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DEVELOPMENT OF MATHEMATICS E-MODULE BASED ON ETHNOMATHEMATICS

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Abstrak
Pesatnya perkembangan teknologi mendukung perkembangan proses pendidikan yang dinamis, salah satunya adalah tersedianya materi terbuka yang kreatif dan inovatif dalam bentuk digital. Penelitian ini bertujuan untuk mengembangkan E-Module pada media etnomatematika dengan menggabungkan budaya Betawi. Penelitian ini menggunakan metode *Research and Development* dengan prosedur pengembangan ADDIE dengan lima tahap, yaitu: Analisis, Desain, Pengembangan, Implementasi, dan Evaluasi. Teknik pengumpulan data dilakukan melalui studi pustaka, wawancara, kuesioner, tes, dan dokumentasi. Teknik analisis data yang digunakan adalah kualitatif dan kuantitatif. Hasil validasi ahli media dan material diperoleh simpulan "sangat layak", hasil pengujian kepraktisan diperoleh simpulan "sangat praktis", dan hasil pengujian dari kelompok besar mendapatkan hasil "sangat praktis". Hasil analisis pretest dan posttest, diperoleh hasil dengan kriteria tingkat efektivitas "sedang" termasuk dalam kategori "cukup efektif". Dapat disimpulkan bahwa E-Module memiliki tingkat efektivitas yang tinggi dan baik untuk digunakan siswa. Secara keseluruhan dapat disimpulkan bahwa hasil penelitian ini menghasilkan produk media yaitu pembelajaran E-Module matematika berbasis etnomatematika yang memiliki kelayakan, efektivitas, dan kepraktisan untuk digunakan sebagai media pembelajaran matematika dalam bahan bangunan sisi datar.

Kata Kunci: e-modul; etnomatematika; pembelajaran; budaya; Betawi

Abstract
The rapid development of technology supports the development of a dynamic educational process, one of which is the availability of creative and innovative open materials in digital form. This research aims to develop an E-Module on ethnomathematical media by combining Betawi culture. This research uses the Research and Development method with the ADDIE development procedure with five stages, namely: Analysis, Design, Development, Implementation, Evaluation. Data collection techniques are carried out through literature studies, interviews, questionnaires, tests, and documentation. The data analysis techniques used are qualitative and quantitative. The results of the validation of media and material experts obtained a "very feasible" conclusion, the results of the practicality test obtained a "very practical" conclusion, and the results of the test from a large group obtained a "very practical" result. The results of the pretest and posttest analysis were obtained with the criteria of "moderate" effectiveness level included in the "moderate" category. It can be concluded that E-Module has a high level of effectiveness and is good for students to use. Overall, it can be concluded that the results of this study produce a media product, namely ethnomathematics-based mathematics E-Module learning which has feasibility, effectiveness, and practicality to be used as a mathematics learning medium in flat side building materials for grade VIII junior high school.

Keyword*: e-module; ethnomathematics; learning; culture; Betawi*

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INTRODUCTION

Education is a fundamental foundation and key to a nation's progress, as a country cannot develop properly without the support of education (Widiansyah, 2017; Hasanah, 2018). Prioritizing education is crucial to improving the quality of education and students' literacy skills in Indonesia, which are currently still low (Fitri, 2021; Amir, Septiarini, & Wardana, 2023). Such a condition would not occur if learning were delivered appropriately and effectively. In today's era of globalization, education should advance by fostering learning skills and the ability to innovate. Changes in learning innovation have made education a key factor in improving human resources because education can develop and maximize the potential of young people to become qualified individuals. This aligns with Leonard (2013), who stated that education is a human effort to humanize people, as the target of education is humans themselves. By developing their potential, both teachers and students are expected to become skilled and high-quality individuals capable of changing conditions.

However, in reality, education in Indonesia is still lagging behind (Fenanlampir, Batlolona, & Imelda, 2019; Shaturaev, 2021). Many students still struggle with learning mathematics, which is often seen as a feared subject by students. This is supported by Gesty, Fedina, & Hermawati (2022), who stated that one of the causes of students' difficulty in learning is misconceptions, which lead to further conceptual errors. According to Mazana, Suero, & Olifage (2019), students' learning and achievement in mathematics are influenced by several factors, including students' attitudes towards the subject, teaching practices, and the school environment. Mathematics is an essential field of study (Seymour, Hunter, & Harper, 2019; Li & Schoenfeld, 2019; Maass et al., 2019), as it is used from elementary to higher education (Bartels, Rupe, & Lederman, 2019). Despite its importance in daily life, students' perception of mathematics as a frightening subject remains unchanged (Fitriana & Aprilia, 2021; Permatasari, 2021).

One of the underlying challenges in Indonesia's education system is the ineffective implementation of instructional delivery (Merona, 2023). In mathematics learning, the process often fails to run effectively; for instance, the numerous formulas and the methods used by teachers are often not innovative (conventional), which results in students lacking motivation to learn mathematics, feeling bored, and showing little interest in the subject (Quro, 2022). Moreover, mathematics is considered a difficult subject, causing students to struggle with conceptual understanding and feel less motivated to learn (Muthmainnah & Purnamasari, 2019). Mathematics is categorized as an abstract science that is highly related to everyday life (Loviana et al., 2020). According to Falentina et al. (2022), mathematics materials are still considered too difficult, compounded by students' lack of conceptual understanding. One of the most challenging topics for students is three-dimensional shapes with flat sides. Math teachers have noted that students need interactive learning media to spark their interest in learning mathematics. Naturally, learning must evolve with the times and continuously improve (Fajjriah et al., 2023).

Learning media serve as tools or instruments used to deliver material in teaching and learning activities (Karo & Rohani, 2018; Purba, 2022). Entering the 21st-century globalization era, Rafiepour & Farsani (2021) identified three main ideas distinguished as effects of globalization: "New Mathematics," "International Comparative Studies," and "Computational Thinking." This is supported by Abramovich, Grinshpan, & Milligan (2019), who stated that students now require both cognitive and practical experiences throughout their mathematics education to become productive 21st-century citizens. Teachers must create and use media (Nurin, Sarip, & Safira, 2022) that facilitate the learning process effectively and efficiently, such as through e-modules (Audina et al., 2023). This issue forms the basis for innovation by integrating mathematical concepts with local culture in the learning process through culturally-based mathematics e-

modules (Kencanawaty & Irawan, 2017). This is referred to as Ethnomathematics. Based on previous interviews, one alternative that can be developed is the creation of interactive ethnomathematics-based e-modules—learning materials that use the cultural context of specific regions in teaching mathematics. E-modules are developed because teaching systems are evolving in line with technological advancements (Fajjriah, Atiqoh, & Hartono, 2023).

In this e-module development, Betawi culture from DKI Jakarta is used as the cultural context integrated into mathematics learning. Culture and mathematics (ethnomathematics) are influenced by specific cultural and societal conditions, thereby encouraging students to think critically and solve problems more specifically (Sarwoedi et al., 2018; Sumiyati, Netriwati, & Rakhmawati, 2018). Betawi local culture that contains elements of ethnomathematics includes traditional houses, local foods, and decorative Betawi ornaments that incorporate the concept of three-dimensional shapes with flat sides. However, existing e-modules in the market have yet to significantly emphasize or incorporate cultural elements as intended. Based on this issue, innovative tools and learning media are needed to make learning effective and engaging for students to learn mathematics through cultural media. This is further supported by Intan (2021), who stated that ethnomathematics-based mathematics modules can attract students' attention. Culturally-based learning media also offer various advantages that can enrich the learning process (Laksana, 2024).

Generally, many studies have explored the development of ethnomathematics-based mathematics e-modules (Sagita, 2022; Rahmadhani et al., 2024; Ayni, 2022; Suryaningsih & Putriyani, 2022; Putriyani, 2019). However, upon analysis, it was found that the developed e-modules did not comprehensively cover the material and failed to explain all relevant topics. Previous research limited the content to prisms and pyramids, so this study aims to develop a more complete and interactive e-module. In terms of color and design, earlier products appeared less appealing as they were dominated by white, which made students less enthusiastic about learning. Based on the analysis of previous developments, the e-module developed in this study includes detailed and complete material on cubes, cuboids, prisms, and pyramids, integrated with multimedia in the form of flipbooks accessible online via the Heyzine web platform. Visually, the media includes colors and images that attract students' interest, encouraging enthusiasm for learning mathematics. Furthermore, this media is interactive, featuring navigation buttons that help students explore the content easily and includes motivational elements such as animations or audio to encourage students to learn more actively and enjoyable.

METHOD

The research method used in this study is development research or Research and Development (R&D). The Research and Development (R&D) method is a research method used to produce a specific product and test its effectiveness. This study employs the ADDIE model (Analyze, Design, Development, Implementation, and Evaluation), which is a research method commonly used to create a product and test its effectiveness (Sugiyono, 2020). The ADDIE model consists of five stages: analysis (Analyze), design (Design), development (Development), implementation (Implementation), and evaluation (Evaluation). The research was conducted from April 2024 to July 2024 at SMP Bina Dharma and SMP Kartika VIII-1.

The development procedure begins with the analysis stage, which includes needs analysis and curriculum analysis. This analysis stage involves determining whether the ethnomathematics-based e-module is necessary and feasible to be implemented in the learning process at SMP Bina Dharma and SMP Kartika VIII-1. The second stage is the design or product planning stage, which includes the collection of references based on the needs and material adjusted from the results of

the analysis. According to Branch (2009), at this stage, everything required will be designed based on the results obtained in the analysis stage. This e-module is specifically designed to be used in mathematics learning, incorporating Betawi cultural elements that contain mathematical concepts. The third stage, the development of the learning e-module, is the process of realizing what has been designed in the previous stage into a final product. In this development phase, the process of creating the e-module learning media using Microsoft PowerPoint began, which was then converted into a flipbook and made accessible through the Heyzine web platform. After the product was completed, validation by media and material experts was carried out to obtain assessments and suggestions for improvement regarding the feasibility of the media and content of the developed product. The fourth stage is the implementation of the e-module, which was tested in a small group involving several students from SMP Kartika VIII-1 totaling 7 students, and then in a large group involving students from SMP Bina Dharma totaling 22 students. In the implementation process, a pretest was administered to assess students' initial ability before using the e-module, followed by a posttest to evaluate students' learning outcomes after using the e-module. The final stage is evaluation, which is carried out at each stage of the development process to improve the media at every phase, resulting in a product that is feasible for use in the learning process.

The data collection techniques used include literature studies, interviews, questionnaires, tests, and documentation. The research instruments used are interview guidelines, expert validation questionnaires, and student validation questionnaires. The data analysis used is qualitative and quantitative with the Likert scale percentage technique. The purpose of this data analysis is to describe the feasibility and practicality of the developed e-module, while the impact of the e-module's effectiveness is measured using the N-gain test on students' pretest and posttest scores.

RESULT

The result of this development research is the creation of a mathematics learning e-module based on ethnomathematics for the topic of three-dimensional solid shapes (polyhedra) for eighth-grade junior high school students. The development of this learning media follows the procedural steps of Research and Development using the ADDIE development model, which consists of five stages. The e-module media was created through the stages of Analysis, Design, Development, Implementation, and Evaluation. The following is an explanation of each stage in the development of the ethnomathematics-based mathematics learning e-module within the ADDIE model:

The first step is the analysis stage. Based on the results of interviews conducted with mathematics teachers at SMP Bina Dharma and SMP Kartika VIII-1, as well as three students, it was found that many students still lack interest in learning mathematics, which often leads them to stop studying the subject altogether (Li & Schoenfeld, 2019). Students still perceive mathematics as a difficult and incomprehensible subject. These difficulties result in students having a limited understanding of the basic concepts, thereby preventing them from meeting the Minimum Mastery Criteria (KKM).

According to Sullivan et al. (2022), students need contextual assistance. However, in schools, teachers still tend to apply outdated or conventional learning media, or the learning media used lacks variety, as some students remain uninterested in mathematics (Fansury et al., 2020; Supriyatno et al., 2020; Kidd & Murray, 2020; Tuma, 2021). One student stated that they had difficulty understanding the entire topic of three-dimensional solid shapes because they did not fully grasp the formulas. As a result, the student expressed the need for support as an alternative to help them better understand the material. In this stage, curriculum analysis was also conducted by identifying the learning material used in both schools, which implement the 2013 Curriculum

(Kurikulum 2013). With Core Competencies 3.9 and 4.9: "Students are able to distinguish, determine, and solve problems related to the surface area and volume of three-dimensional solid shapes (cubes, rectangular prisms, prisms, and pyramids)."

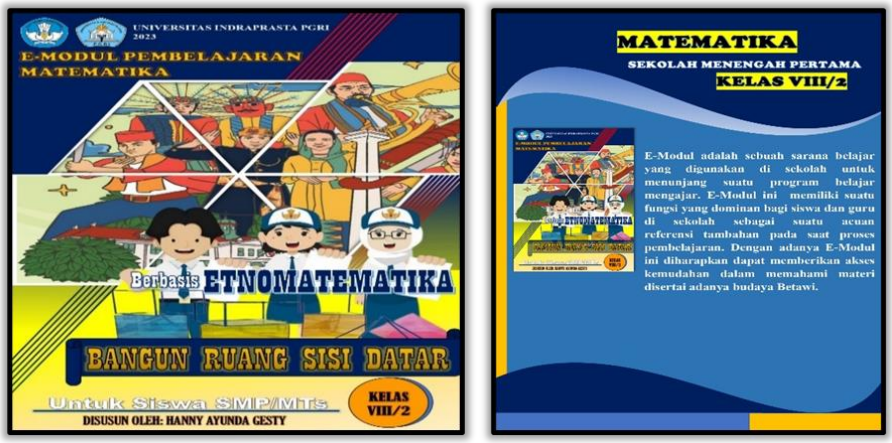


Figure 1. Front Cover (a) Back Cover (b)

The second step is the design stage. This stage is carried out after the completion of the analysis stage, namely by determining what type of media is needed by the students. At this stage, the media is designed according to the needs and then converted into a media draft. The details of the media design stage begin with collecting references to gather information regarding the topic of three-dimensional shapes for eighth-grade students. The material references used are sourced from the Grade VIII Mathematics textbook for SMP/MTs published by the Ministry of Education and Culture. The book was written by Asári et al. (2017) and published by the Curriculum and Book Center, Balitbang, Ministry of Education and Culture, with the topic of Three-Dimensional Shapes. After the references and information are collected, the design process of the e-module media begins, consisting of three sections: the introductory section, which includes the cover to the introduction; the main content section, which consists of learning activities 1 to 4 up to the competency test; and the closing section, which includes the glossary to the author's biography. The media design was created using Microsoft PowerPoint and then imported into the Heyzine website to convert the file into a flipbook format containing multimedia elements, making the media appear more interactive. It is equipped with navigation buttons to help students easily find material from one page to another. The third step is the development stage, where the creation of the e-module is carried out based on the design that has been prepared.

The development of the e-module begins with the introductory section, consisting of the cover to the introduction; the main content section, consisting of learning activities 1 to 4 up to the competency test; and the closing section, consisting of the glossary to the author's biography. The results of the e-module media development are shown in Figure 1 and Figure 2.

The next step after the development of the e-module is conducting a media trial or validation by media and content experts. At this stage, revisions to the learning media must be made if there are any suggestions or comments from the experts in order to improve the feasibility of the media. This validation is carried out to determine whether the developed e-module is feasible or not before it is implemented for students.

The media validation uses a questionnaire or media trial instrument by experts, which has been prepared to assess the feasibility of the media. The recap of the validation results by the experts can be seen in Table 1.

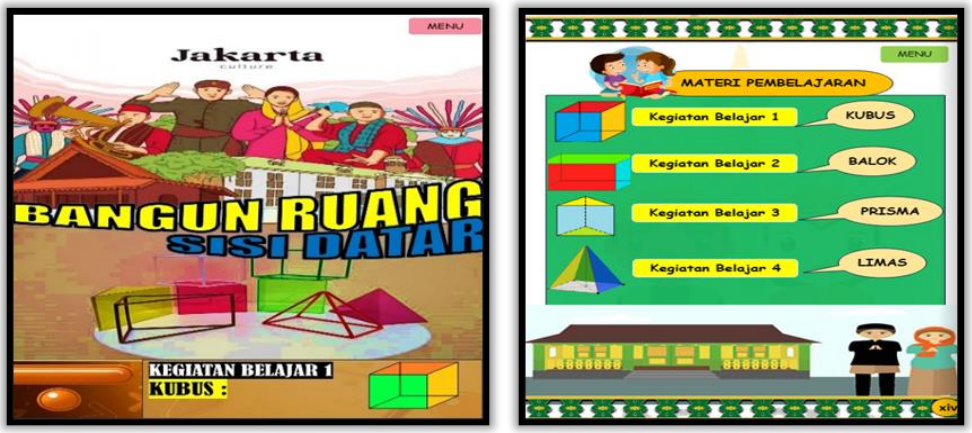


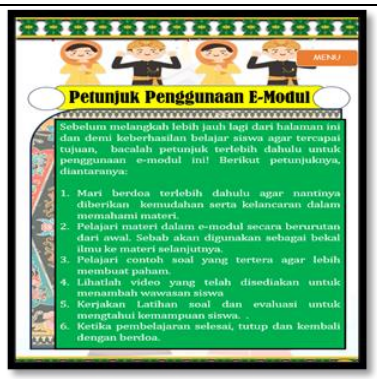
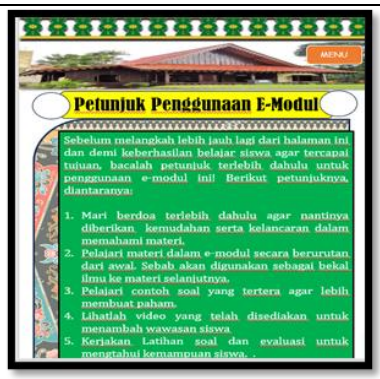
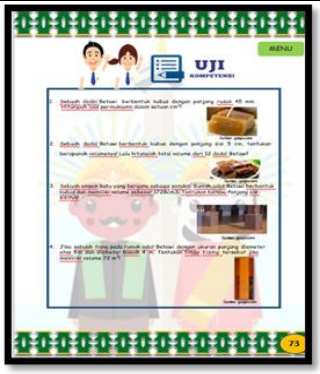
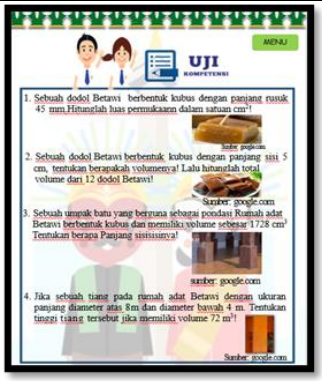
Figure 2. E-Module Menu (a) E-Module Evaluation (b)

Table 1. Overall Expert Validation Results

No	Expert	Percentage	Criteria
1	Media 1	82,73%	Highly Feasible
2	Media 2	87,27%	Highly Feasible
3	Materi 1	93,64%	Highly Feasible
4	Materi 2	97,27%	Highly Feasible

Based on all the validation results presented in Table 1, it is shown that the developed e-module is overall categorized as "Highly Feasible", with an average overall validity percentage from all experts of 90.23%.

Table 2. Before and After Media Revisions

No	Before Revision	Revision	After Revision
1		Mengganti gambar kartun, dengan gambar yang memuat unsur etnomatematika Betawi	
2		Memperbesar tulisan pada tes akhir yaitu Uji Kompetensi agar jelas	

The fourth step is implementation, which aims to test the practicality or attractiveness of the e-module through two testing stages. At this stage, the e-module is given to students for learning the topic of three-dimensional geometric shapes with flat surfaces. Practicality testing and

effectiveness testing are the two activities carried out in this implementation phase. The practicality test is conducted through small group and large group trials, while the effectiveness test is based on the results of the pretest and posttest scores. After the ethnomathematics-based e-module is validated by the validators, a media trial is then carried out with the students.

Next, the ethnomathematics-based mathematics e-module was tested on two groups: the first group was a small group consisting of 7 students from SMP Kartika VIII-1, and the second group was a large group consisting of 22 students from SMP Bina Dharma, in order to evaluate its practicality. The results of the small group trial are presented in Table 3.

Table 3. Small Group Trial Results

No	Assessment Aspect	Assessment Score	Maximum Score	Criteria	Percentage
1	E-Module Display	159	175	Very Practical	90,86%
2	E-Module Presentation	126	140	Very Practical	90%
3	Content in the Media	166	175	Very Practical	94,86%
4	Student Interest in the E-Module	178	210	Practical	84,76%
Total Overall Percentage					**89,86%**

With an average practicality score of 89.86%, Table 3 indicates that the practicality percentage of the small group falls under the "Very Practical" category. In addition, 22 students participated in the large group trial to determine the practicality of the same e-module media. The results of the large group trial are presented in Table 4.

Table 4. Large Group Trial Results

No	Assessment Aspect	Assessment Score	Maximum Score	Criteria	Percentage
1	E-Module Display	508	175	Very Practical	92,36%
2	E-Module Presentation	417	140	Very Practical	94,77%
3	Content in the Media	518	175	Very Practical	94,18%
4	Student Interest in the E-Module	600	210	Very Practical	90,10%
Total Overall Percentage					**92,86%**

Based on the analysis results in Table 4, the practicality percentage in the large group falls into the "Very Practical" category, with an average practicality validity score of 92.86%.

In addition to determining whether the media is practical, the purpose of the large group trial stage is also to assess the effectiveness of the e-module through pretest and posttest evaluations. The results of the pretest and posttest scores, calculated using the N-gain formula, are presented in Table 5 based on the tests conducted on 22 students.

Table 5. Results of N-gain pretest and posttest

Result	*pretest*	*posttest*	*Post-Pre*	Ideal Score (100-*Pre*)	N-Gain *Score*	N-Gain *Score*%
Mean	55	80	25	45	0,56	56

Based on Table 5, it is known that the analysis results of the pretest and posttest obtained an average score of 55 for the pretest and an average score of 80 for the posttest, indicating that students experienced an improvement in learning. These results were then calculated using the N-gain test to determine effectiveness, resulting in a score of 0.56, which falls under the “moderate” effectiveness level and is categorized as “Fairly Effective.”

The final step is Evaluation. This stage is a comprehensive evaluation of all the research and development steps that have been carried out, namely from the previous four stages (analysis, design, development, and implementation). At this stage, the E-Module product becomes a final

product that is feasible, high-quality, practical, and effective after going through revisions and trials. Ultimately, this stage yields a final media product that can be used by students as a companion learning tool to facilitate the learning of mathematics, particularly on the topic of solid shapes with flat sides for 8th-grade students in the second semester of junior high school.

DISCUSSION

This study has produced an ethnomathematics-based E-Module learning media, an electronic learning resource for mathematics, specifically on the topic of three-dimensional shapes with flat surfaces, integrated with Betawi cultural elements for eighth-grade junior high school students. This E-Module is an interactive learning media enriched with multimedia components, allowing various instructional materials to be presented effectively, along with guidance to assist students in learning. According to Sa'adah et al. (2020), the quality of learning information reception is enhanced when supported by interactive media. The integration of Indonesian culture—specifically Betawi culture—into this E-Module aims to improve students' mathematical understanding, especially in learning about three-dimensional shapes with flat surfaces, which many students perceive as difficult. Moreover, this E-Module encourages students to study independently and more actively by assigning them evaluation exercises at the end of each material section, allowing them to assess their understanding of the content.

This research, which resulted in the final product of an E-Module, falls under the category of Research and Development (R&D) and utilizes the ADDIE development model. The stages carried out include Analyze, Design, Development, Implementation, and Evaluation. The development method is used to create a specific E-Module product through validation testing. The feasibility of this ethnomathematics-based mathematics E-Module is determined through validation or trials conducted by media and material experts. Although similar to other mathematics E-Modules, this media stands out through its innovation, such as the integration of multimedia and cultural components. One of its practical features is the ease of access via the Heyzine online platform, which converts the media into a flipbook format, making it accessible from laptops or smartphones anytime and anywhere (flexible). This is supported by student interviews conducted after learning activities, which revealed that students found the E-Module helpful and engaging due to its user-friendly format and its inclusion of images and illustrations of everyday objects, particularly those reflecting Betawi culture. The instructional videos, which combine cultural insights with the topic of three-dimensional shapes with flat surfaces, have also contributed to heightened student enthusiasm.

The ethnomathematics-based E-Module features a green color scheme and Betawi cultural ornaments that provide a visually calming effect. Blue tones, symbolizing junior high school students, are also incorporated. This is reflected in the design of the E-Module's cover, which includes both thematic colors and illustrations of junior high school students to clarify the intended target audience—eighth graders. The selection of material for the E-Module was based on a needs analysis that identified students' difficulties in understanding formulas, particularly those related to prisms and pyramids, resulting in many students scoring below the Minimum Mastery Criteria (KKM). The E-Module is also complete in terms of formulas, example problems accompanied by ethnomathematical illustrations, instructional videos, and navigation buttons that link pages, allowing students to find the materials they need easily. Example problem solutions and practice questions are included as formative assessments at the end of each topic. Additionally, an answer sheet submission form is provided via QR Code, enabling students to submit their work by simply scanning or tapping the code. Quizzes using the Quizizz application are incorporated to make learning more enjoyable and to prevent boredom. These gamified quizzes also help students

sharpen their problem-solving skills by repeatedly practicing questions, encouraging a competitive spirit to score highly by answering questions correctly. The E-Module concludes with a competency test that summarizes questions from previously covered materials. The purpose of these evaluations and tests is to measure students' understanding after learning the content (Arikunto, 2021).

The test questions are developed in a variety of formats using Betawi cultural contexts, which are embedded with mathematical concepts to help students understand the content more easily (Sari & Gunansyah, 2018). According to Putri & Ardi (2021), this development research has a positive impact on improving student learning outcomes through instructional media. Learning about three-dimensional shapes with flat surfaces offers practical benefits for everyday life, such as calculating surface area and volume, making this material highly relevant and useful for students. Furthermore, this media does not only teach mathematics but also provides cultural insights alongside games and quizzes. Previous studies have developed E-Modules for teaching three-dimensional shapes (Sagita, 2022; Rahmadhani, 2022; Ayni, 2022; Putriyani, 2019; Khairiyah, 2019; Kurniasari et al., 2018). However, the media developed in this study has more advantages in terms of design, feasibility, content completeness, practicality, and effectiveness.

The following presents a comparison between the current development and previous research. The E-Module developed in this study covers four types of three-dimensional shapes (cubes, cuboids, prisms, and pyramids), whereas earlier works—such as by Sagita (2022)—only focused on prisms and pyramids and lacked follow-up evaluations after each topic. Additionally, those modules did not include a glossary to help students understand specific terms used within the E-Module. From the explanations above, it is clear that the ethnomathematics-based mathematics E-Module developed in this study possesses many advantages, including comprehensive content, effective design, multimedia features, and interactivity. Unlike previous developments, this E-Module incorporates a variety of multimedia components and a strong emphasis on Betawi culture, which reinforces its ethnomathematical value—something rarely found in similar modules. Its attractiveness lies in the use of visuals, illustrations/animations, quiz games, videos, and color schemes that are aesthetically pleasing and support the clarity of concepts. This media increases student enthusiasm and interest in learning mathematics, especially through the use of the Quizizz application, which fosters a healthy competitive spirit among students to score highly and rank at the top. Based on the findings discussed, it can be concluded that the ethnomathematics-based mathematics E-Module is an instructional material that demonstrates feasibility, practicality, engagement, and effectiveness in building student enthusiasm and enhancing learning interest in mathematics.

CONCLUSION

Based on the research findings and the discussion in the previous sections, it can be concluded that the development of an ethnomathematics-based mathematics e-module for eighth-grade junior high school students using the ADDIE development model resulted in the following evaluation outcomes: Media Expert 1 gave a score of 82.73% with a "very feasible" category, and Media Expert 2 gave a score of 87.27%, also classified as "very feasible." The average score from the two media experts was 85%, indicating that the media is "very feasible." The validation results from two material experts showed that Expert 1 gave a score of 93.64% and Expert 2 gave a score of 97.27%, both falling into the "very feasible" category. The average score from the two material experts was 95.45%, which is also considered "very feasible." The small group trial of the e-module, conducted with 7 students from SMP Kartika VIII-1, resulted in a score of 89.86%, categorized as "very practical." Meanwhile, the large group trial involving 22 students from SMP

Bina Dharma yielded a percentage of 92.86%, also classified as "very practical." The effectiveness of the e-module was assessed through pretest and posttest scores analyzed using the N-gain test, resulting in a score of 0.56, which falls under the "moderate" level of effectiveness, categorized as "fairly effective." It can thus be concluded that the e-module has a good level of effectiveness for use by students. Based on all evaluation results, the e-module meets the criteria of feasibility, effectiveness, and practicality, making it suitable as a supporting learning tool for mathematics, particularly for the topic of three-dimensional shapes with flat surfaces in eighth-grade junior high school.

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