was used in mathematics learning at SMP Negeri 1 Kawedanan to examine its practicality and effectiveness. In the Evaluation stage, data from expert validation, implementation, and student learning outcomes were analyzed to determine the product's quality and identify further improvements. Formative evaluation was conducted throughout the development process, particularly through expert review and revisions before classroom implementation.

The research was conducted at SMP Negeri 1 Kawedanan, located on Jalan Ahmad Yani, Kawedanan District, Magetan Regency, East Java, Indonesia, during the even semester of the 2025/2026 academic year. The school was selected based on its ongoing collaboration with the researchers and preliminary findings indicating that mathematics learning still relied partly on textbooks and printed LKPDs. This context was considered relevant for developing an interactive digital learning resource that integrates local cultural contexts and three-dimensional

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visualization.

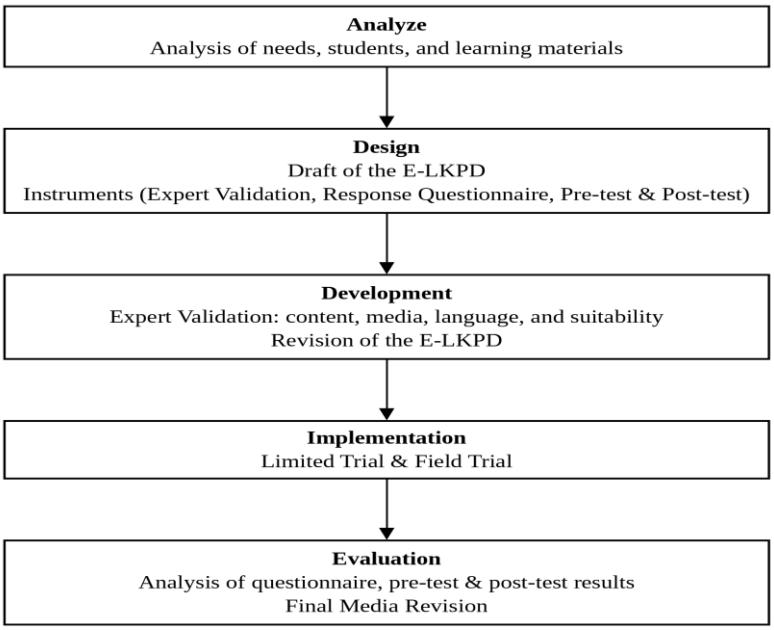


Figure 1. Stages of the ADDIE Development Model

The research population consisted of eighth-grade students at SMP Negeri 1 Kawedanan, comprising two classes, VIII-A and VIII-B. The participants were selected using purposive sampling in two stages. Class VIII-B was selected for the limited trial, involving 10 students, as some students in the class were undertaking internships and were unavailable to participate. Class VIII-A was selected for the field trial, involving 27 students. The limited trial aimed to identify initial issues with the E-LKPD and inform product revisions before its implementation in the field trial.

The research instruments consisted of validation sheets for material experts, media experts, language experts, and learning-resource suitability experts to assess product validity; a student response questionnaire to assess practicality; and pre-test and post-test questions to measure students' understanding of flat-sided solid geometry, including cubes, cuboids, prisms, and pyramids. The effectiveness test employed a one-group pretest–posttest design without a control group. Data were collected through classroom observations, semi-structured interviews with the eighth-grade mathematics teacher, expert validation, student response questionnaires, and pre-test and post-test administration.

The validity of the research instruments was assessed using Aiken's V, with coefficients ranging from 0.88 to 0.91, based on evaluations by three expert raters. Instrument reliability was examined using Cronbach's alpha, with coefficients ranging from 0.63 to 0.83. The reliability test was conducted with students from class VIII-C, which was separate from the classes involved in the limited and field trials. These procedures were used to assess the validity and internal consistency of the research instruments before their use in data collection.

The results were interpreted according to the criteria proposed by Maharani et al. (2025), with percentages of 81%–100% categorized as very valid or very practical. Before comparing pre-test and post-test scores, the normality of the data was assessed using the Shapiro–Wilk test (Nurhaswinda et al., 2026). For normally distributed data, the Paired-Samples t-Test was used to examine differences between pre-test and post-test scores, whereas the Wilcoxon Signed-Rank Test was applied when the normality assumption was not met. The effectiveness of the E-LKPD was further evaluated using N-Gain to measure the improvement in students' conceptual understanding and classical mastery to determine the proportion of students achieving the minimum mastery criterion (KKM) of 75. The E-LKPD was considered effective if the N-Gain reached at least the moderate category (≥ 0.30 or 30%) and more than 80% of students achieved scores of at least 75.

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RESULTS AND DISCUSSION

The interactive mathematics E-LKPD based on ethnomathematics of Magetan local architecture was developed through the stages of the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation).

Analysis

The analysis stage was conducted through interviews with teachers and observation of eighth-grade mathematics learning at SMP Negeri 1 Kawedanan. The needs analysis results show that the school has implemented the Merdeka Curriculum, but learning of flat-sided solid geometry is still conventional, and no interactive digital media linking the material to the ethnomathematics of Magetan's local buildings is yet available. The problem analysis reveals that teachers still rely on printed LKPD and textbooks as the sole reference, so the potential of Magetan's local architecture as a contextual learning resource has not been utilized. The student analysis shows that students have difficulty visualizing three-dimensional shapes and tend to memorize formulas, but show high interest in digital media and real contexts in their surrounding environment. The material analysis then determined the scope of the material as cubes, cuboids, triangular prisms, and quadrilateral pyramids in accordance with the Merdeka Curriculum for grade VIII, which was elaborated into learning outcomes and objectives as a reference for compiling the E-LKPD.

Design

Based on the analysis results, the researchers designed the E-LKPD as a website using the Lovable platform. The design process began with the development of a flowchart illustrating the product's navigation flow and branching structure. A storyboard was then prepared to outline the content and layout of each page, including Home, Main Menu, Instructions, Learning Outcomes and Objectives, Material, Exploration, Practice Questions, Reflection, Teacher Menu, and Researcher Profile. At this stage, the researchers also prepared the research instruments used to evaluate the product, consisting of expert validation sheets covering material, media, language, and suitability; a student response questionnaire to assess practicality; and pre-test and post-test questions to evaluate the effectiveness of the E-LKPD in improving students' understanding of flat-sided solid geometry.

Development

The design that had been prepared was then realized into a complete E-LKPD product through the Lovable platform in accordance with the established storyboard. The research instruments that had been prepared were quantitatively validated using Aiken's V index, with the content validity results for the student response questionnaire and the pre-test and post-test questions ranging from 0.88–0.91 and classified as high; the instruments were then tested for reliability using the Cronbach's Alpha technique, with results ranging from 0.63–0.83, all of which fell in the reliable category, so the instruments were declared feasible to use. The E-LKPD product was then validated by experts, with the validation results presented in Table 1.

Table 1. Expert Validation Result

No.	Validation	Score	Maximum Score	Percentage	Category
1.	Material Expert	191	210	90.95%	Very Valid
2.	Media Expert	108	115	93.91%	Very Valid
3.	Language Expert	56	70	80%	Valid
4.	Suitability Expert	131	140	93.57%	Very Valid
5.	Combined Average	-	-	89.6%	Very Valid

Based on the above results, there were a number of improvement suggestions, including adjusting the formulation of learning outcomes, replacing the image of the building in the triangular prism material to be more realistic, adjusting terms according to the KBBI (Indonesian dictionary) such as changing “segitiga” to “segi tiga” and “segiempat” to “segi empat,” and improving the font color on the teacher menu page for better readability. All suggestions were followed up through product revision before entering the implementation stage at the following link https://e-lkdpetnomatematika.lovable.app. The main displays of the

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E-LKPD are presented in Figure 2, Figure 3, and Figure 4.

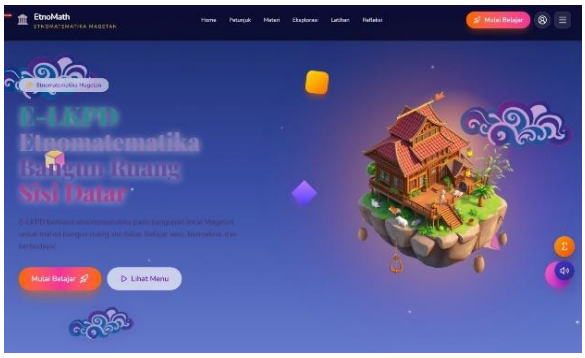


Figure 2. E-LKPD Home Display

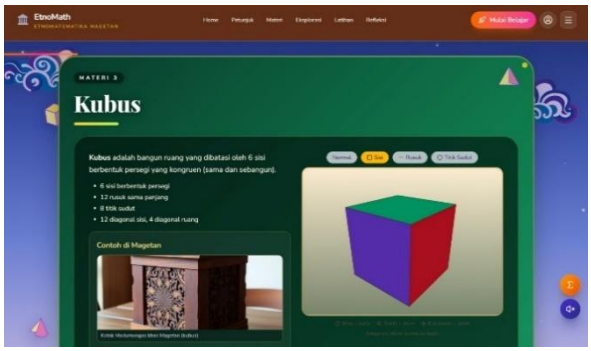


Figure 3. E-LKPD Material Display



Figure 4. E-LKPD Building Exploration Display

Implementation

The revised E-LKPD product was then tested on students of SMP Negeri 1 Kawedanan in two stages: a limited trial involving 10 students of class VIII-B and a field trial involving 27 students of class VIII-A. The limited trial was conducted in one meeting and the field trial in two meetings, each lasting approximately 90 minutes, with the sequence of activities consisting of an opening and explanation of the activity's objectives, working on pre-test questions, using the interactive mathematics E-LKPD through the shared link, working on post-test questions, and filling out the student response questionnaire at the end of the session.

At the next stage, the researchers analyzed the level of effectiveness and practicality of the E-LKPD, where the level of effectiveness was assessed based on students' pre-test and post-test answers. The effectiveness results are listed in Table 2 below.

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Table 2. E-LKPD Effectiveness Result

Statistical result	Limited trial (n = 10)	Field trial (n = 27)
Pre-test mean	77.00	83.52
Post-test mean	88.00	90.74
Shapiro–Wilk, pre-test	Statistic: 0.940	Statistic: 0.954
	Sig.: 0.555	Sig.: 0.262
Shapiro–Wilk, post-test	Statistic: 0.888	Statistic: 0.913
	Sig.: 0.163	Sig.: 0.027
Statistical test	Paired-samples t-test	Wilcoxon signed-rank test
Test statistic	t = −5.659	Z = -4000
Degrees of freedom	df = 9	-
p-value	p < .001	p < .001
N-Gain	0.533	0.421
Classical mastery	90%	100%

These results show that the interactive mathematics E-LKPD based on ethnomathematics of Magetan local architecture is able to improve students' conceptual understanding of flat-sided solid geometry material, with a level of improvement in the moderate category, or fairly effective in helping students understand the learning concept. Next is the analysis of the E-LKPD's level of practicality based on the student response questionnaire. The practicality results are listed in Table 3 below.

Table 3. E-LKPD Practicality Results

No.	Trial	Score	Maximum Score
1.	Limited Trial	796	900
2.	Field Trial	2,083	2,430

Based on the analysis of the student response questionnaire, both trials obtained percentages in the range of 81%–100% and fall into the very practical category. This is considered very good for implementation, so it is ready to be tested on a wider scale through field trials in an actual class sample.

Evaluation

The final stage, evaluation, was carried out by processing all the data obtained from both trial stages, including expert validation results, student response questionnaires, and pre-test and post-test data, to determine the overall level of validity, practicality, and effectiveness of the interactive mathematics E-LKPD based on ethnomathematics of Magetan local architecture. The results of the evaluation of these three aspects are described and further interpreted as follows.

Validity of the Interactive Mathematics E-LKPD Based on Ethnomathematics

The expert validation results indicated that the interactive ethnomathematics-based E-LKPD achieved an overall validity score of 89.6%, categorized as very valid. This result suggests that the product integrates mathematical content, cultural context, language, and digital presentation in a manner considered appropriate by the experts. The material and suitability assessments indicate that the selected flat-sided solid geometry concepts can be presented through Magetan's local architectural context, potentially helping students recognize geometric properties in familiar structures. This connection is consistent with the ethnomathematics perspective, which emphasizes the relationship between mathematical knowledge and cultural practices and artifacts. By connecting geometric concepts with local architecture, the E-LKPD provides opportunities for students to relate abstract mathematical ideas to objects in their cultural environment (Moron & Resi, 2025).

The integration of cultural context may also support conceptual understanding by giving students concrete points of reference when exploring the properties of cubes, cuboids, prisms, and pyramids. Rather than encountering geometric concepts solely through formulas and symbolic representations, students can examine architectural forms and relate their features to mathematical representations. When combined with three-dimensional visualization and interactive activities, this approach may help students identify geometric elements and

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understand relationships between real-world objects and abstract concepts. However, the validity results establish the appropriateness of the learning resource based on expert judgment; they do not, by themselves, demonstrate an improvement in students' conceptual understanding.

The assessment of the media also suggests that the E-LKPD's presentation, navigation, and interactive features were considered suitable for supporting its intended learning activities. These features are important because digital learning resources need to communicate information clearly and enable students to engage with the material effectively. Nevertheless, the language assessment received a comparatively lower score, indicating that language accuracy and the consistency of mathematical terminology required particular attention. Revisions based on expert feedback, including the refinement of terminology in accordance with the Indonesian language standard (KBBI), were therefore important steps in improving the product before classroom trials. This process illustrates the role of formative evaluation in identifying weaknesses and refining a learning resource prior to its implementation.

These findings are broadly consistent with P. Widiyanto and Afghohani (2025), who reported high validity scores for an ethnomathematics-based worksheet using cultural heritage, and Wahyuningsih and Wibowo (2024), who also reported favorable expert assessments of an ethnomathematics-based E-LKPD. Such similarities suggest that integrating cultural contexts into mathematics learning resources can produce materials that meet expert expectations when their content, presentation, and learning activities are appropriately designed. However, the present study extends this line of work by combining Magetan's local architectural context with interactive digital activities and three-dimensional visualization for learning flat-sided solid geometry. Overall, the validation findings support the conclusion that the developed E-LKPD is suitable for proceeding to classroom trials, while its practicality and effectiveness must be established through the subsequent analyses of student responses and learning outcomes.

Practicality of the Interactive Mathematics E-LKPD Based on Ethnomathematics

The student response questionnaires indicated that the E-LKPD achieved practicality scores of 88.4% in the limited trial and 85.7% in the field trial, both categorized as very practical and exceeding the threshold of 70.01% proposed by Astuti (2021). These findings suggest that students generally perceived the E-LKPD as accessible and easy to use. Its flexibility of access through a link on various devices, communicative design, and interactive features may have contributed to this positive perception (Susanti et al., 2025, 2026b). In particular, quizzes, three-dimensional animations, and images of Magetan's local architecture provide varied ways for students to engage with geometric concepts. These features may make learning activities more engaging and help students connect mathematical representations with familiar cultural objects. This interpretation is consistent with Prayoga et al. (2022), who emphasized the importance of engaging learning media in supporting students' acceptance and independent use of instructional resources.

The automatic feedback feature in the practice-question menu also contributes to the E-LKPD's practical value by allowing students to identify incorrect answers immediately without waiting for manual assessment by the teacher. Such feedback can support independent learning by helping students recognize errors and reconsider their understanding during practice. However, the practicality findings indicate students' perceptions of usability and the suitability of the learning resource; they do not, on their own, establish improvements in conceptual understanding.

Although the practicality score decreased from 88.4% in the limited trial to 85.7% in the field trial, both results remained within the very practical category. This difference should be interpreted cautiously because the trials involved different numbers of participants and were conducted under different implementation conditions. The larger field trial may have captured a broader range of student experiences, although the score difference alone does not establish the reason for the decrease. Classroom observations, which indicated that students were generally active and able to operate the E-LKPD independently, provided additional evidence of its usability during learning activities. These findings are consistent with Wahyuningsih and Wibowo (2024) and Safitri et al. (2025), who reported positive practicality assessments of

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digital E-LKPDs. Nevertheless, the present findings specifically indicate that integrating interactive digital features with Magetan's local architectural context can produce a learning resource that students perceive as practical to use. Therefore, the E-LKPD meets the practicality criterion and addresses the second research question.

Effectiveness of the Interactive Mathematics E-LKPD Based on Ethnomathematics

The effectiveness of the E-LKPD was evaluated by comparing students' pre-test and post-test scores. In the limited trial, the mean score increased from 77 to 88. The Paired-Samples t-Test indicated a statistically significant difference ($p < 0.001$). In the field trial, the mean score increased from 83.52 to 90.74. Because the post-test data did not meet the normality assumption, the Wilcoxon Signed-Rank Test was used and also indicated a statistically significant difference ($p < 0.001$). These results suggest that students' conceptual understanding improved after using the E-LKPD in both trials. However, because the study employed a one-group pre-test–post-test design without a control group, the improvements cannot be attributed exclusively to the E-LKPD.

The N-Gain scores were 0.533 in the limited trial and 0.421 in the field trial, both within the moderate category according to Trirahayu et al. (2024). Classical mastery reached 90% (9 of 10 students) in the limited trial and 100% (27 of 27 students) in the field trial, exceeding the predetermined criterion of 80%. These findings indicate that most students achieved the minimum mastery criterion after using the E-LKPD, although the moderate N-Gain scores suggest that the extent of improvement varied and that opportunities remain to strengthen conceptual understanding further.

The improvement may be related to the E-LKPD's integration of local architectural contexts, interactive activities, and three-dimensional visualization. Students who have difficulty imagining solid shapes from two-dimensional representations may benefit from learning activities that connect geometric properties with familiar objects. Through these connections, students can explore the characteristics of cubes, cuboids, prisms, and pyramids in a more meaningful context rather than relying solely on formulas and abstract diagrams. This interpretation is consistent with Ardinata et al. (2024) and Sitaresmi et al. (2026), who highlighted the potential of culturally relevant contexts to strengthen students' connections with geometric concepts. It also aligns with Setiana and Nuryadi (2021), who reported better conceptual understanding among students learning with an ethnomathematics-based E-LKPD than among those receiving conventional instruction. Nevertheless, the present study did not isolate the effects of cultural context, interactivity, and three-dimensional visualization, so their individual contributions cannot be determined.

The moderate N-Gain results may also reflect the relatively short implementation period, which comprised one to two 90-minute meetings to address four types of solid geometry. Students had limited time to explore and consolidate the concepts. As Batiibwe (2025) emphasizes, integrating ethnomathematics into learning is an ongoing process. Longer implementation with opportunities for repeated exploration, discussion, and reflection may provide further opportunities to strengthen conceptual understanding. However, this possibility requires further investigation. Overall, the findings support the effectiveness of the E-LKPD in improving students' pre-test and post-test performance and achieving the specified mastery criterion, thereby addressing the third research question.

CONCLUSIONS AND SUGGESTIONS

This development research produced an interactive mathematics E-LKPD based on ethnomathematics of Magetan local architecture, which was declared very valid with a combined validity percentage of 89.6%, very practical with a practicality percentage of 88.4% in the limited trial and 85.7% in the field trial, and effective in improving junior high school students' understanding of flat-sided solid geometry concepts, as shown by the increase in average pre-test to post-test scores from 77 to 88 in the limited trial, and from 83.52 to 90.74 in the field trial, with N-Gain in the moderate category (0.533 and 0.421) and classical mastery above 80% in both stages. These findings directly answer the three research problems and

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objectives regarding the validity, practicality, and effectiveness of the product. Theoretically, this research reinforces the view that cultural objects around students, particularly local architecture, can pedagogically visualize abstract solid geometry concepts. Practically, this E-LKPD can be used as an alternative teaching material that integrates local culture into mathematics learning at school, either by teachers or independently by students.

This research has a number of limitations that need to be considered, including the material scope covering only four flat-sided solid shapes, trials conducted only at one school with a limited number of subjects so that results cannot yet be widely generalized, the product's dependence on internet access through the Lovable platform, a relatively short implementation duration so that the improvement in conceptual understanding remains in the moderate category, and language aspects of the product that still require further refinement. Based on these limitations, future research is recommended to develop similar E-LKPD with a broader scope of solid geometry material, incorporate ethnomathematics contexts from other regions as enrichment, extend the implementation duration so that the impact of improved conceptual understanding can be observed more optimally, and give special attention to refining the linguistic aspects of the product.

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