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How Valid is the Development of the E-Module for AR-enabled Cube Surface Area Material in The Context of The Palembang Wardrobe?

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Abstrak

Penelitian ini bertujuan untuk menghasilkan e-modul materi luas permukaan kubus menggunakan konteks lemari khas Palembang dengan bantuan teknologi *augmented reality* yang valid. Penggunaan e-modul yang berkaitan dengan kehidupan sehari-hari siswa di era digital seperti saat ini memberikan manfaat berupa fleksibilitas dan aksesibilitas, interaktivitas, pembaruan konten yang *up-to-date*, serta efisiensi biaya dan waktu, sehingga materi pembelajaran menjadi lebih relevan, bermakna, dan dapat membantu siswa meningkatkan kemampuan pemecahan masalah yang nyata. Jenis penelitian yang digunakan adalah *Research and Development* atau penelitian dan pengembangan dengan prosedur penelitian model pengembangan ADDIE yaitu *Analyze* (Analisis), *Design* (Desain), *Development* (Pengembangan), *Implementation* (Implementasi), dan *Evaluation* (Evaluasi), tetapi dalam artikel ini tidak membahas mengenai tahap implementasi dan evaluasi, hanya sampai pada bagian pengembangan. Subjek yang digunakan dalam penelitian ini adalah siswa kelas VIII SMP Negeri 50 Palembang. Pengumpulan data dilakukan dengan menggunakan angket dan wawancara. Hasil pengembangan e-modul divalidasi oleh pakar dan diperoleh nilai rata-rata sebesar 0,8 dengan kategori tinggi. Kemudian dilakukan tahap uji coba kelompok kecil sebanyak 6 orang siswa untuk melihat kelayakan e-modul. Sehingga dapat disimpulkan bahwa e-modul materi luas permukaan kubus menggunakan konteks lemari khas Palembang dengan bantuan teknologi *augmented reality* telah valid berdasarkan penilaian pakar dan komentar siswa.
Kata kunci: E-Modul Matematika, PMRI, *Augmented Reality*.

Abstract

This research aims to produce an e-module of cube surface area material using the context of a Palembang wardrobe with the help of valid augmented reality (AR) technology. The use of e-modules with real-world or contextual problems familiar to students in today's digital age offers several advantages, including flexibility and accessibility, interactivity, up-to-date content updates, and cost and time efficiency, making learning materials more relevant, meaningful, and can help students improve their real-world problem-solving skills. The type of research used is Research and Development (R&D) or research and development with the ADDIE (Analyze, Design, Development, Implementation, and Evaluation) development model research procedure, but this article does not discuss the implementation phase, only the development part. The subjects used in this research were class VIII students at SMP Negeri 50 Palembang. Data collection was carried out using questionnaires and interviews. The results of the e-module development were validated by experts and an average score of 0.8 was obtained in the high category. Then a small group trial phase of 6 students was carried out to see the feasibility of the e-module. So it can be concluded that the e-module on the surface area of a cube using the context of a Palembang wardrobe with the help of augmented reality technology is valid based on expert assessments and students comments.
Keywords: Augmented Reality, Mathematics E-Module, PMRI.

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INTRODUCTION

In this 21st century, science and technology is growing rapidly and has a profound impact on all aspects of life (Sujana & Rachmatin, 2019). Impact of the development of science and technology now, society is required to further enhance its capabilities and competences, so that humans can balance themselves in this modern age (Mulyani & Haliza, 2021). However, there are several factors that fuel the current development of science and technology, one of which is the Covid-19 pandemic. The virus first appeared in late December 2019 in Wuhan City, Hubei Province, China, then entered Indonesia in early March 2020 (Sindi et al., 2020). The Covid-19 pandemic is a new problem for the entire order of life in Indonesia, one in the field of education.

According to the Declaration of the Minister of Education No. 4 of 2020 on the implementation of educational policy in the emergency of the spread of coronavirus disease (Covid-19), mandate is contained for teaching learning activities to be carried out from home online (Kemdikbud, 2020). Online learning is intended so that students do not meet and interact directly with many people in receiving learning at school (Purlilaiceu, 2021). However, online learning has an influence on the interaction between teachers and students, because it has to adapt in the face of changing learning environments and may have an impact on student learning outcomes (Putria et al., 2020).

One of the topics affected by Covid-19 is mathematics. Mathematics is also the most avoided subject, because it contains formulae that are difficult to understand (Wulandari, 2020). In fact, the majority of students think that mathematics is a very difficult lesson to imagine (Bela et al., 2021). In a study carried out by Maryanih et al. (2018) it was found that students had difficulty understanding the concepts of cubes and beams, finding and using surface wide formula and also the volume of cube and beam, this was due to remembering the ready-to-use formula, so that students easily forgot the formula. It demands that teachers innovate in learning using science and technology.

Teachers can innovate in designing and preparing interactive learning materials, materials, and media (Yantoro et al., 2021). Innovative learning materials are creative and exciting, and can be used in both online and luring learning (Irmawati et al., 2020). The use of innovative learning materials can also stimulate the motivation and spirit of students in the learning process (Perawati et al., 2020). The teaching materials needed at present are teaching materials that can support the quality of online learning such as e-modules (Arjana & Upayogi, 2022).

On the other hand, interactive learning media can also train students' learning independence because students interact with the media as long as students are interacting with teachers (Widjayanti et al., 2018). One of the interactive learning media is augmented reality through the Edu Assemblr software. Augmented reality is a technology that combines objects in the form of two dimensions or three dimensions, then integrated into the real environment / world so that it will create a combined space and display it at the same time (real time) (Alifah et al., 2021). Augmened reality has some advantages, such as more interactive because objects can be displayed as if they were present in a real environment, more attractive visual display, easy and effective in use, simple object display because it shows only a few objects, and does not require much cost (Supriono & Rozi, 2018).

Mathematical learning will be more meaningful when the material is directly linked to the problems of the student's everyday life or contextual problems. It is in line with the opinion of Mawartini et al. (2021) that everyday life is a starting point in learning mathematics so it is more emphasizing that processes are more important than results. One of the affirmative approaches to contextual problems is the PMRI (Pendidikan Matematika Realistik Indonesia) approach.

PMRI is a mathematical concept that connects something that happens in a student's life with learning mathematics so that the mathematic concept appears real and acceptable to the student (Dewi & Agustika, 2020). PMRI has characteristics such as learning begins with presenting contextual problems, students can solve problems using small groups, including contextual learning, student-centred learning, teachers acting as facilitators, and can make students more active in learning. Therefore, the use of PMRI as an approach in developing a teaching material will make the delivery of material more focused and meaningful.

In this article using the PMRI approach that includes culture as a context is the Palembang wardrobe. The reason the researchers use this context is to introduce the cultural diversity that exists in Indonesia and improve students problem-solving skills. From that, this article will discuss the development of a large cubic surface e-module using the context of a typical Palembang wardrobe with the help of augmented reality technology.

METHOD

This research was carried out at the 50th Palembang State High School in the strange 2022/2023 semester school year. The research test that will be discussed in this article is a small group of six students to test the eligibility of the e-module. This type of research is research and development. The development results are teaching materials in the form of e-modules that are

validated by experts and students comments. While the development procedure is the ADDIE development model, the data collection tool includes validation lifts and interviews.

The validation tray consists of 46 statements consisting of three aspects covering content and presentation, appearance, and language, as well as a column of comments and suggestions. The validating tray is given to the validator as a form of assessment of the e-module that has been designed at the development phase. Data analysis techniques in this study include qualitative and quantitative descriptive analysis.

Qualitative descriptive analysis techniques are used to analyze the data of interviews with teachers and students, notes, suggestions, or comments given by experts. Meanwhile, quantitative descriptive analysis is used to determine the validity, practicality, and potential effects of the developed e-modules.

Validation Angle Analysis

Quantitative validity data using the likert scale with the evaluation scores i.e. very disagree (1), disagreed (2), sufficient (3), agreed (4), and very agreed (5). Further, expert validation assessment scores are analyzed using the Aiken's V formula. To categorize the validity value results of e-modules can be seen through Table 1.

Table 1. Validity category

Validity Value	Validity Value
$0 \leq V < 0{,}4$	Low Validity
$0{,}4 \leq V < 0{,}8$	Current Validity
$0{,}8 \leq V \leq 1$	High Validity

RESULTS AND DISCUSSION

This research uses the ADDIE development model that consists of five phases: Analyze, Design, Development, Implementation and Evaluation (Branch, 2009). However, this article does not cover the phase of implementation. The following is the results of the research of the development of a large material module on the cubic surface using the context of the typical wardrobe of Palembang with the help of augmented reality technology.

Analysis Phase

The initial phase of the e-module development process is the analysis phase. The researchers conducted an analysis of the needs, curriculum, and characteristics of students. The need analysis was conducted through interviews with relevant teachers, it was found that the school still uses the raw books as basic textbooks and has never used modules with a guided

approach to students' understanding of concepts, so that students often find it difficult to solve problems if they forget about the formula. The teacher also said that the problem-solving ability of the students in the school was not good enough, it was worsened by the online learning system due to the outbreak of Covid-19 in late last year.

Later in the curriculum analysis, it was found that the school used the 2013 curricula and one of the materials studied in the eighth grade was the building material of flat side space. At the phase of student characteristics analysis, conducted interviews with three students and obtained results that students liked fun learning, such as books with images and animations as well as learning media, students also liked learning associated with everyday problems because it was easy to imagine. So the researchers were interested in developing an e-module.

Planning Phase

After the analysis, the researchers conduct a study of the material and approaches that are suitable to be developed as the student's teaching material. At this phase, researchers compile the components of the needs of the teaching materials, prepare devices, and compile research instruments. Furthermore, researchers can determine and design the appropriate teaching material, i.e. e-modules developed using a PMRI approach that includes cultures such as Palembang typical wardrobe and Polya problem-solving indicators, with large cubic surface material with the help of augmented reality technology.

Development Phase

After the e-module and other research tools are designed, the researchers submit the e-module along with a validation sheet to three expert validators to obtain validation values along with comments and suggestions for improvement. As for the validity value obtained, 0.8, it belongs to the high validity category with details as shown in Table 2.

Table 2. E-module validity value

Aspects	Validator I	Validator II	Validator III	V	Description
Content and Presentation	77	85	66	0,87	High Validity
Display	109	106	101	0,76	Current Validity
Language	12	12	12	0,75	Current Validity
Overall	198	203	179	0,8	Current Validity

In addition, the validator also gives comments and suggestions not to mention the name of the building space such as "cube" on the student activity sheet, then for the suggestion the researchers make improvements. A view of the e-module before fixing can be seen in Figure 1.

Figure 1. Activity sheet before repair

In Figure 1 it can be seen that the researchers are still writing the word "cube-shaped", the suggestion given by the validator is that it is enough to show a sample wardrobe or write down its characteristics. Then the improvements that the researchers made can be seen in Figure 2.

Figure 2. Activity sheet after repair

The improvement the researchers made was to remove the word "like a cube" and turn it into a characteristic of the cube itself. The validator also gives suggestions about the AR animation display that was created, i.e. overlapping the AR shape and giving engravings on the cubic shape of the typical Palembang wardrobe as in Figure 3 and Figure 4.

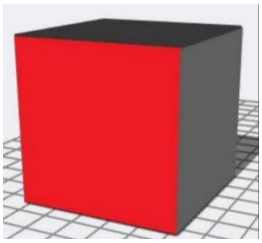


Figure 3. Cubic AR view before fixing

Figure 4. Cubic AR view after fixing

After the e-module was fixed on the validator's suggestion, the researchers conducted a limited trial of a small group of six students with a high, medium, and low level of mathematical ability to see if it was worthy to be tested on a large group at the implementation phase.

The use of e-modules in the small-group trial phase using the media of the laptop belonging to the researchers. Students are first introduced to the typical Palembang wardrobe through the reading material studied on the e-module, as shown in Figure 5.

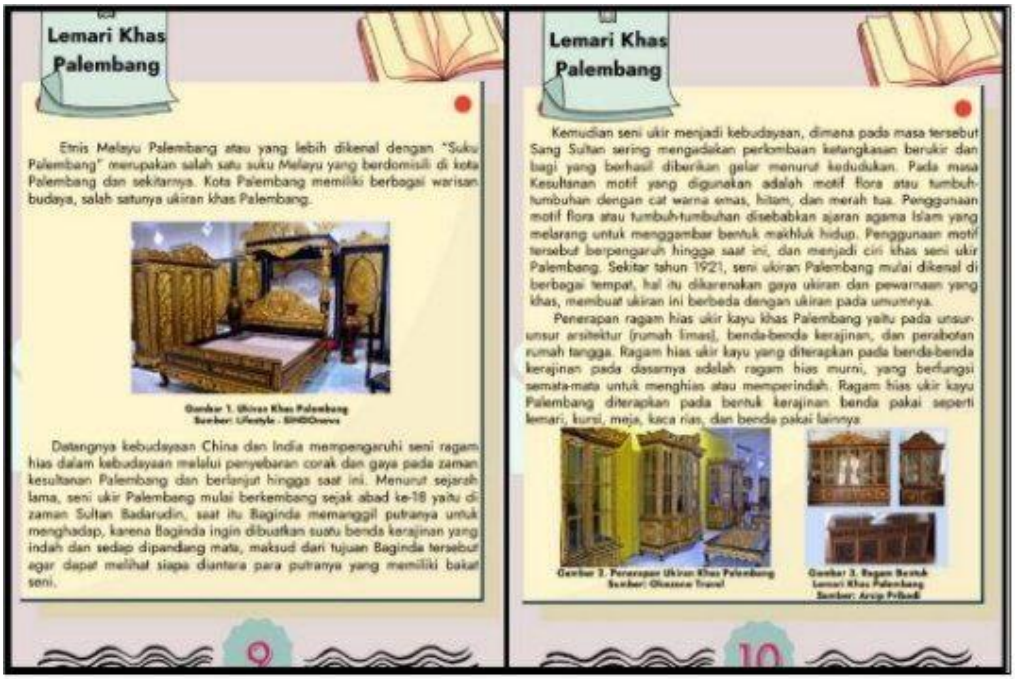


Figure 5. Readings about the typical wardrobe of Palembang

After reading and getting acquainted with the typical Palembang wardrobe, students at the small group test phase were given a activity sheet that can be seen in Figure 6.

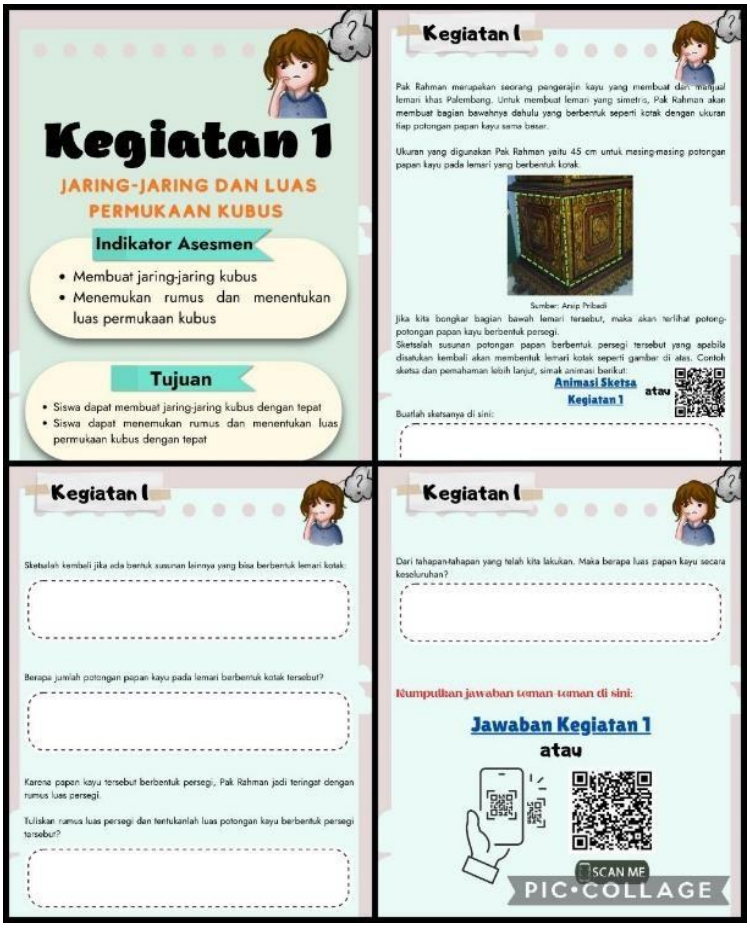


Figure 6. Activity sheet on the cubic surface area

In Figure 6 it is seen that the students are given a sheet of activity with several phases in finding a large formula of the cubic surface. This is in line with the PMRI characteristics starting from the use of context as the bottom of the typical Palembang wardrobe. In the use of models for progressive mathematics, students are asked to determine the cubic parts of the closet with the square boards that make up the wardrobe. Then the students are invited to assemble the square boards to form the cubic networks, in this section will be shown an animation (virtual) of one of the examples of the cube networks through the Edu Assemblr as in Figure 7.

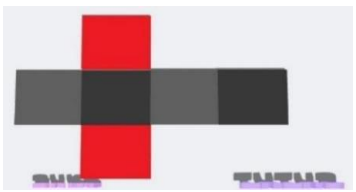


Figure 7. Cube grid AR view

Then the students calculate the area of the entire field (board) on the cubic shaped wardrobe. Next, students are asked to determine the formal formula of the cube surface area. Using the student's construction results, the student builds his own knowledge in making cubic nets. Picture of the cubic nets made by the students can be seen in Figure 8.

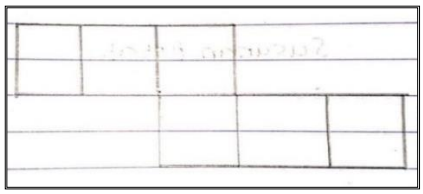


Figure 8. Utilization of student construction results in cube surface exploration activities

Students' answers in Figure 8 show that students are already able to describe the cubic nets. Interactivity that occurs in students is when students discuss together in making networks and determining the size of the cubic surface. During the discussion one of the students initiates making cubic networks using pieces of paper and then inspires the other students. As for the conversation between the students:

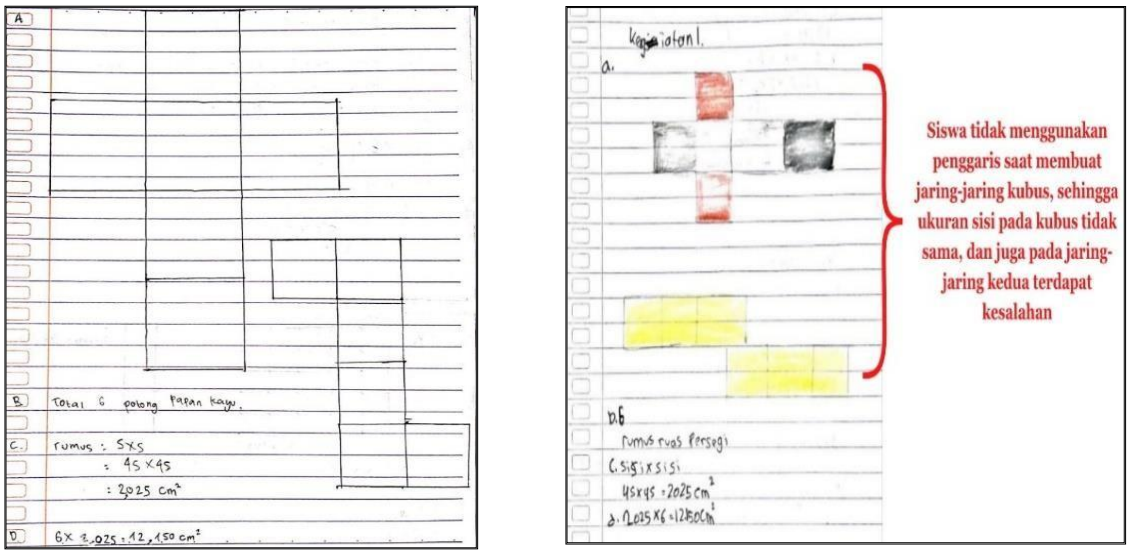
Student A: From this piece of paper, you can make a box shape like the animation.

Student B: So what if you want a different sequence?

Student C: Depends, if it's closed, it can be a box again, it means it can.

After that, students and teachers discussed and concluded the meaning of the cube surface area and its formula, as well as the link between the cubic surface and the typical Palembang wardrobe.

The activity also contains indicators of Polya's problem solving. The first indicator is the understanding of the problem, students are asked to understand the contextual problems that occur and also display the AR of the cube-shaped wardrobe with its networks, then get the things that are known and asked on the problem. Further on the second indicator of strategic planning, students are directed towards problem solving, such as depicting the cubic networks in shapes other than that of Assemblr Edu, writing the name and number of flat buildings found on the cubes, and writing the formula of the flat building. On the strategy implementation indicator, it is recommended to determine the cube surface area based on the instructions on the activity sheet. On the final indicator of re-examination, students try to use a formal formula based on the conclusions of the discussion for this activity, whether the results obtained in a formal way are the same as the informal way they do in this activity. Figure 9 is a small group of students' answers.



(a) (b)

Figure 9. SY (a) & MRO (b) responses to activity determining the cubic surface area of the e-module

Figure 9 is the result of the answers of SY and MRO students for the activity of determining the size of the cubic-shaped wardrobe surface. SY is a student with high abilities, he can answer questions thoroughly and accurately, SY can also describe cubic nets correctly. MRO is a student with low abilities who can actually answer all the questions, only in the performance of MRO's is poorly arranged. When describing the cubic networks, the MRO does not use a grid so that the size of each side of the cube on the networks described by the MRA is slightly misguided, whereas in the other pictures do not form cube networks.

After completing the activity sheet, students can collect their answers through the barcode or can through the link that has been presented, then students together with the researchers conclude their work on the work sheet on the surface area of the cube and check if the answers they have written are correct. After given the activity cube area search, students in small groups are given about the evaluation test and elevate the student's response to see if at the phase of the small group trial already gives a positive value to the practicality and potential effects of the e-module developed, and also look at the comments and advice given by students before conducting the large group test.

Also conducted interviews with students at the phase of small group trials to get comments and suggestions from students as improvement materials. Students in small group trials commented that the e-module was interesting and easy to use, but there were still errors in some writing, and students also suggested adding some pictures of the typical Palembang

wardrobe to the reading material to match the given evaluation topic. Then the researchers made the corrections to correct the wrong words and added a typical Palembang wardrobe image that was originally like in Figure 5 to be like Figure 10.

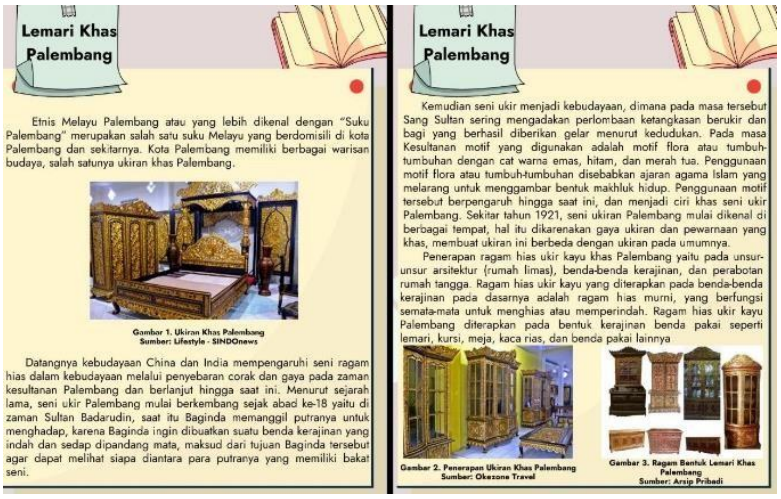


Figure 10. Readings about the typical wardrobe of Palembang after repairs

Evaluation Phase

The evaluation phase is performed at each phase. At the final evaluation obtained the weakness of the e-module developed that the evaluation test is still in the module instead of using the google form or similar so that the question can be seen by the students before the test evaluation.

The teaching material developed in this research is a mathematical e-module with vast material on the cubic surface with the help of augmented reality technology. This e-module was developed with the aim that students can be used independently by students with or without the help of others to improve problem-solving skills of students of the eighth grade high school. The development of this e-module uses a PMRI approach that involves culture with the intention of introducing the culture that exists in Indonesia, one of which is a typical Palembang wardrobe, besides the use of this context is expected to be able to make students imagine problems on issues as if they were real so that students feel responsible in finding solutions and conclusions. E-module material wide cubic surface using the context of the typical wardrobe Palembang has met valid criteria.

CONCLUSION

Based on the research results and discussion, this study produced an e-module on the surface area of a cube that uses the context of a traditional Palembang wardrobe and is supported by augmented reality technology. Based on the validator's assessment, this e-module has a high validity value of 0.8. In addition, comments from students also show that this e-module is interesting, easy to use, and easy to understand, with a few suggestions for improvement. Therefore, it can be concluded that this e-module is feasible to be used in learning.

This study is limited to the development of an e-module on the surface area of a cube with the context of a traditional Palembang wardrobe and augmented reality technology. The validation results and students responses are only limited to the sample used in this study. The use of e-modules with local cultural contexts and augmented reality technology can improve students' interest and understanding of learning materials. The results of this study can be a reference for the development of similar teaching materials in the future.

Recommendations for further research include developing more creative and interesting e-modules or teaching materials by using other cultural contexts, conducting broader trials to determine the effectiveness of using e-modules in improving students learning outcomes, integrating the latest technologies, such as virtual reality or mixed reality, to enhance the students learning experience, and investigating the impact of using context-based e-modules on other aspects, such as students learning motivation and attitudes.

REFERENCES

Alifah, R., Megawaty, D. A., & Satria, M. N. D. (2021). Pemanfaatan Augmented Reality Untuk Koleksi Kain Tapis (Study Kasus: Uptd Museum Negeri Provinsi Lampung). *Jurnal Teknologi Dan Sistem Informasi (JTSI)*, *2*(2), 1–7. http://jim.teknokrat.ac.id/index.php/JTSI

Arjana, I. G., & Upayogi, I. N. T. (2022). Pengembangan Home-Laboratory Based Digital Practicum Module Dalam Menunjang Pembelajaran Jarak Jauh Pada Matakuliah Praktikum Fisika Dasar. *Wahana Matematika Dan Sains: Jurnal Matematika, Sains, Dan Pembelajarannya*, *16*(1), 1858–0629.

Bela, M. E., Wewe, M., & Lengi, S. (2021). Pengembangan Modul Matematika Materi Aritmatika Sosial Berbasis Pendekatan Saintifik Untuk Siswa Kelas VII SMP. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(1), 391–400. https://doi.org/10.31004/cendekia.v5i1.461

Branch, R. M. (2009). Instructional Design: The ADDIE Approach [University of Georgia 604]. In *Springer Science + Business Media*. https://doi.org/10.1007/978-3-319-19650-3_2438

Irmawati, I., Setiani, Y., & Marethi, I. (2020). Penerapan Model Pembelajaran Kooperatif Make A Match Dengan Pendekatan Saintifik Untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa. *UJMES (Uninus Journal of Mathematics Education and Science)*, *5*(1), 33–38.

Kemdikbud. (2020). *Kemendikbud Terbitkan Pedoman Penyelenggaraan Belajar dari Rumah*. Kemdikbud.Go.Id. https://www.kemdikbud.go.id/main/blog/2020/05/kemendikbud-terbitkan-pedoman-penyelenggaraan-belajar-dari-rumah

Maryanih, Afrilianto, M., & Rohaeti, E. E. (2018). Analisis Kesulitan Siswa Smp Dalam Memahami Konsep Kubus Balok. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *1*(4), 751–758. https://doi.org/10.22460/jpmi.v1i4.p751-758

Mawartini, A. D., Riyadi, & Daryanto, J. (2021). Pengembangan Bahan Ajar Berbasis Pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) Pada Materi Waktu, Jarak, dan Kecepatan untuk SD Kelas V. *JPI (Jurnal Pendidikan Indonesia): Jurnal Ilmiah Pendidikan*, *7*(3), 162–167. https://digilib.uns.ac.id/dokumen/detail/95017/Pengembangan-Bahan-Ajar-Berbasis-Pendekatan-Pendidikan-Matematika-Realistik-Indonesia-PMRI-pada-Materi-Waktu-Jarak-dan-Kecepatan-Untuk-SD-Kelas-V%0Ahttps://digilib.uns.ac.id/dokumen/download/95017/NTU3Nzk1/Pe

Mulyani, F., & Haliza, N. (2021). Analisis Perkembangan Ilmu Pengetahuan dan Teknologi (Iptek) Dalam Pendidikan. *Jurnal Pendidikan dan Konseling (JPDK)*, *3*(1), 101–109. https://doi.org/10.31004/jpdk.v3i1.1432

Perawati, R., Nindiasari, H., & Syamsuri, S. (2020). Pengaruh E-Learning Menggunakan Quipper School Terhadap Kemandirian Belajar dan Hasil Belajar Siswa SMP Pada Pelajaran Matematika. *TIRTAMATH: Jurnal Penelitian Dan Pengajaran Matematika*, *2*(2), 177. https://doi.org/10.48181/tirtamath.v2i2.8980

Purlilaiceu. (2021). Efektivitas Pembelajaran Jarak Jauh (PJJ) Pada Masa Pandemi Covid-19 di FKIP Universitas Mathla'ul Anwar Banten. *Mendidik: Jurnal Kajian Pendidikan Dan Pengajaran*, *7*(1), 65–71. https://doi.org/10.30653/003.202171.158

Putria, H., Maula, L. H., & Uswatun, D. A. (2020). Analisis Proses Pembelajaran dalam Jaringan (DARING) Masa Pandemi Covid- 19 Pada Guru Sekolah Dasar. *Jurnal Basicedu*, *4*(4), 861–870. https://doi.org/10.31004/basicedu.v4i4.460

Sindi, S., Ningse, W. R. O., Sihombing, I. A., R.H.Zer, F. I., & Hartama, D. (2020). Analisis Algoritma K-Medoids Clustering Dalam Pengelompokan Penyebaran Covid-19 Di Indonesia. *Jurnal Teknologi Informasi*, *4*(1), 166–173. https://doi.org/10.36294/jurti.v4i1.1296

Sujana, A., & Rachmatin, D. (2019). Literasi Digital Abad 21 Bagi Mahasiswa PGSD: Apa, Mengapa, dan Bagaimana. *Conference Series Journal*, *1*(1), 1–7. https://ejournal.upi.edu/index.php/crecs/article/view/14284

Supriono, N., & Rozi, F. (2018). Pengembangan Media Pembelajaran Bentuk Molekul Kimia Menggunakan Augmented Reality Berbasis Android. *JIPI (Jurnal Ilmiah Penelitian Dan Pembelajaran Informatika)*, *3*(1), 53–61. https://doi.org/10.29100/jipi.v3i1.652

Widjayanti, W. R., Masfingatin, T., & Setyansah, R. K. (2018). Media Pembelajaran Interaktif Berbasis Animasi Pada Materi Statistika Untuk Siswa Kelas 7 SMP. *Jurnal Pendidikan Matematika*, *13*(1), 101–112. https://doi.org/10.22342/jpm.13.1.6294.101-112

Wulandari, S. (2020). Media Pembelajaran Interaktif Untuk Meningkatkan Minat Siswa Belajar Matematika Di SMP 1 Bukit Sundi. *Indonesian Journal of Technology, Informatics and Science (IJTIS)*, *1*(2), 43–48. https://doi.org/10.24176/ijtis.v1i2.4891

Yantoro, Y., Hariandi, A., Mawahdah, Z., & Muspawi, M. (2021). Inovasi guru dalam pembelajaran di era pandemi COVID-19. *JPPI (Jurnal Penelitian Pendidikan Indonesia)*, *7*(1), 8–15. https://doi.org/10.29210/02021759