JTAM (Jurnal Teori dan Aplikasi Matematika)
http://journal.ummat.ac.id/index.php/jtam
p-ISSN 2597-7512 | e-ISSN 2614-1175
Vol. 8, No. 4, October 2024, pp. 1249-1261

Augmented Reality Learning Media with Ethnomathematic Approach to Grow Students' Mathematics Learning Motivation

Dhina Cahya Rohim[1], Fida Maisa Hana[1], Manggalastawa[1*], Safira Saharani[1], Ade Ima Afifa Himayati[1]
[1]Primary Teacher Education, Universitas Muhammadiyah Kudus, Indonesia
manggalastawa@umkudus.ac.id

Article History:
Received : 09-07-2024
Revised : 09-10-2024
Accepted : 19-10-2024
Online : 22-10-2024

Keywords:
Augmented Reality;
Ethnomathematics;
Motivation to Learn Mathematics;

ABSTRACT

The efforts that can be made to increase learning motivation are through the use of learning media integrated with current technology with a culture-based approach that students often find in everyday life. The purpose of this study was to describe the importance of AR in mathematics learning, the use of technology in ethnomathematics, and the effects of AR in fostering student learning motivation. This research method is Systematic Literature Review (SLR) with the PRISMA (Preferred Recording Items for Systematic Review and Meta-analysis) technique. The article search process uses a database from international journals indexed by Scopus and found 287 articles. Then a feasibility study was carried out according to the specified criteria so that 18 final articles were obtained. The results of the study showed that: (1) the use of AR in mathematics learning is very important because it has a positive impact such as improving learning outcomes, increasing learning motivation, improving the quality of learning, creating fun learning, improving learning experiences and improving creative thinking skills; (2) Cultural integration combined with technology provides benefits, namely learning becomes interesting so that it can foster student learning motivation, the form of integration between AR technology and ethnomathematics can be in the form of developing interactive learning media, modules or android-based media; and (3) Several studies using AR-based learning media have provided significant results in increasing students' learning motivation.

https://doi.org/10.31764/jtam.v8i4.25740

A. INTRODUCTION

Mathematics learning has an important role in education because its applications are very relevant in everyday life, but there are still students who face difficulties in understanding mathematics (Chen et al., 2024). Many students have difficulty solving math problems because the learning process tends to focus on memorizing formulas without providing a deep understanding of concepts (Nurmaya et al., 2021). Mathematics is considered a difficult subject, which causes anxiety and lack of learning motivation (Supriadi et al., 2024). Thus, it is necessary to carry out learning innovations in order to foster students' mathematics learning motivation.

Learning motivation needs to be increased because it is related to student learning outcomes (Supriadi et al., 2024). Increasing learning motivation is very important because it is one of the key factors in determining learning success (Held & Hascher, 2023). Learning motivation not only encourages students to actively participate in the educational process, but

also influences how they overcome challenges that arise. Some opinions state that learning motivation is an effort to achieve educational goals (Hu et al., 2024). In this context, students who have strong motivation tend to be more focused and persistent in the face of difficulties, because they have a clear vision of what they want to achieve. In addition, learning motivation acts as a driver for students' learning efforts, so that those who have high motivation and tend to follow the learning process better (Rachmavita, 2020).

One strategy to increase students' motivation to learn mathematics is through integrating mathematics learning with the surrounding culture (Fendrik et al., 2020). Mathematics is a subject that is very closely related to everyday life, so including cultural elements is very important to do. Culture contains mathematical elements that are often called ethnomathematics (Pathuddin & Raehana, 2019). The scope of ethnomathematics in mathematics education emphasizes socio-cultural influences, factors in learning activities, and mathematics is a cultural product (Lena et al., 2019). Ethnomathematics can make it easier for students to learn mathematics. This is because learning will be in accordance with the local cultural context and related to everyday life, so that students are able to explore their creative ideas more easily (Rudyanto et al., 2018). Thus, it can be emphasized that mathematics learning is also related to elements of the surrounding culture which can be used to foster learning motivation.

Another effort to increase learning motivation can be done by utilizing the use of innovative media as a learning resource or teaching material (Andriani et al., 2024). In line with this statement, another opinion states that one way to increase student learning motivation is through the use of interesting learning methods and utilizing innovative learning media (Firdayati, 2020). Innovative learning media can be developed in accordance with current technological developments. By utilizing the latest technology, students can access learning materials more easily and flexibly, and engage in more interesting and relevant learning experiences (Nurvitasari1 & Sulisworo, 2023). Learning media are aids designed to meet educational needs, and can be created in various forms, including audio, visual, or other forms that are in accordance with technological developments (Hariyono & Nur Widhi, 2021). Technology-based learning media can provide enthusiasm and attract students' attention and interest so that they are motivated to carry out active learning (Rachmavita, 2020). The limited availability of technology-based interactive learning media in mathematics learning has an impact on students' learning process (Putri et al., 2023).

Another opinion states that one approach to increasing learning motivation is to use technology-based learning media to enhance students' learning experiences (Wong et al., 2022). The use of technology in subject integration certainly has the hope of simplifying and visualizing abstract concepts into something that is easy to understand. Current technology provides opportunities for students to access it and interact through it in achieving their learning experience (Ozcakir & Cakiroglu, 2021). Another opinion explains that technology is very important as a form of new innovation in learning media to help students' mathematics learning process (Syafril et al., 2021). Mathematics learning in this case requires technology that is appropriate to learning needs. Mathematics learning that is packaged by integrating technology in it is able to provide a meaningful learning experience, both in terms of content, procedures, products, and learning environments (Guzmán et al., 2018).

One form of technology that can be used as a medium for learning mathematics is Augmented Reality (AR). AR is a technology medium that has the ability to combine virtual experiences with the real world, providing a more realistic impression at a much higher level of reality (Zhao & Wang, 2024). The use of AR in learning can make it easier for students to understand teaching materials according to the real situations and conditions they face (Ferdiman et al., 2023). Mathematics learning that adapts AR-based technology as a medium is very effective, especially for geometry or other materials, because it is able to provide appropriate learning experiences to students (Ozcakir & Cakiroglu, 2021). AR-based mathematics learning can provide learning experiences in analyzing information, predicting outcomes, improving problem-solving skills, and improving decision-making skills (Hanggara et al., 2023). Geometry learning materials packaged with AR-based technology can provide a special attraction for students (Auliya & Munasiah, 2019).

The use of AR technology with an ethnomathematics approach is expected to be able to increase students' motivation to learn mathematics. Previous relevant research related to the use of technology as a learning resource measures more on the relationship between media use and its influence on student learning outcomes. There are previous studies that have been conducted on mathematics learning that examine ethnomathematics and learning motivation, but these studies have not used AR technology. Some of these studies include research by Buchori & Prasetyowati, 2021; Amelia et al., 2022; Sa'diah et al., 2022; Mahmudah et al., 2023; Mahmud & Cempaka, 2022; Lena et al., 2019; dan Rudyanto et al., 2018. There is still a limited number of studies that review or present a brief overview of the ethnomathematics approach in fostering learning motivation, which combines AR technology using the Systematic Literature Review method. The novelty of this research is analyzing efforts to foster motivation to learn mathematics through the use of AR technology with an ethnomathematics approach that is in accordance with the needs of students in learning mathematic. This research is important to be conducted so that further research can use existing technology or design technology as a learning resource either as teaching materials, media, or supporting teaching aids to increase motivation to learn mathematics. The purpose of this study is to describe (1) the importance of using AR in mathematics learning; (2) the use of technology in ethnomathematics; and (3) the effect of AR in fostering learning motivation.

B. METHODS

The method used in this study is a systematic literature review (SLR) by adapting a qualitative descriptive approach. Systematic literature review (SLR) is a way to explore previous articles or research, then synthesize and analyze scientific evidence to answer a topic or thing systematically (Lame, 2019). Research questions are made based on the needs of the chosen topic. The research questions in this study are (1) how important is AR in mathematics learning; (2) how is the use of technology in ethnomathematics; and (3) how is the effect of AR in fostering learning motivation.

This study applies the PRISMA (Preferred Recording Items for Systematic Review and Meta-analysis) technique with a flow diagram of databases and registers only mode through several procedures, namely identification, screening and inclusion (Prill et al., 2021). The identification process is carried out by searching for articles according to the research

questions. The search process is used to obtain relevant sources to answer the Research Question and other related references (Haddaway et al., 2022). The article search process uses the keywords "Ethnomathematics and augmented reality in mathematics learning", then "Motivation to learn mathematics" with a standard reference search engine in international journals indexed by Scopus with the site address https://www.sciencedirect.com/ and as a supporter using the site https://www.google.com.

Furthermore, criteria are determined to decide whether the data found is suitable for use in research or not. Studies are suitable for selection if they meet inclusive and exclusive criteria. Inclusive criteria include (1) IC1: Scopus indexed international journals published between 2015-2024; (2) IC2: ethnomathematics and augmented reality in mathematics learning; and (3) IC3: fostering motivation to learn mathematics. While exclusive criteria include (1) EC1: determination of duplicate articles; (2) EC2: not included in mathematics learning; (3) EC3: learning in the realm of disabilities; and (4) EC4: close access. The results of the collection of these articles are then analyzed and synthesized. Researchers determine the Quality Assessment, namely A1: International journals published between 2015 - 2024, A2: whether they discuss the use of AR media in mathematics learning and A3: whether the use of technology is able to foster students' motivation to learn mathematics. This data filtering is used to answer research questions. Furthermore, researchers collect data based on predetermined criteria, then analyze the data that has been collected. The results of the data analysis will be used as a reference in answering research questions. The results of the article screening analysis are presented in a flow chart as shown in Figure 1.

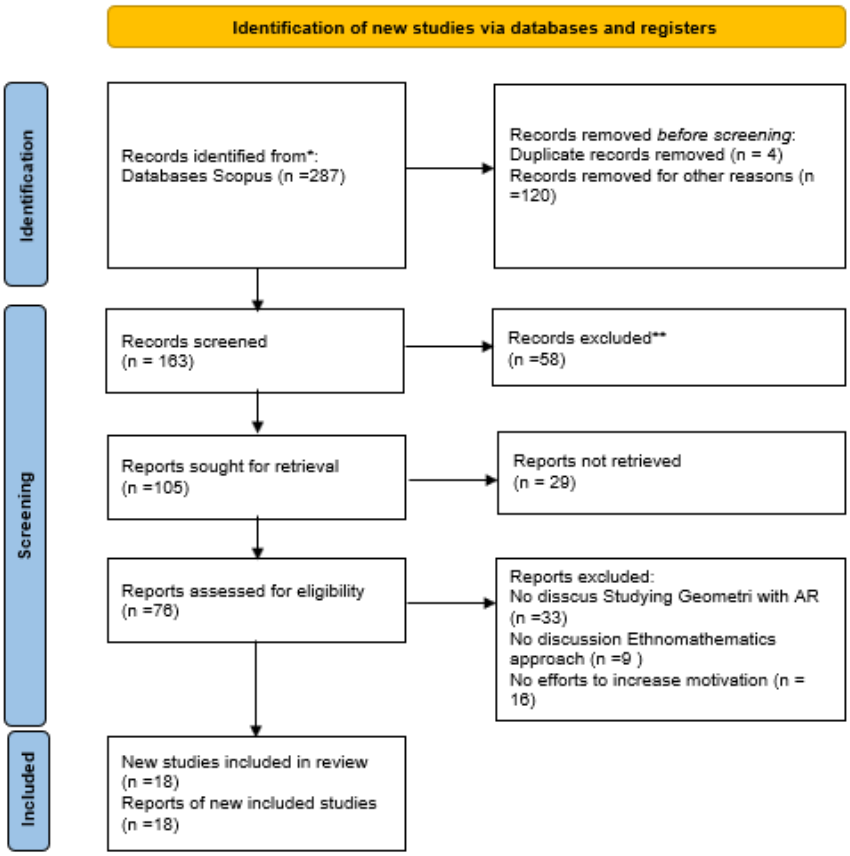

Figure 1. PRISMA flow chart result

The search results using keywords obtained 287 articles. The screening process of the articles recorded 163 articles that met the criteria. Furthermore, they were selected and searched to take the complete file based on the "open access" article for a deeper review and produced 105 articles. After adjusting the eligibility, 76 articles were obtained that met. Reduction was carried out again by looking at the feasibility study through Quality Assessment so that 18 final articles were obtained.

C. RESULT AND DISCUSSION

The results of the article search process on the "Scopus" database with inclusive criteria topics with each keyword "Ethnomathematics and augmented reality of mathematics learning" then "Motivation to learn mathematics" obtained 287 articles. The distribution of data on the number of studies each year can be seen in Figure 2.

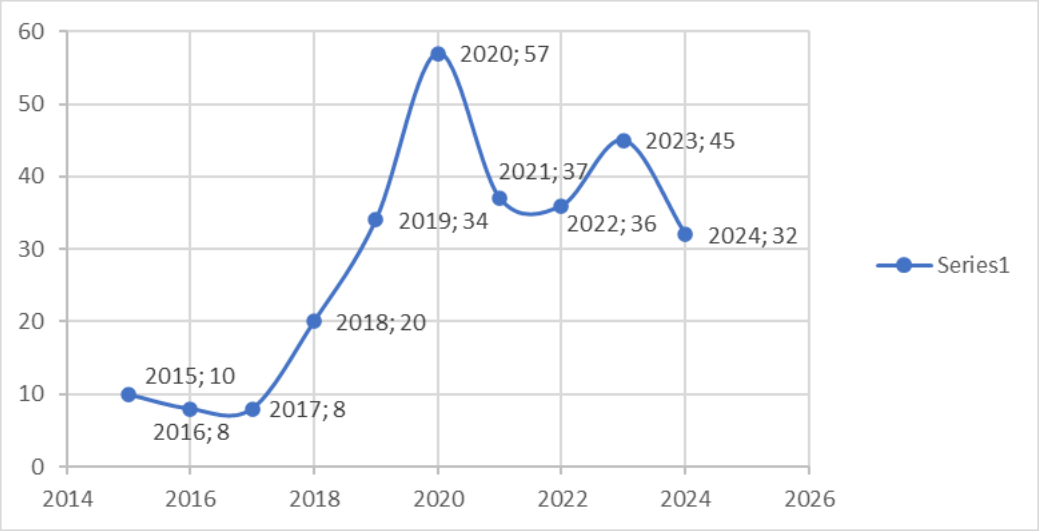

Figure 2. Search Result Article Data

Based on Figure 2, it is known that 10 articles were published in 2015, 8 articles were published in 2016 and 2017, 20 articles in 2018, 34 articles were published in 2019, 57 articles were published in 2020, 37 articles were published in 2021, 36 articles were published in 2022, 45 articles were published in 2023 and 32 articles were published in 2024. Notes on articles that were deleted due to duplication were 4 articles while notes on articles that were deleted due to other criteria were 120 articles. So that the results of the screening of the articles recorded 163 articles that met the criteria. Furthermore, they were selected and searched to take the complete file based on the "open access" article for a deeper review and 105 articles were produced. After adjusting the feasibility of the entire content, 76 articles were obtained that met. Reduction was carried out by looking at the feasibility study through exceptions based on Quality Assessment. Based on the results of the Quality Assessment, 18 final articles were obtained with data as in Table 1.

Table 1. The Result of Quality Assesmen

No.	Nama Penulis	Hasil Penelitian	A1	A2	A3
1	Iparraguirre-Villanueva, 2024	This research is about the context of using AR technology that the GeoGebra v calculator in 3 dimensions with AR is very useful, helps improve mathematics learning, and motivates students.	√	√	√
2	Syafril et al., 2021	This study successfully designed and tested how effective the virtual geometry application is in AR-based mathematics learning. Overall, it can attract students' interest and motivation if the material provided is taught through various learning tools and media.	√	√	√
3	Ozcakir & Cakiroglu, 2021	The use of AR technology provides a very important and effective way to learn three-dimensional geometric objects by imitating reality by simply complementing it with virtual elements. AR helps to increase learning motivation through the use of smartphones as a supporting mechanism for learning mathematics.	√	√	√
4	Wong et al., 2022	Research states that the use of AR in learning mathematics is something fun and motivating. Learning content using AR makes mathematical concepts clearer and can apply what to real life.	√	√	√
5	Volioti, 2023)	AR technology has an important role in improving the learning experience of students in elementary schools. AR has the potential to engage, motivate, and deepen understanding and needs to be accompanied by student-centered learning activities.	√	√	√
6	Koparan et al., 2023	This research on the context of using AR technology shows that its use for geometry learning and learning methods supported by AR technology can improve student learning outcomes.	√	√	√
7	Cai, 2020	Learning by integrating AR in mathematics has a positive impact on students' learning outcomes and attitudes.	√	√	√
8	Richardo et al., 2023	This research is about the context of using AR technology by combining the cultural context or ethnomathematics context of Yogyakarta, which can effectively improve creative thinking skills and foster students' learning motivation.	√	√	√
9	Nadzri, 2023	This research is about the context of using AR technology, that teaching materials with a combination of AR technology can improve achievement and foster motivation to learn mathematics in geometry material.	√	√	√
10	Rudyanto et al., 2018	The results of the study show that Flash Multimedia Technology arranged in ethnomathematics can make it easier for students to learn mathematics more flexibly, in accordance with the Indonesian cultural context, and related to everyday life	√	√	√
11	Lena et al., 2019	The results of the study show that the design of learning resources developed with a scientific approach characterized by ethnomathematics in geometry material is interesting to use in learning in elementary schools.	√	√	√
12	Fendrik fendrik et al., 2020	The results of the study show that ethnomathematics learning becomes more interesting and meaningful for students, especially in geometry subjects.	√	√	√

No.	Nama Penulis	Hasil Penelitian	A1	A2	A3
13	Muhammad et al., 2019	The results of the study show that students have good literacy skills in geometry material through an ethnomathematics approach at Borobudur Temple.	√	√	√
14	Damayanti et al., 2023	Development of curved three-dimensional shape learning media ethnomathematics-based using AR can be used as a mathematics learning media.	√	√	√
15	Wang & Yu, 2015	The results of the study showed that student learning motivation increased significantly with the use of interactive media.	√	√	√
16	Guo & Chen, 2021	The results of this study indicate that strategies to increase motivation to learn mathematics by integrating the use of technology are not limited to achieving learning objectives alone, but rather to stimulate the will, help, and inspire in achieving success in learning mathematics.	√	√	√
17	Rachmavita, 2020	The results of this study indicate that to increase students' learning motivation, it is necessary to have interactive media technology that is attractive both in terms of appearance and media content.	√	√	√
18	Poçan, 2023	The results of the study show that the application of mobile AR technology used in the learning context environment has a positive effect on mathematics learning achievement and motivation.	√	√	√

Based on the data in Table 1, several studies were selected because they had sufficient problems, approaches, and information for data selection. Furthermore, an analysis was carried out in order to answer the following research questions.

1. The Importance of AR in Mathematics Learning

The results obtained in Table 2 show several relationships between mathematics learning integrated with the use of AR technology. The data description is based on findings in research that mention the success of using AR as a learning resource (applications, teaching aids, teaching materials, and supporting devices for mathematics learning). Based on the results of the analysis, it was found that the use of AR in mathematics learning is very important because it has a positive impact as in the following Table 2.

Table 2. The importance of using AR

No.	The Important Impact of Using AR on Mathematics Learning	Number of Reference Articles
1	Improving learning outcomes	2
2	Improving learning motivation	6
3	Improving the quality of mathematics learning	1
4	Creating enjoyable learning	1
5	Improving students' learning experiences	1
6	Improving creative thinking skills	1

Based on the Table 2, it can be seen the importance of using AR which can have a positive impact on mathematics learning. Several studies have shown that the implementation of AR technology in mathematics learning geometry material has shown success and benefits ranging from understanding the concept of the material, ease of use, to enthusiasm and growth of

student motivation (Ozcakir & Cakiroglu, 2021)(Wong et al., 2022)(Koparan et al., 2023)(Cai et al., 2020)(Nadzri et al., 2023). Augmented reality that can provide success is certainly inseparable from the role of teachers as designers in the classroom. Augmented reality is not easy to use in a context without planning, teachers must design it carefully and analyze learning needs. Teachers as facilitators and developers in learning can compile learning procedures in using AR, design task processes using AR, or make it easier to adjust learning needs according to the analysis of the material to be delivered. Learning mathematics with appropriate technology can provide success in achieving learning goals.

AR technology for learning offers many benefits that support the process of teaching and learning mathematics. The application of AR makes it easier for students to learn geometry and this happens through the visualization of spatial figures (Ozcakir & Cakiroglu, 2021). Many mathematical materials can be solved using this tool, but the easiest to relate to real situations is the geometry of solid shapes. The success of using AR is because it can display the actual appearance without having to present the concrete object. Tools scanned via mobile phones can be easily displayed by teachers and students themselves. Learning becomes fun because technology in learning with AR is still limited (Wong et al., 2022). Learning mathematics, especially in schools, with this tool can simplify abstract concepts into something more concrete and therefore more meaningful. The advantages of using AR in learning are that users can create and experiment with real situations presented, the device is user-friendly, and easy to use (Villanueva et al., 2024). Another opinion states that learning technology using AR has three advantages, namely (1) the availability of detailed displays of objects and learning materials in a realistic manner; (2) its interactivity is supported by the latest and sophisticated video, image and animation features; and (3) it increases student motivation and interest in learning (Syafril et al., 2021).

2. The Use of Technology in Ethnomathematics

The results of the research review on the use of technology in ethnomathematics generally show good relationships. The ethnomathematics approach certainly requires the support of learning media in a process, both in core learning activities, as an intermediary media, or in fostering motivation to learn mathematics. Learning with an ethnomathematics approach becomes more interesting and meaningful for students, especially in geometry subjects (Rudyanto et al., 2018). Teachers as facilitators integrate culture in mathematics learning and develop cultural content to support elementary school students' mathematical connection skills. The use of the ethnomathematics approach has an influence on the success of learning (Lena et al., 2019; Fendrik et al., 2020; Muhammad et al., 2019). The advantages of the ethnomathematics approach include: (1) ethnomathematics provides greater insight for students, both in mathematics and its relationship to natural materials and culture; (2) makes learning more interesting; (3) provides elements of culture and other knowledge; and (4) builds nationalism and love for local culture (Lena et al., 2019). The ethnomathematics approach provides success and space for ease in exploring learning experiences.

Cultural integration combined with technology in mathematics learning provides more interesting benefits so that it can increase students' motivation to learn (Rudyanto et al., 2018). For example, the integration between AR technology and an ethnomathematics approach in the

form of developing Curved Three-Dimensional Shape Learning Media is declared feasible and can help improve student motivation and learning outcomes (Damayanti et al., 2024). From the study, it shows that the student response to learning reaches 96% very good. Students feel interested and motivated to learn and are more active in participating in learning activities. Other studies on the development of ethnomathematics augmented reality and android-based learning multimedia state that the combination of AR and ethnomathematics can improve creative thinking skills, learning motivation and student learning outcomes (Richardo et al., 2023). The results of the practicality test of the media by the teacher reached a percentage of 89% while the practicality test by the students reached 84%.

Although not many people use it yet, AR technology has the potential to be integrated with the ethnomathematics approach. This is because ethnomathematics objects from cultural elements can be a medium to display real situations in AR (Sudirman et al., 2020). Another opinion states that the integration of AR and ethnomathematics can be a medium to help preserve local culture in an area (Phunsa, 2014). Researchers and practitioners should be able to use this media as a tool to help learn mathematics because the character of students in elementary schools is still in the concrete operational stage so it will be easier to use to introduce mathematical concepts (Richardo et al., 2023; Guo & Chen, 2021).

3. The effect of AR on learning motivation

Certain interactive technologies or media can increase motivation to learn mathematics, are claimed to be more interesting and can focus students' attention (Rachmavita, 2020). The results of a review of several filtered articles show that most of them state that students' learning motivation increases with the use of technology-based interactive learning media. Technology-based learning media that is used directly for learning certainly provides more attention to students. This means that technology attracts attention if there is direct involvement in its use by teachers and students.

One study stated that the application of AR technology used in learning has an effect on motivation to learn mathematics (Poçan et al., 2023). The post-test score of students' learning motivation using AR was 4.32 while those who did not use AR were 4.05. The test results showed a significant difference so that it can be said that learning using AR technology media can increase students' learning motivation. Other studies have shown that there is a significant difference in student performance between the experimental group and the control group with a score for the post-test ($F(1,59) = 33.848$, $p = 0.000$; eta squared = 0.377) and the delayed post-test ($F(1,59) = 14.740$, $p = 0.000$; eta squared = 0.208). This shows that the use of AR-based modules can improve students' learning achievement because they have a good understanding of concepts and learning motivation (Nadzri et al., 2023). Research on the use of AR-based mobile learning media obtained the results of the t-test differences between the experimental group and the control group, there was a significant difference ($t = 2.99$, $p < 0.01$) with an average motivation score of the experimental group of 4.05 and the control group of 3.63. This shows that AR-based mobile learning media can increase students' learning motivation (Chiang et al., 2014). Other research explains that the strategy of using technology in learning can increase students' learning motivation, foster interest in learning and the desire

to learn, and maintain active and efficient learning conditions (Wang & Yu, 2015; Guo & Chen, 2021).

All components of the learning strategy play an important role in increasing learning motivation, depending on learning needs and will increase further if a contextual approach is used that is related to everyday life (Yeni et al., 2019). The use of AR can be integrated with a culture-based approach that is appropriate to the context of everyday life because learning will become more interesting (Richardo et al., 2023). This integration potential can be an opportunity for further researchers to combine the ethnomathematics approach with AR technology to increase student learning motivation. Research that integrates AR with ethnomathematics is still limited so that more in-depth research can be conducted. This integration will provide benefits, including ethnomathematics elements can become real objects displayed in AR and can help preserve local culture in a region (Sudirman et al., 2020; Phunsa, 2014). In general, the relationship between AR and ethnomathematics has a good impact and is influential in fostering learning motivation (Damayanti et al., 2024).

D. CONCLUSION AND SUGGESTIONS

Based on the results of the research that has been conducted referring to the results of the SLR conducted in journals published from 2015 - 2024, it can be concluded that (1) the use of AR in mathematics learning is very important because it has a positive impact such as improving learning outcomes, increasing learning motivation, improving the quality of mathematics learning, creating fun learning, improving student learning experiences and improving creative thinking skills; (2) Cultural integration combined with technology provides benefits, namely learning becomes more interesting so that it can foster student learning motivation, the form of integration between AR technology and ethnomathematics can be in the form of developing interactive learning media, modules or android-based media; and (3) several studies that use AR-based learning media provide significant results in increasing student learning motivation. The weakness of this study is the limited number of articles that discuss direct intervention between AR, ethnomathematics and its influence on students' learning motivation. In addition, several relevant studies could not be reviewed because the articles were inaccessible (closed access). This can be an opportunity and recommendation for further research to combine the ethnomathematics approach with AR technology to improve students' learning motivation through the development of various forms of interactive learning media.

ACKNOWLEDGEMENT

The author would like thank to the Rector and LPPM of Universitas Muhammadiyah Kudus who have given to author the opportunity to conduct research. Author also would like to thank all parties who have helped. The author hopes that this article can be useful for the author himself in particular and society in general and can be used as a reference for further research.

REFERENCES

Amelia, S., Wedi, A., & Husna, A. (2022). Pengembangan Modul Berbantuan Teknologi Augmented Reality Dengan Puzzle Pada Materi Bangun Ruang. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *5*(1), 62–71. https://doi.org/10.17977/um038v5i12022p062

Andriani, D., Afas, M. Z., Irawan, I., & Rofiqah, A. (2024). Pengaruh Media LKPD Interaktif Berbasis Liveworksheet Terhadap motivasi dan Hasil belajar Bahasa Inggris siswa kelas VII MTs Nurul Huda. *Titian Ilmu: Jurnal Ilmiah Multi Sciences*, *16*(2), 79–86.

Auliya, R. N., & Munasiah, M. (2019). Mathematics learning instrument using augmented reality for learning 3D geometry. *Journal of Physics: Conference Series*, *1318*(1), 0–5. https://doi.org/10.1088/1742-6596/1318/1/012069

Buchori, A., & Prasetyowati, D. (2021). Pengembangan E-Modul Matematika Interaktif Berbasis Augmented Reality Pada Materi Bangun Ruang. *Widya Balina*, *6*(2), 325–338. https://doi.org/10.53958/wb.v6i2.195

Cai, S., Liu, E., Shen, Y., Liu, C., Li, S., & Shen, Y. (2020). Probability learning in mathematics using augmented reality: impact on student's learning gains and attitudes. *Interactive Learning Environments*, *28*(5), 560–573. https://doi.org/10.1080/10494820.2019.1696839

Chen, H., Disney, L., & Li, L. (2024). Studying children's motives in mathematical problem-solving during transition from kindergarten to school: A Conceptual PlayWorld approach. *Learning, Culture and Social Interaction*, *48*(August), 100850. https://doi.org/10.1016/j.lcsi.2024.100850

Chiang, T. H. C., Yang, S. J. H., & Hwang, G. J. (2014). An augmented reality-based mobile learning system to improve students' learning achievements and motivations in natural science inquiry activities. *Educational Technology and Society*, *17*(4), 352–365.

Damayanti, I. I., Ayu, A., Sariah, U. I., Mustaqfiroh, M., Oktaviani, I. A., & Nursyahidah, F. (2024). Development of ethnomathematics-based curved three-dimensional shape learning media using augmented reality. *AIP Conference Proceedings*, *3106*(1), 86–96. https://doi.org/10.1063/5.0215290

Fendrik, M., Marsigit, & Wangid, M. N. (2020). Analysis of riau traditional game-based ethnomathematics in developing mathematical connection skills of elementary school students. *Elementary Education Online*, *19*(3), 1605–1618. https://doi.org/10.17051/ilkonline.2020.734497

Ferdiman, B., Al Akbar, H., Faturrahman, M. R., & Maulana, F. I. (2023). Development of Augmented Reality Application in Physics through Newton's Laws and Object Interaction. *Procedia Computer Science*, *227*, 699–708. https://doi.org/10.1016/j.procs.2023.10.574

Firdayati, L. (2020). Peningkatan Motivasi Belajar Siswa Melalui Discovery Learning Dengan Geogebra Pada Materi Transformasi. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(3), 833. https://doi.org/10.24127/ajpm.v9i3.2899

Guo, N., & Chen, J. (2021). Application of Learning Motivation Theory in Mathematics Teaching in Primary Schools. *ACM International Conference Proceeding Series*, 626–629. https://doi.org/10.1145/3452446.3452598

Guzmán, J. L., Piguet, Y., Dormido, S., Berenguel, M., & Costa-Castelló, R. (2018). New Interactive Books for Control Education∗. *IFAC-PapersOnLine*, *51*(4), 190–195. https://doi.org/10.1016/j.ifacol.2018.06.064

Haddaway, N. R., Page, M. J., Pritchard, C. C., & McGuinness, L. A. (2022). *Campbell Systematic Reviews - 2022 - Haddaway - PRISMA2020 An R package and Shiny app for producing PRISMA 2020-compliant.pdf* (pp. 1–14).

Hanggara, Y., Qohar, A., & Sukoriyanto. (2023). Interactive Mobile Technologies. *International Journal of Interactive Mobile Technologies*, *17*(15), 135–154.

Hariyono, M., & Nur Widhi, E. (2021). Geoshape Digital: Media Pembelajaran Dalam Meningkatkan Pemahaman Konsep Matematika Sd. *Jurnal Ilmiah Pendidikan Dasar*, *8*(1), 35. https://doi.org/10.30659/pendas.8.1.35-50

Held, T., & Hascher, T. (2023). Stability and change of secondary school students' motivation profiles in mathematics: Effects of a student intervention. *Journal of School Psychology*, *100*.

Hu, J., Kang, T., Zhang, J., & Ma, X. (2024). The chain mediating effect of learning goal distress and excessive learning motivation from unknown locus of control on migrant middle school students' learning anxiety. *Acta Psychologica*, *248*(June), 104350.

https://doi.org/10.1016/j.actpsy.2024.104350

Koparan, T., Dinar, H., Koparan, E. T., & Haldan, Z. S. (2023). Integrating augmented reality into mathematics teaching and learning and examining its effectiveness. *Thinking Skills and Creativity*, *47*(February), 101245. https://doi.org/10.1016/j.tsc.2023.101245

Lame, G. (2019). Systematic literature reviews: An introduction. *Proceedings of the International Conference on Engineering Design, ICED*, *2019-Augus*(AUGUST), 1633–1642. https://doi.org/10.1017/dsi.2019.169

Lena, M. S., Netriwati, N., & Suryanita, I. (2019). Development of teaching materials of elementary school student with a scientific approach characterized by ethnomathematics. *Journal of Physics: Conference Series*, *1318*(1). https://doi.org/10.1088/1742-6596/1318/1/012060

Mahmud, M., & Cempaka, M. (2022). Pengembangan E-Modul Pembelajaran Tematik Terintegrasi Profil Pelajar Pancasila Berbasis Augmented Reality (AR). *Jurnal Kajian Dan Pengembangan Umat*, *5*(2), 154–167. https://doi.org/10.31869/jkpu.v5i2.3818

Mahmudah, R., Kudsiah, M., Ahmadi, Z., & Rohim. (2023). Pengembangan Modul Interaktif Berbasis Augmented Reality Pada Materi Bangun Ruang Kelas V Sekolah Dasar. *PEDAGOGIC: Indonesian Journal of Science Education and Technology*, *3*(2), 65–74. https://doi.org/10.54373/ijset.v3i2.206

Muhammad, A. F. N., Marsigit, & Soeharto. (2019). A case study of geometri literacy in elementary school through ethnomathematics at borobudur temple Indonesia. *International Journal of Scientific and Technology Research*, *8*(10), 1041–1045.

Nadzri, A. Y. N. M., Ayub, A. F. M., & Zulkifli, N. N. (2023). The Effect of Using Augmented Reality Module in Learning Geometry on Mathematics Performance among Primary Students. *International Journal of Information and Education Technology*, *13*(9), 1478–1486. https://doi.org/10.18178/ijiet.2023.13.9.1952

Nurmaya, R., Herawati, R., & Ratnaningsih, N. (2021). Pengembangan Bahan Ajar Berbasis Etnomatematika Pada Materi Transformasi Geometri. *RANGE: Jurnal Pendidikan Matematika*, *2*(2), 123–129. https://doi.org/10.32938/jpm.v2i2.941

Nurvitasari1, I., & Sulisworo, D. (2023). Pengembangan LKPD Berbasis Augmented Reality Sebagai Media Pembelajaran Matematika. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *7*(1), 1. https://doi.org/10.33603/jnpm.v7i1.5347

Ozcakir, B., & Cakiroglu, E. (2021). An augmented reality learning toolkit for fostering spatial ability in mathematics lesson: Design and development. *European Journal of Science and Mathematics Education*, *9*(4), 145–167. https://doi.org/10.30935/SCIMATH/11204

Pathuddin, H., & Raehana, S. (2019). Etnomatematika: Makanan Tradisional Bugis Sebagai Sumber Belajar Matematika. *MaPan*, *7*(2), 307–327. https://doi.org/10.24252/mapan.2019v7n2a10

Phunsa, S. (2014). Applying Augmented Reality Technology to Promote Traditional Thai Folk Musical Instruments on Postcards. *Proceedings of the International Conference on Computer Graphics, Multimedia and Image Processing, Kuala Lumpur, Malaysia, 2014*, *August*, 64–68.

Poçan, S., Altay, B., & Yaşaroğlu, C. (2023). The Effects of Mobile Technology on Learning Performance and Motivation in Mathematics Education. *Education and Information Technologies*, *28*(1), 683–712. https://doi.org/10.1007/s10639-022-11166-6

Prill, R., Karlsson, J., Ayeni, O. R., & Becker, R. (2021). Author guidelines for conducting systematic reviews and meta-analyses. *Knee Surgery, Sports Traumatology, Arthroscopy*, *29*(9), 2739–2744. https://doi.org/10.1007/s00167-021-06631-7

Putri, S. N., Anak Agung Gede Agung, & I Kadek Suartama. (2023). E-module with the Borg and Gall Model with a Contextual Approach to Thematic Learning. *Journal for Lesson and Learning Studies*, *6*(1), 27–34. https://doi.org/10.23887/jlls.v6i1.57482

Rachmavita, F. P. (2020). Interactive media-based video animation and student learning motivation in mathematics. *Journal of Physics: Conference Series*, *1663*(1). https://doi.org/10.1088/1742-6596/1663/1/012040

Richardo, R., Wijaya, A., Rochmadi, T., Abdullah, A. A., Nurkhamid, Astuti, A. W., & Hidayah, K. N. (2023). Ethnomathematics Augmented Reality: Android-Based Learning Multimedia to Improve Creative Thinking Skills on Geometry. *International Journal of Information and Education Technology*, *13*(4), 731–737. https://doi.org/10.18178/ijiet.2023.13.4.1860

Rudyanto, H. E., Ghufron, A., Hartono, & Gembong, S. (2018). Multimedia flash mathematics with cultural perspective (Ethnomathematics) to develop elementary school students' creative thinking. *Journal of Advanced Research in Dynamical and Control Systems*, *10*(6 Special Issue), 1714–1720.

Sa'diah, Ruhiat, Y., & Sholihah. (2022). Vox Edukasi : Jurnal Ilmiah Ilmu Pendidikan PENGEMBANGAN E-Modul Interaktif Berbasis Augmented. *Vox Edukasi: Jurnal Ilmiah Ilmu Pendidikan*, *13*(April), 21–29. http://jurnal.stkippersada.ac.id/jurnal/index.php/VOX

Sudirman, S., Yaniawati, R. P., Melawaty, M., & Indrawan, R. (2020). Integrating ethnomathematics into augmented reality technology: Exploration, design, and implementation in geometry learning. *Journal of Physics: Conference Series*, *1521*(3). https://doi.org/10.1088/1742-6596/1521/3/032006

Supriadi, N., Jamaluddin Z, W., & Suherman, S. (2024). The role of learning anxiety and mathematical reasoning as predictor of promoting learning motivation: The mediating role of mathematical problem solving. *Thinking Skills and Creativity*, *52*(December 2023), 101497. https://doi.org/10.1016/j.tsc.2024.101497

Syafril, S., Asril, Z., Engkizar, E., Zafirah, A., Agusti, F. A., & Sugiharta, I. (2021). Designing prototype model of virtual geometry in mathematics learning using augmented reality. *IOP Conference Series: Earth and Environmental Science*, *1796*(1). https://doi.org/10.1088/1742-6596/1796/1/012035

Villanueva, O. I., Paulino-Moreno, C., Chero-Valdivieso, H., Espinola-Linares, K., & Cabanillas-Carbonell, M. (2024). Integration of GeoGebra Calculator 3D with Augmented Reality in Mathematics Education for an Immersive Learning Experience. *International Journal of Engineering Pedagogy*, *14*(3), 92–107. https://doi.org/10.3991/ijep.v14i3.47323

Wang, Y. Z., & Yu, C. Z. (2015). Effect of interactive E-Learning on pupils' learning motivation and achievement in mathematics. *Communications in Computer and Information Science*, *529*, 313–317. https://doi.org/10.1007/978-3-319-21383-5_53

Wong, J., Bayoumy, S., Freeke, A., & Cabo, A. J. (2022). Augmented Reality for Learning Mathematics: a Pilot Study With Webxr As an Accessible Tool. *SEFI 2022 - 50th Annual Conference of the European Society for Engineering Education, Proceedings*, 1805–1814. https://doi.org/10.5821/conference-9788412322262.1216

Yeni, Y. R., Syarifuddin, H., & Ahmad, R. (2019). The effect of contextual teaching and learning approach and motivation of learning on the ability of understanding the mathematics concepts of grade v student. *IOP Conference Series: Earth and Environmental Science*, *314*(1). https://doi.org/10.1088/1755-1315/314/1/012064

Zhao, Y., & Wang, Q. (2024). Applying augmented reality multimedia technology to construct a platform for translation and teaching system. *Heliyon*, *10*(7), e28700. https://doi.org/10.1016/j.heliyon.2024.e28700