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INTERACTIVE ELECTRONIC MODULE INTEGRATED WITH AUGMENTED REALITY CONTEXT OF LOCAL WISDOM OF JAMBI CULTURE

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Abstract

There are many studies discussing the development of interactive electronic modules, but only a few integrate them using Augmented Reality and local culture. This study aims to develop a valid and practical interactive E-Module using Augmented Reality technology with the context of Jambi's local cultural wisdom as an alternative interesting teaching material to visualize a concept in increasing understanding related to the structure of an object that is relevant to everyday life. The research was developed with 4D stages (Define, Design, Develop, and Disseminate). Data collection was carried out using expert validation sheets, practicality questionnaire sheets and documentation. The results of the study indicate that the developed e-module is valid and practical. The results of media and material validation at the expert validation stage showed results of 96.86% and 93.75% that the e-module has been valid and very well developed. Practicality is seen at the small group stage (3 high-ability students, 3 medium-ability students and 3 low-ability students) which gave results of 85.415% so that the e-module is practical and categorized as very good. Furthermore, the field test (17 students) provided a descriptively positive response to the developed electronic module. This research also impacts the process of transforming culture into a learning medium, providing solutions for cultural preservation in the digital age, and fostering positive energy between education, culture, and the use of technology in learning.

Keywords: Augmented Reality, Ethnomatematics, Interactive E-module, Jambi Culture, Geometry

Abstrak

Terdapat banyak penelitian yang membahas pengembangan modul elektronik interaktif, namun hanya sedikit yang mengintegrasikannya dengan menggunakan Augmented Reality dan budaya lokal. Penelitian ini bertujuan mengembangkan E-Modul interaktif yang valid dan praktis dengan menggunakan teknologi Augmented Reality dengan konteks kearifan lokal budaya Jambi sebagai alternatif bahan ajar yang menarik untuk memvisualisasikan suatu konsep dalam menambah pemahaman terkait struktur suatu objek yang relevan dengan kehidupan sehari-hari. Penelitian dikembangkan dengan tahapan 4D (Define, Design, Develop, and Disseminate). Pengumpulan data dilakukan dengan menggunakan lembar validasi ahli, lembar angket kepraktisan dan dokumentasi. Hasil penelitian menunjukkan bahwa e-modul yang dikembangkan tergolong valid dan praktis. Hasil validasi media dan materi pada tahap validasi ahli menunjukkan hasil 96,86% dan 93,75% bahwa e-modul telah valid dan dikembangkan dengan sangat baik. Kepraktisan dilihat pada tahap small group (3 mahasiswa kemampuan tinggi, 3 mahasiswa kemampuan sedang dan 3 mahasiswa kemampuan rendah) yang memberikan hasil 85.415% sehingga e-modul tergolong praktis dan dikategorikan sangat baik. Selanjutnya field test (17 mahasiswa) secara deskriptif memberikan respon yang positf terhadap modul elektronik yang dikembangkan. Penelitian ini juga memberikan dampak terhadap proses tranformasi budaya menjadi media pembelajaran, memberikan solusi untuk pelestarian budaya di era digital serta memberikan energi positif antara pendidikan, kebudayaan serta penggunaan teknologi dalam pembelajaran.

***Kata kunci**: Augmented Reality, Budaya Jambi, Etnomatematika, E-modul Interaktif, Geometri.*

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INTRODUCTION

Rapid technological advances, as well as more frequent staring at gadget screens than textbooks, mean that current learning needs to adapt to the times and the needs of students. Teaching materials, which are the main support in learning, need to be developed. Teaching materials that are one form of integration with the technology in question are e-modules. E-modules using augmented reality technology can be one of the alternative learning innovations (Buchori & Prasetyowati, 2021; Saumi et al., 2022). According to Rusnandi et al. (2015) Augmented Reality interpreted as technology that combines two- or three-dimensional virtual objects into a real three-dimensional environment as well as project object the in time real. Furthermore Alfitriani et al. Alfitriani et al. (2021) state that Augmented Reality This can visualize a the concept that abstract so that can add understanding related structure a object. In the world of education, the use of Augmented Reality can be an interesting alternative learning media if integrated with e-modules or teaching materials.

Studies related to e-module development research have been widely conducted by previous studies, including research (Ula and Fadila, 2018; Wahyudi, 2019), the conclusion obtained is that e-modules are categorized as very interesting when used in learning. This interactive e-module can also be used independently anytime and anywhere and can be accessed via cellphone or using a PC or laptop. The content taught in schools/ colleges should reflect its relevance in community life (Ojose, 2011). As previously explained, research on the development of electronic modules has progressed rapidly, but it is still not integrated with augmented reality and is also separated from knowledge of local culture. Three-dimensional geometry learning is also still taught textually. This gap causes mathematics learning to be less meaningful and relevant for students. This is due to the lack of a bridge between "school mathematics" and "life mathematics." Education cannot be separated from cultural values, especially local culture. Practically, to be able to maintain and preserve cultural values can be done through teaching materials or media. Education is an effective medium for transforming culture from generation to generation.This research aims to fill this gap by developing teaching materials in the form of electronic modules that complement and contextualize three-dimensional material in learning using the integration of augmented reality technology and local wisdom. On this study, use contextual which used is context local wisdom of Jambi culture. The context of local wisdom of Jambi culture is an approach used to "bring students closer" to culture and knowledge (Muslimahayati, 2020; Prahmana et al., 2021; Widiantari et al., 2022). The use of ethnomathematics or local wisdom as a context in learning has been widely carried out by previous studies (Afgani & Paradesa, 2021; Cervantes-Barraza & Araujo, 2023; Hortelano & Lapinid, 2024; Muslimahayati & Wardani, 2019; Pathuddin et al., 2021). The local wisdom chosen is Jambi culture which has not been widely explored. In fact, Jambi culture is very rich and has many historical and cultural relics of the community which need introduced And preserved. E-Module interactive become one of choice material teach which can get used to participant educate for study independent in school or at home, with or without teachers.

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The geometry course was chosen for development in this research because it is the basic material that serves as the foundation that first-year students of the Mathematics Education study program at UIN Sulthan Thaha Saifuddin Jambi. This material is a prerequisite before entering the geometry of planes and solid and transformation geometry courses. The teaching materials used so far are not yet proprietary teaching materials and have not been developed according to the needs and characteristics of students in the mathematics education study program. They are adaptations of previous modules from other universities. Geometry material in learning requires visualization, not just theory. Therefore, in this study, an e-module integrated with Augmented Reality was developed with the context of Jambi's local cultural wisdom on geometry material. Learning without just theory will certainly be able to attract students' interest, the use of images, videos, and interesting writing will help students in understanding the material. The aim of this research is to produce an interactive electronic module based on augmented reality technology in the context of Jambi cultural local wisdom on Geometry Material that is valid, practical and effective. The module electronic developed is flexible and very broad to be developed in learning. The use of e-modules based on augmented reality with the context of this wisdom is expected to contribute to the quality of education in Indonesia and the preservation of Jambi culture introduced through learning. Geometry material in learning requires visualization, not just theory, so that it is easier to understand the learning. E-Module based on Augmented Reality with context wisdom local culture Jambi on material geometry this is in a way theory of course will be able to attract students because the material presented is not in a way monoton. However use Images, video, as well as writing interesting that will help students in understanding the material. This e-module has a flexible nature and is very broad to be developed in learning. The use of e-module based on augmented reality with context wisdom It is hoped that this local Jambi culture can contribute to the quality of education in Indonesia as well as the preservation of Jambi culture which is introduced through learning. The introduction of local cultural wisdom for the young generation of Jambi as the successors of the nation is important so that it does not fade.

METHODS

This development research uses the 4D model (Define, Design, Develop, and Disseminate) as described Thiagarajan et al. (1974) . The product produced in this research is an electronic module integrated with augmented reality technology and local Jambi cultural wisdom in three-dimensional material.

Define stage

This definition stage aims to define and obtain information about the variables to be studied. At this stage, the study was conducted by digging up information about e-modules, augmented reality technology, local wisdom of Jambi culture, ethnomathematics, three-dimensional material, and other literature. Furthermore, curriculum analysis, material analysis, and student needs analysis for electronic modules were also conducted. This was done to see the problems and needs of the research subjects regarding the

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materials being developed. Curriculum analysis and material analysis were carried out through literature studies at the research site. Student needs analysis was carried out by distributing an open questionnaire consisting of several questions with the following indicators: 1) Geometry learning using e-modules in class; 2) Difficulties in learning geometry and suggestions; 3) Knowledge about Augmented Reality; 4) Knowledge about local wisdom of Jambi culture. All stages carried out in this stage are expected to produce e-modules that are in accordance with the needs and characteristics of the research subjects.

Design Stage

The design phase aimed to create an electronic module integrated with augmented reality technology and incorporating the local wisdom of Jambi culture.The interactive e-module design phase must align with core competencies and the learning curriculum. The applications used in this research were bookcreator.com and canva.com. The Geometry E-module material with Augmented Reality technology and local wisdom of Jambi Culture includes learning content on batik decorative motifs that focus on Jambi Batik with Jasmine Motif, Kajang Lako Traditional House, and Kerinci Special Potato Dodol. In addition to the e-module prototype, this phase also prepared an expert validation sheet and a student response questionnaire.

Develop Stage

This development stage aims to produce a valid and practical interactive e-module. This is achieved through validation by experts who will assess the e-module. Validation is conducted by two lecturers from the Mathematics Education Study Program who will assess the material and media aspects. Validation criteria for the media aspect include: a) e-module appearance (attractiveness, accuracy, consistency, clarity, and completeness); and b) Illustration (image integration, use of context, color selection, ease of use, and overall appearance). Material validation criteria include: a) Appropriateness of the title in presenting the content; b) Easy-to-understand and easy-to-solve questions for independent activities; c) Clarity of material description; d) Appropriateness of Learning Outcomes to the content; e) Clarity of problem solving to facilitate understanding of the material; f) Appropriateness of the material to achieve maximum learning outcomes; g) Coherence of the material/content description in the teaching materials to enhance student understanding; and h) Clarity of the material description in the e-module.

This development step also tests the practicality of the e-module. The e-module was tested on 9 students with the criteria of 3 high-ability students, 3 medium-ability students, and 3 low-ability students. There were 8 questions asked in the practicality questionnaire using 5 indicators: a) Suitability of the e-module to the geometry material presented and its context b) Language used c) Presentation or appearance of the e-module d) Ease of use of the e-module e) Innovation in the development of the e-module. Next, students were asked to fill out the questionnaire in the form of a Likert scale with four answer choices: strongly agree, agree, disagree, and strongly disagree.

Questionnaire analysis was used to determine the practicality of the interactive e-module. Data obtained from the questionnaire was analyzed using a Likert scale. The steps in the analysis are as follows.

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Table 1. Categories of practicality of positive and negative statements

Statements	Positive Statements	Negative Statements
Strongly Agree	4	1
Agree	3	2
Dissagree	2	3
Strongly Dissagree	1	4

Next, the score is calculated by finding the percentage, which is the sum of the scores obtained divided by the total score and multiplied by 100%. The achievement qualification table is presented in Table 2.

Table 2 Qualification level of achievement

No	Achievement Level	Qualification	Information
1	76 - 100%	Very Good	Very Good, no need to revise
2	51 - 75%	Good	Decent, needs to be revised
3	36 - 50%	Enough	Fairly Decent, needs to be revised
4	< 35%	Not Good	Not suitable, needs to be revised

Futhermore, the product is tested on first-year students of the Mathematics Education Study Program, UIN Sulthan Thaha Saifuddin Jambi, Class of 2024, totaling 17 students. The field test stage is carried out to see the practicality to the use of electronic modules from research subjects. The characteristics of practicality are seen in terms of efficiency, usability and whether or not a learning is interesting. The indicators are as follows: a) The e-module is easy to use; b) Has a use to help students in learning the material; c) Can help students learn independently; and d) The e-module attracts students' interest in learning mathematics. In this research, we did not reach the dissemination stage and only limited the development stage.

RESULTS AND DISCUSSION

The results of this study are to develop and produce an Interactive Electronic Module product based on Augmented Reality Technology in the Context of Local Wisdom of Jambi Culture on Geometry Material that is valid, practical and effective. As for more details, it is described below.

Define Stage

At this stage, information was obtained regarding the curriculum used at the research location and also identified the three-dimensional material that will be developed as in Table 3.

Table 3. Curriculum and material information

Information	Results
Curriculum Identification	The curriculum used in the Mathematics Education Study Program, Faculty of Tarbiyah and Teacher Training, UIN Sulthan Thaha Saifuddin Jambi is the KKNI Curriculum oriented to MBKM. The Mathematics Education Study Program has been Accrited Excellent through SK LAMDIK No. 586 / SK / LAMDIK / Ak / S / VI / 2024 starting from March 13, 2024 to March 12, 2029. The Scientific Vision of the Mathematics Education Study Program is "Integrating technology and culture in education and learning based on realistic mathematics in 2035". The Profile of Graduates of the Mathematics Education Study Program is Educator, Research Assistant, Teaching Materials Developer and Edupreneur.

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Information	Results
Material Identification	The material to be tested in this study is geometry material with the following learning outcomes: 1) Students understand the position of points, lines, and planes in space; 2) Students are able to analyze the projection of points, lines, and planes in space correctly; 3) Students are able to analyze distances in space, distances between points, points lines, points - planes, lines, lines - planes, and planes in space correctly; 4) Students are able to analyze angles in space, angles between lines and planes, angles between lines and lines, angles between two planes correctly.

Furthermore, a needs analysis was also conducted by distributing questionnaires to identify the needs of students who were made the research class. The needs analysis was asked to 17 students as research subjects. The questionnaire distributed included 4 indicators. For indicator 1) Geometry learning using e-modules in class, the data obtained that The number of students who felt the need for teaching materials in the form of E-Modules was 63.2% and 36.8% really needed it. In addition, only 52.6% of students had learned geometry using e-modules. For indicator 2) Difficulties in learning geometry and suggestions, as many as 52.6% of students have difficulty in understanding how to work accurately and carefully, 26.3% have difficulty in solving problems, and 21.2% have difficulty in applying formulas. For indicator 3) Knowledge about Augmented Reality, the results obtained There are 6 out of 17 students who do not know about Augmented Reality. In addition, Students want to learn geometry using Augmented Reality that can see 3D visuals of the objects being studied, help students operate applications in creating a project, and develop games that challenge students to solve geometric puzzles. For the last indicator 4) Knowledge about local wisdom of Jambi culture, the results showed that 15 out of 17 students liked it if local Jambi cultural wisdom was integrated into geometry learning.

Design stage

The design stage is carried out using the blender application, namely the bookcreator.com application and the canva application. After that, the e-module is converted to be accessible from various devices, including PCs, laptops, tablets, and mobile phones. Three-dimensional geometry material will be developed especially for the position of points, lines and angles as well as the projection of points, lines and angles. The e-module product created using the local wisdom of Jambi Culture consists of 35 pages (including the front and back covers). A number of features specific to the intended use of the E-Module product are included in the content page for example, the e-module is made in several parts, including the cover page, preparation page, table of contents, concept map, Instructions for Use of the e-module, learning materials, practice questions, glossary, and bibliography. The Geometry E-module material with Augmented Reality technology and local wisdom of Jambi Culture includes learning content on batik decorative motifs focused on Jambi Batik with Jasmine Motif, Kajang Lako Traditional House, and Kerinci Typical Potato Dodol. The design of the interactive electronic module is presented in the Figure 1until 12.

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Figure 1. Cover

Figure 2. List of contents

Figure 3. Course Learning Outcome

Figure 4. Kajang Lako, Traditional House of Jambi Province as a Context

Figure 5. Potato Dodol, a specialty of Kerinci Regency as a Context

Figure 6. Jambi Batik with Jasmine Motif as a Context

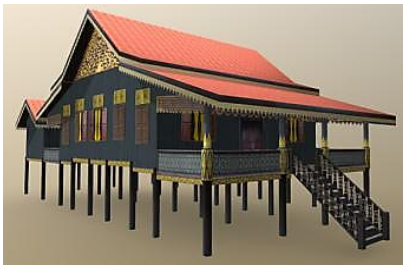

Figure 7. Augmented Reality and 3D Technology of Kajang Lako Traditional House

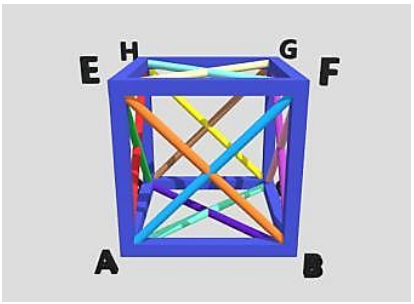

Figure 8. Augmented Reality and 3D Technology of Spatial Building (Cubes and Blocks)

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Figure 9. Integrated with Youtube or learning videos that can be accessed online

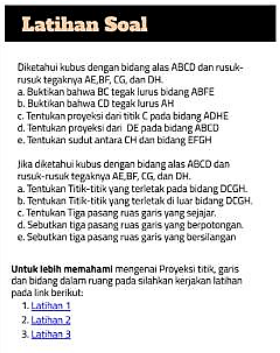

Figure 10. Practice questions integrated with wordwall and wizer.me applications

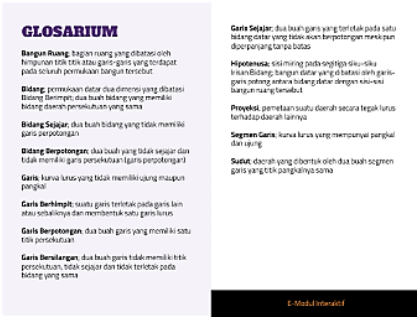

Figure 11. Glosary

Figure 12. Bibliography

Development stage

At this stage, the researcher provided the design results to experts to assess its validity. The experts consisted of 2 mathematics education lecturers who were material and media experts. The experts came from two universities, namely UIN Sulthan Thaha Saifuddin Jambi and UIN Raden Fatah Palembang. The experts assessed the E-Module Based on Augmented Reality Technology in the Context of Jambi Local Wisdom Culture on Geometry Material. The experts assessed the product on a validation questionnaire that had been given which contained 8 for material validation and 10 questions for media validation, questions using a Likert scale (1-4) and provided suggestions for improvement.

Table 5 and 6 presents the validation results data from Validator A and B.

Table 5. Material validation result

No.	Validator	Validation Result	
		Percentage	Category
1	Validator A	95%	Very Good
2	Validator B	92,5%	Very Good

Table 6. Media validation result

No.	Validator	Validation Result	
		Percentage	Category
1	Validator A	100%	Very Good
2	Validator B	93,73%	Very Good

Suggestions and input from the validator include the following: a. The language and explanation of the description of the module must be more effective; b. The combination of cover colors and writing needs to be considered for readability and attractiveness; c. Add instructions for working on questions equipped with Augmented Reality media; and d. Quality improvements can provide a touch of interaction

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with users. After receiving an assessment, comments and suggestions from the validator, the researcher then revised the electronic module.

There are 8 questions asked in the practicality questionnaire at this stage with indicators: a) Suitability of the e-module with the geometry material presented and its context b) Language used c) Presentation or appearance of the e-module d) Ease of use of the e-module e) Innovation in developing the e-module. Furthermore, students are asked to fill out the questionnaire in the form of a Likert scale with four answer choices: strongly agree, agree, disagree and strongly disagree.

Based on the results of the questionnaire it shows that the E-Module Based on Augmented Reality Technology in the Context of Local Wisdom of Jambi Culture on geometry material gets an average of strongly agree with a percentage of 85.415%. This means that the e-module that was developed is very good with improvements or revisions according to suggestions and comments from students at this stage.

The Comments and Suggestion at this stage, namely a) Interactive E-Module based on augmented reality technology in the context of Jambi's local cultural wisdom using easy-to-understand language, coupled with images and illustrations to help understanding. The suggestion is that perhaps in the discussion material, examples of Jambi culture can be added to add to its cultural aspects, but overall it is very good; b) This e-Module is very interesting, not boring and really follows technological developments, the visuals in it help students to understand the material very well. The suggestion might be to fill the design with color; c) This e-module is very interesting for students because the design composition and the material provided are easy to understand and most importantly, follow current technological developments.

Based on the results of the comments and suggestions above, several things that need to be revised at this stage are as follows:

1. Design selection is made more attractive
2. The color selection is made more varied to make it more attractive.
3. In the discussion material, examples of Jambi culture were added.

Furthermore, the product is tested on first-year students of the Mathematics Education Study Program, UIN Sulthan Thaha Saifuddin Jambi, Class of 2024, totaling 17 students. This stage began with learning by the lecturer, who provided an access link to the interactive e-module based on augmented reality (AR) technology with local Jambi cultural wisdom. Each student was asked to listen to the learning and read and understand the material and problems in the e-module that had been given. Next, after each student had worked on the questions, students were asked to fill out the practicality sheet provided and answer descriptively. Tessmer (1993) practicality indicators, the characteristics of practicality are seen in terms of efficiency, usefulness and whether or not a learning is interesting. The indicators are as follows: a) The e-module is easy to use; b) It has the usefulness to help students in learning the material; c) It can help students learn independently; and d) The e-module attracts students' interest in learning mathematics.

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Table 6 Summary of Practicality Sheet Answers

No	Category	Statement	Result
1	***Ease and Clarity***	• Was there any part that was particularly difficult?	88.24% answered that there were no particularly difficult parts, and the e-module was very clear, but 11.76% answered that there were some very difficult parts.
		• What is explained in this module clear?	100% answer this e-module is clear
2	***Independence***	• Can you study this e-module at home or at school?	100% answered yes/can
		• Can you use this e-module without assistance?	47.06% answered that they could use the electronic module without help, but 52.9% answered that they could not use it electronic module without assistance.
3	***Interest and Acceptance***	• Did you feel challenged when using the e-module?	82.35% answered that they felt challenged by this e-module and 17.65% answered that they did not.
		• Will you use this e-module to study?	100% answered yes/of course
4	***Value or Benefit***	• Will studying this e-module help you do your job better?	100% answered yes/of course
		• By answering the questions in this e-module, have you improved your understanding of mathematics, improved your creativity, and improved your critical thinking skills?	100% answered yes/of course
		• What new things did you learn from this E-Module?	100% answers many new things, especially the use of augmented reality, making learning more exciting and getting to know more about Jambi's local wisdom when studying the material on points, planes and three-dimensional space.

Based on the summary of the practicality evaluation sheet in Table 6, it is known that the majority of students responded positively to the developed e-module. This also indicates that the developed e-module is considered practical. However, in terms of independence, 52.6% of students were unable to use this e-module independently. According to the researcher's analysis, this occurs partly because students are not yet accustomed to using e-modules and are still dependent on teachers/lecturers. Therefore, the use of this e-module is necessary as a habituation exercise. Furthermore, 17.65% of students responded that they did not feel challenged by using this electronic module. This was because they felt a lack of challenge in their problem-solving knowledge, which had not yet reached a deep and progressive higher level of cognitive development.

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The drawback in this stage is that the electronic module is distributed via a limited link only to students of the Mathematics Education Study Program at UIN Sulthan Thaha Saifuddin Jambi.

The research findings indicate that the electronic module developed by integrating Augmented Reality technology and utilizing the context of Jambi's local cultural wisdom is valid and practical. These results align with the underlying theory: culture-based learning is a new innovation for students in learning materials by linking it to local wisdom. Therefore, the use of culture in learning becomes an option to "bring closer" mathematics learning. This research aligns with previous research that links learning with culture, such as research conducted by Fitriani et al. (2021), Ikhwanudin (2018), Murtadlo et al. (2023), Muslimahayati (2020) and also Wardani and Suniasih (2022).

This research is also enriched by the integration of augmented reality technology into learning. This is also in line with previous research that uses augmented reality in learning, such as research (Saumi et al., 2022), which resulted in the development of e-modules based on Augmented Reality that can be used as one of the learning media. Additionally, research by Buchori and Prasetyowati (2021) that produced interactive e-modules for mathematics on the topic of circles for grade VIII has tested their validity and feasibility. However, this research has advantages because it integrates technology and culture in learning.

The findings of this research include:

1) Learning three-dimensional geometry becomes more engaging and enjoyable using e-modules. This is because it provides students with hands-on and interactive experiences to visualize spatial figures using Augmented Reality and utilizes cultural context to concretely understand abstract material.
2) This electronic module is a tool for preserving local culture in this digital era.
3) Electronic modules facilitate better absorption of knowledge due to their multi-sense approach (visual, auditory, interactive).

The weekness of this research are summarized as follows:

1) A paid premium account is required to fully utilize the Augmented Reality application.
2) The module does not fully represent Jambi's local wisdom.
3) The dissemination phase has not been maximized and is still limited to the Mathematics Education Study Program at UIN Sulthan Thaha Saifuddin Jambi.

This research not only develops electronic module products but also has the following impacts:

1) Transforming culture, from merely being an object of study to becoming a medium for learning.
2) Providing solutions to the need for innovation in learning media, while also providing a platform for generations to preserve culture.
3) Encouraging positive synergy between education, culture, and the use of technology in learning.

CONCLUSIONS

This research has produced a product in the form of an Interactive E-module Based on Augmented Reality Technology in the Context of Local Wisdom of Jambi Culture on Geometry Material that is valid and practical. Valid is illustrated from the results of the validator's assessment (expert review stage) in the material and media

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validation categories, respectively producing values of 96.87% and 93.75% in the very valid category with very good interpretation.

Based on the results of the questionnaire at the small group stage, it shows that the E-Module Based on Augmented Reality Technology in the Context of Local Wisdom of Jambi Culture on geometry material gets strongly agree with a percentage of 85.415%. This means that the e-module that was developed is very good. This means that the e-module developed is very practical and interpreted very well. Based on the summary of the practicality evaluation sheet in disseminate stage it is known that the majority of students responded positively to the developed e-module. This also indicates that the developed e-module is considered practical. This research also has an impact on the process of transforming culture into learning media, providing solutions for preserving culture in the digital era and providing positive energy between education, culture and the use of technology in learning.

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