Volume 2, Nomor 1, March 2024
Pi-Radian: Journal of Mathematics Education
https://journal.pustakailmiah.id/index.php/piradian
DOI: https://doi.org/10.63214/piradian.v2i1.pp41-50

DEVELOPMENT OF AUGMENTED REALITY LEARNING MEDIA TO IMPROVE MATHEMATICAL PROBLEM-SOLVING SKILLS OF 8TH GRADE JUNIOR HIGH SCHOOL STUDENTS

Sheilla Zalzabilla Al-jabar[1], Siti Rosidah[2], Eka Ririn Nur Rosidah[3]

[1]IKIP Siliwangi, Indonesia
aljabarfortask@gmail.com
[2]IKIP Siliwangi, Indonesia
sitirosidah928@gmail.com
[3]IKIP Siliwangi, Indonesia
ririn.aljawawiyah.29@gmail.com

Article Info

Article History
Received: 20-01-2023
Revised: 03-03-2024
Accepted: 21-03-2024

Keywords
Development of learning media;
Augmented Reality;
Mathematical problem solving skills

Corresponding Author
Sheilla Zalzabilla Al-jabar,
IKIP Siliwangi
Cimahi, Indonesia
aljabarfortask@gmail.com

Abstract

This research aims to develop learning media that can assist students in enhancing their mathematical problem-solving skills in 8th grade junior high school. This study utilizes a design research method with a development study approach conducted in two phases: initial design and formative evaluation, including self-evaluation, prototyping (expert review, one-to-one, and small groups), and field research conducted at SMP Negeri 7 Cimahi. The research subjects consist of 35 students from class VIII E of the junior high school. Data collection techniques used in this study include documentation, interviews, student response questionnaires, and tests. The research data are analyzed quantitatively and qualitatively. The data analysis results reveal that this study produces a logically reasoned mathematical thinking for Augmented Reality learning media on two-dimensional solid shapes that are valid, practical, and have potential effects. In this regard, the Augmented Reality learning media has valid and constructive content, as well as language validation from expert reviews. Conversely, the practicality of the Augmented Reality learning media has been achieved through revisions based on one-to-one feedback and small group discussions. Furthermore, the prototype of the Augmented Reality learning media has shown potential effects in enhancing students' mathematical problem-solving skills.

How to Cite:

Al-Jabar, S. Z., Rosidah, S., & Rosidah, E. R. N. (2024). Development of augmented reality learning media to improve mathematical problem-solving skills of 8th grade junior high school students. *Pi Radian: Journal of Mathematics Education*, *2*(1), 41-50.

Print ISSN: 3031-9552, Online ISSN: 3031-9544

INTRODUCTION

Mathematical abilities of students in Indonesia have not developed optimally and are still relatively low. According to the results of the Trends in International Mathematics and Science Study (TIMSS) study (Wafa & Fahmi, 2020), students' mathematical abilities, particularly in the field of geometry, ranked 51 out of 56 countries participating in the survey. In this survey, Indonesia obtained an average score of 394, while the international average was 500. One of the causes of difficulty in geometry topics is that students find it challenging to visualize the studied geometric figures, in line with the research objectives of Octaviani et al. (2021), which state that a lack of spatial visualization skills can affect students' ability to solve geometry problems, as supported by the research of Unonongo et al. (2021), on problem-solving in geometry, which showed a final result of 53.51% in the low category due to students' lack of understanding of two-dimensional solid shapes. Therefore, a solid understanding of the content, especially in two-dimensional solid shapes, is needed to overcome difficulties in problem-solving.

Novita et al. (2018), stated that difficulties in solving geometry problems are influenced by two factors: internal and external. Internal factors are influenced by students' interest in learning geometry and their intelligence, which play a significant role in strengthening geometry concepts. External factors are caused by inappropriate teaching methods. Based on these factors, appropriate media and methods are required to help students overcome their low problem-solving skill in geometry.

Learning media includes physical tools that can be used to deliver instructional content, such as books, pictures, and graphs. This aligns with the research conducted by Latifurrohman (Bernard, 2015), which found that using media in teaching is more engaging, and the presented material is easily understood by students. Students are required to be independent and capable of solving mathematical problems, especially in the topic of two-dimensional solid shapes. According to Mukaromah (2020), using media in teaching can provide new and enjoyable experiences for both teachers and students. It not only diversifies the learning process but also motivates students to enjoy and engage with the material, resulting in improved student mindset. By using media, students actively participate in the learning process, making learning about two-dimensional solid shapes more interesting, unique, and enjoyable. One such media is Augmented Reality technology.

Augmented Reality technology is a visual technology that combines virtual objects with real-world views in real-time (Pambudi et al. 2018). By using Augmented Reality technology on an Android smartphone, a three-dimensional virtual model similar to real objects can be used to visualize geometric objects directly on a flat surface, such as a piece of paper. Therefore, an Android-based application using Augmented Reality technology as a geometry learning media can be an alternative method to help students understand various specific geometric objects and enhance their problem-solving skills once they have visualized these two-dimensional solid shapes. Students will find it easier to solve problems encountered in their learning process.

Augmented Reality media can solve students' difficulties in visualizing geometric objects and also motivate them to engage in mathematics learning. The presence of Augmented Reality media can help students visualize abstract objects, as mentioned in the study by (Octaviani et al. 2021). When students can imagine abstract objects, such as two-

Print ISSN: 3031-9552, Online ISSN: 3031-9544

dimensional solid shapes, they will find problem-solving easier. Previous studies on the use of Augmented Reality learning media, such as Larasati & Widyasari (2021), have shown that learning with Augmented Reality media can significantly improve mathematical problem-solving skill, especially for students with kinesthetic and visual learning styles. Additionally, Pambudi et al. (2018), found that learning with Augmented Reality resulted in better learning outcomes compared to conventional methods.

Considering the importance of problem-solving skills, the National Council of Teachers of Mathematics Kelly (2006), states that students' abilities in making connections, reasoning, communication, problem-solving, and representation should be emphasized. Problem-solving skills in students can enhance their reasoning, critical thinking, and creativity in problem-solving (Puadi, 2016). Based on these considerations, the researcher aims to develop Augmented Reality learning media to enhance problem-solving skills in 8th grade junior high school students.

METHOD

This study focuses on the development of Augmented Reality learning media to enhance problem-solving skills in 8th grade junior high school students. The research model used is development research. Design Research is a research method with a development model to design and develop interventions in learning, such as teaching programs, strategies, and instructional materials (Nieveen & Folmer, 2013). The intervention in design research is to produce a program design, learning strategies, and instructional materials that can be used to empirically solve problems in the learning or educational process. This study employs a development research approach. Development studies involve developing design principles for practical benefits.

The development research is conducted in two phases: the preliminary phase and the formative evaluation phase. They include self-evaluation, prototyping (expert review and one-to-one with low resistance to revisions), small group evaluation, and field testing (high resistance to corrections). In the preliminary phase, the researcher arranges the research location, research subjects, and other preparations, including the research schedule. The formative evaluation phase is divided into three stages: self-evaluation, prototyping, and field testing.

Self-evaluation consists of two stages: analysis and design. The analysis stage is the initial stage in research development. In this stage, the researcher conducts a needs analysis and curriculum analysis. The needs analysis is carried out to understand the conditions of the school as the research subject, which requires the learning media designed by the researcher. Furthermore, the curriculum analysis is conducted to determine the curriculum used in the school, identify the core competencies, basic competencies, and topics covered in mathematics education that can be used as material for developing learning media based on the TPACK concept. In the design stage, the researcher designs the product to be developed, which is the Augmented Reality learning media to enhance problem-solving skills in junior high school students. The design of the learning media will be referred to as prototype I.

The prototyping stage consists of three phases: expert review, one-to-one, and small group evaluation. In this stage, the designed product is evaluated. Expert review involves

Print ISSN: 3031-9552, Online ISSN: 3031-9544

subject matter experts and media experts. The basis for expert review is to assess whether the provided learning media meets the students' needs. The assessment process is based on their expertise in problem-solving skills. This stage aims to test the validity of the problem items that include problem-solving skill indicators in the developed learning media, including content, construction, and language used in the media. The experts evaluate and validate the prototype I learning media developed in the self-evaluation stage. Based on the expert review, the Augmented Reality learning media is revised according to the suggestions and inputs from the experts. The opinions and feedback from the experts (validators) regarding the designed media are documented for revision purposes and to declare the validity of the student media. The revised prototype I in this stage is referred to as prototype II.

One-to-one is the stage where prototype I, which has been developed, is tested individually with several students. This stage runs parallel to the expert review stage, so the revised results in this stage are used to edit the designed learning media in prototype I to produce prototype II. Small group evaluation is the stage where prototype II is developed for expert review and tested one-to-one with several students who have different abilities (heterogeneous). In this stage, six students are asked to discuss and study the designed student media and provide comments or suggestions about the Augmented Reality learning media. This trial aims to determine the practicality of the developed learning material. Based on the feedback and suggestions from the students, the media is revised to produce prototype III.

Lastly, the field test is the stage of implementing the research with one class as the subject (35 students). The suggestions and trial results in prototype II are based on the revision of the prototype II design. The product tested in the field test must meet quality criteria. There are three quality criteria: validity (from experts), practicality (easy to use), and the potential to enhance students' mathematical problem-solving skills (potential effect).

RESULTS AND DISCUSSION

The development process of learning media consists of three stages: self-evaluation, prototyping (expert review, one-to-one, and small group), and field testing. Self-evaluation consists of two stages: analysis and design. In the analysis stage, the researcher conducts a needs analysis and curriculum analysis. The needs analysis is carried out to understand the school's condition as the research subject, which requires the development of learning media by the researcher. The conditions include conventional mathematics teaching to optimize time, lack of attention from teachers to students' understanding of the topic of two-dimensional solid shapes, students not being allowed to bring mobile phones to school, and the limited training on interactive and innovative learning media creation in schools, especially in mathematics education, despite the use of technology-assisted learning media.

The curriculum analysis is conducted to determine the curriculum used in the school, understand the core competencies, basic competencies, and topics covered in mathematics education that can be used as material for developing learning media based on the TPACK concept. After conducting the curriculum analysis, it was found that SMP Negeri 7 Cimahi uses the 2013 curriculum. Based on this curriculum, the core competencies for the topic of two-dimensional solid shapes include: (a) Appreciating and embracing the teachings of their religion, (b) Valuing and embodying honest, disciplined,

Print ISSN: 3031-9552, Online ISSN: 3031-9544

responsible, caring (tolerance, mutual cooperation), courteous, and confident behavior in effectively interacting with the social and natural environment within the scope of their interactions and existence, (c) Understanding and applying knowledge (factual, conceptual, and procedural) based on curiosity about science, technology, art, and culture related to observable phenomena and events, (d) Processing, presenting, and reasoning in the concrete domain (using, decomposing, arranging, modifying, and creating) and the abstract domain (writing, reading, calculating, drawing, and composing) according to what is learned in school and other sources with the same perspective/theory.

The basic competencies for the topic of two-dimensional solid shapes include: (1) Determining the surface area and volume of cubes, rectangular prisms, prisms, and pyramids, (2) Solving problems related to the surface area and volume of two-dimensional solid shapes such as cubes, rectangular prisms, prisms, and pyramids. In the design stage, the researcher designs the product to be developed, which is Augmented Reality learning media to enhance problem-solving skills in 8th grade junior high school students. The design of the learning media will be referred to as prototype I.

Figure 1. Augmented Reality Learning Media Interface

In Figure 1, the interface of the Augmented Reality learning media can be observed. After the evaluation stage, which resulted in the prototype I of the learning media, the learning media was further validated through expert review and one-to-one testing. Results should be clear and concise. The results should summarize (scientific) findings rather than providing data in great detail. Please highlight the differences between your results or findings and the previous publications by other researchers. The results of this stage will be presented in the table below:

Print ISSN: 3031-9552, Online ISSN: 3031-9544

Table 1. Table's Title

No	Aspect	First Validation			Second Validation		
		Score of Validator 1	Score of Validator 2	Score of Validator 3	Score of Validator 1	Score of Validator 2	Score of Validator 3
		Meida Expert	Media Expert	Media Practitioner	Media Expert	Media Expert	Media Practitioner
1.	Contents	4,4	4,5	4,2	4,8	4,5	4,2
2.	Apperance	3,2	3	3,5	5	4,5	4
3.	Audio	4,7	4	5	4	4	5
4.	Didactic	4,7	4,7	4	4,7	4,7	4
5.	Construction	4,3	4,5	4	4,8	4,5	4
6.	Technical	4,7	3	4	4,7	4,7	4
Score Average		4,025	3,94	4,12	4,67	4,47	4,24
Percentage		80,5%	78,9%	82,3%	93,4%	89,4%	84,8%
Criteria		quite valid	quite valid	very valid	very valid	very valid	very valid

Based on the above Table 1, the validation results of the Augmented Reality media obtained from validator 1 increased from 80,5% to 93,4%. Validator 2 showed an increase from 78.9% to 89.4%. The practitioner validator achieved a percentage of 82.3% in the first validation and 84.8% in the second validation.

Table 2. Results of Content Expert Validation (Expert Review)

No	Aspect	First Validation		Second Validation	
		Score of Validator 1	Score of Validator 2	Score of Validator 1	Score of Validator 2
		Material Expert	Material Practitioner	Material Expert	Material Practitioner
1.	Content	4	3,8	4	4
2.	Didactic	3,7	4	4,7	4
3.	Construction	4	3,5	4,5	4,5
4.	Technical	4,7	4,3	4	4,3
Score Average		4,08	3,9	4,29	4,21
Percentage		81,7%	78,2%	85,8%	84,2%
Criteria		very valid	valid	very valid	very valid

In Table 2, the content validation results obtained from validator 1, who is a lecturer, showed a score increase from 81,7% to 85,8%, both categorized as Highly Valid. Validator 2, who is a practitioner or subject teacher, maintained a score of 84,2%, remaining in the Valid category and becoming Highly Valid.

Based on the above research results, each stage can be categorized into two objectives: the feasibility of learning media and the effectiveness of learning media. Until the small group stage, the data obtained includes the validity of content experts, media experts, and student responses, all of which indicate a feasible category. Before the developed learning

Print ISSN: 3031-9552, Online ISSN: 3031-9544

media is widely used and implemented in schools, its suitability must be immediately checked and validated by experts. This validation assesses the validity of the developed instructional materials, and it is conducted by lecturers from IKIP Siliwangi and practitioners or mathematics teachers in schools, based on their expertise and criteria. This stage and implementation are considered appropriate according to Panjaitan et al. (2021), as the validation process by experts is an important sequence to determine the suitability of using the learning media. The validation is conducted with validators and appropriate assessment indicators.

This process is carried out to assess the progress of the learning media. The indicators used as references are based on Hendriana et al. (2017) in their article. In the validation stage of the learning media, which involved two expert validators and one validator from practitioners, the average score obtained was 89.2% with a highly positive criterion. This indicates that the Augmented Reality-assisted learning media is suitable for use with minor revisions. Additionally, the researchers validated the content by having it assessed by one expert validator and one practitioner validator. The average score obtained was 94.13% with a highly positive criterion. Consequently, the researchers conducted a limited trial of the learning media product and received positive responses from students who used the Augmented Reality learning media. Some revisions were made based on student feedback, including correcting typographical errors.

Once the media was deemed valid by the lecturers, it was then tested with students of varying proficiency levels in the classroom to gather their responses through questionnaires. The overall results of the student response questionnaires indicated that the media was effective in helping them visualize the previously abstract concept of two-dimensional objects. However, some feedback was given regarding typographical errors and unclear font choices when presented. The testing continued with a small group of 30 students representing high, low, and moderate proficiency levels, as outlined below:

Table 3. Student Responses on Learning Media (Small Group)

Point	Sum of Vote	Point x Sum of Vote
2	9	18
3	96	288
4	175	875
5	305	1525
Total	600	2706
Percentage		90,2%

In the small group testing phase, the student responses yielded a percentage of 90,2% with a highly positive category. After conducting the small group test, it can be concluded that the media is ready to be used in the learning process. Subsequently, a field test was conducted with one class of 35 eighth-grade students. The results are presented in the table below:

Print ISSN: 3031-9552, Online ISSN: 3031-9544

Table 4. Pretest-Posttest T-Test Results (Field Test)

Paired Samples Test							
		Paired Differences			t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	E Pretest – E Posstest	875	-46,94286	8,09482	1,36827	-49,72352	-44,16219

In Table 4, the obtained value for sig (2-tailed) is 0,000. Based on the above table, the sig (2-tailed) value is found to be 0,000. If a one-tailed test is desired, the sig value is divided by 2, resulting in a sig value of 0,000. Since sig < 0.05, the null hypothesis (H_0) is rejected, indicating that the average posttest score is significantly better than the average pretest score. As the posttest scores show improvement, it can be concluded that the media is effective for use in learning.

CONCLUSION

Based on the research results, it can be concluded that the development of learning media using Augmented Reality can be considered valid, practical, and has the potential to enhance problem-solving skill of junior high school students in the topic of flat-sided solid shapes. The validity of the learning media is indicated by the expert review stage, where one expert in the subject matter and two other experts in the field of media have validated the developed media, along with one mathematics teacher at the school. The developed media is considered valid in terms of its construct, content, and language. Meanwhile, the practicality of the developed learning media can be observed in the one-to-one and small group stages, where the learning media can be easily used by students. The potential effect is evident in the field test stage, which assesses the problem-solving skill of junior high school students in the topic of flat-sided solid shapes.

REFERENCES

Bernard, M. (2015). Meningkatkan Kemampuan Komunikasi Dan Penalaran Serta Disposisi Matematik Siswa Smk Dengan Pendekatan Kontekstual Melalui Game Adobe Flash Cs 4.0. *Infinity Journal*, *4*(2), 197–222. https://doi.org/10.22460/infinity.v4i2.84

Kelly, C. (2006). Using Manipulatives in Mathematical Problem Solving : A Performance-Based Analysis Let Us Know How Access to This Document Benefits You . *The Mathematics Enthusiast*, *3*(2), 184–193.

Larasati, N. I., & Widyasari, N. (2021). Penerapan Media Pembelajaran Berbasis Augmented Reality Terhadap Peningkatan Pemahaman Matematis Siswa Ditinjau Dari Gaya Belajar. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika*, *7*(1), 45–50. https://jurnal.umj.ac.id/index.php/fbc/article/view/5524

Mukaromah, E. (2020). Pemanfaatan Teknologi Informasi dan Komunikasi dalam Meningkatkan Gairah Belajar Siswa. *Indonesian Journal of Education Management and Administration Review*, *4*(1), 179–185. http://www.yourdictionary.com/library/reference/word-definitions/definition-of-technology.html.

Print ISSN: 3031-9552, Online ISSN: 3031-9544

Nieveen, N., & Folmer, E. (2013). *Educational Design Research Educational Design Research*. Enschede : Netherlands Institute for Curriculum Development: SLO. http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ815766

Novita, R., Prahmana, R. C. I., Fajri, N., & Putra, M. (2018). Penyebab kesulitan belajar geometri dimensi tiga. *Jurnal Riset Pendidikan Matematika*, *5*(1), 18–29. https://doi.org/10.21831/jrpm.v5i1.16836

Octaviani, K. D., Indrawatiningsih, N., & Afifah, A. (2021). Kemampuan Visualisasi Spasial Siswa Dalam Memecahkan Masalah Geometri Bangun Ruang Sisi Datar. *International Journal of Progressive Mathematics Education*, *1*(1), 27–40. https://doi.org/10.22236/ijopme.v1i1.6583

Pambudi, K. H. B., Buchori, A., & Aini, A. N. (2018). Pengembangan Media Pembelajaran Berbasis Android Menggunakan Augmented Reality Pada Materi Bangun Ruang Sisi Datar. *Jurnal Pendidikan Matematika Dan Sains*, *6*(1), 61–69.

Puadi, E. F. W. (2016). Meningkatkan Kemampuan Pemecahan Masalah Matematis Mahasiswa PTIK Melalui Pembelajaran Berbasis Masalah. *Jurnal Matematika Ilmiah STKIP Muhammadiyah Kuningan*, *2*(2), 212–231. http://jurnal.upmk.ac.id/index.php/jumlahku/article/view/341/249

Unonongo, P., Ismail, S., & Usman, K. (2021). Analisis Kemampuan Pemecahan Masalah pada Materi Bangun Ruang Sisi Datar di Kelas IX. *Jambura Journal of Mathematics Education*, *2*(2), 43–49. https://doi.org/10.34312/jmathedu.v2i2.10591

Wafa, A. K. A., & Fahmi, S. (2020). Pengembangan Media Pembelajaran Berbasis Android Pada Materi Bangun Ruang Sisi Datar. *UrbanGreen Conference Proceeding Library*, 11–17.

Print ISSN: 3031-9552, Online ISSN: 3031-9544

Print ISSN: 3031-9552, Online ISSN: 3031-9544