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INTEGRATING AUGMENTED REALITY VIA ASSEMBLER STUDIO TO FOSTER MATHEMATICAL CREATIVE THINKING IN ISLAMIC ELEMENTARY STUDENTS

Lita Sepriyanti, Wulan Andini, Ahmad Arifuddin
Universitas Islam Negeri Siber Syekh Nurjati Cirebon, Indonesia

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Abstract

This study aims to develop Augmented Reality (AR)-based learning media using Assembler Studio and to examine its validity, practicality, and effectiveness in improving students' mathematical creative thinking skills. The research employed the Research and Development (R&D) method using the ADDIE model with a one-group pretest-posttest design. The subjects were 20 fifth-grade students and a teacher at Public Islamic Elementary School Cirebon City, Indonesia. The results showed that the material expert validation scored 72% (valid category) and the media expert validation scored 96% (very valid category). The practicality of the media was indicated by teacher responses of 80% (practical category) and student responses of 93% (very practical category). The effectiveness was demonstrated by an N-gain score of 0.661 (moderate category) and the paired sample t-test result with a significance value of 0.000 < 0.05, proving a significant difference between pre-test and post-test. Therefore, the AR-based media was declared valid, practical, and effective for use in elementary mathematics learning.

Keywords: augmented reality, assembler studio, plane figures, creative thinking skill.

Abstrak

Penelitian ini bertujuan untuk mengembangkan media pembelajaran berbasis Augmented Reality (AR) menggunakan Assembler Studio dan menguji validitas, praktikalitas, dan efektivitasnya dalam meningkatkan kemampuan berpikir kreatif matematis siswa. Penelitian ini menggunakan metode Research and Development (R&D) menggunakan model ADDIE dengan desain one-group pretest-posttest. Subjek penelitian adalah 20 siswa kelas V dan seorang guru di Sekolah Dasar Islam Negeri Kota Cirebon, Indonesia. Hasil penelitian menunjukkan bahwa validasi ahli materi memperoleh skor 72% (kategori valid) dan validasi ahli media memperoleh skor 96% (kategori sangat valid). Praktikalitas media ditunjukkan oleh respons guru sebesar 80% (kategori praktis) dan respons siswa sebesar 93% (kategori sangat praktis). Efektivitas ditunjukkan oleh skor N-gain sebesar 0,661 (kategori sedang) dan hasil uji-t sampel berpasangan dengan nilai signifikansi 0,000 < 0,05, yang membuktikan adanya perbedaan yang signifikan antara pre-test dan post-test. Dengan demikian, media berbasis AR dinyatakan valid, praktis, dan efektif digunakan dalam pembelajaran matematika sekolah dasar.

Kata Kunci: *Augmented Reality, Assembler Studio,* Bangun Datar, Berpikir Kreatif

Coresponding Author
litasepriyanti09@gmail.com
Universitas Islam Negeri Siber Syekh Nurjati Cirebon, Indonesia

INTRODUCTION

In the digital era, technology has become an essential part of various aspects of life, especially in education. Educational technology has also developed very rapidly with the aim of improving the quality of learning and preparing young people to face future challenges. Learning will be more meaningful if teachers are able to utilize appropriate technology to support the delivery of material. The use of technology in learning can increase students' motivation and creative thinking skills. In mathematics learning, technology-based media not only facilitate understanding of abstract concepts but also play a vital role in enhancing students' creative thinking skills (Dewi, 2023).

Creative thinking skills are very important in everyday life, especially in mathematics. Creative thinking is characterized by the ability to solve problems with unconventional, unique, different, and original approaches (Khairiah & Amir, 2021). This ability is a crucial mental process that must be possessed by every individual to achieve success in overcoming various challenges, as problem-solving is a highly important aspect of life (Fitriana et al., 2024). Creative thinking skills often emerge when a person faces problems in life. D. Fasko states that "Creativity is associated with the ability to handle high task novelty," meaning that someone who encounters problems will become accustomed to thinking, and those problems will be related to the knowledge they possess, leading to the emergence of new ideas or alternative solutions to the challenges they face (Widia et al., 2020). Students' creative thinking skills have not shown good results, as evidenced by Hendrawati, (2017), who stated that students' creative thinking abilities had not reached optimal outcomes, which was proven by their low learning achievement in mathematics.

In Nurdiana & Caswita, (2024) study, the results showed that most students were at a low level of creativity in solving problems. This indicates that students still experience difficulties in applying creative thinking in more complex contexts. Meanwhile, research by Arifuddin, (2019) revealed that the creative thinking ability of Islamic elementary school students in fraction material was also relatively low, with an average score of 26.88. The study conducted by Sanusi et al., (2020) stated that students' mathematical creative thinking ability was still low. Meanwhile, Aflah et al., (2023) reported that students' creative thinking ability was still very low, as seen from the evaluation results of 25 students, in which only 10 students were able to meet the indicators of creative thinking ability. Furthermore, Acesta, (2020) showed that the low level of students' creative thinking ability was evident, with only about 40% of students able to reach above the minimum mastery criteria.

This is reinforced by the evidence from the test conducted by the researcher to measure students' mathematical creative thinking ability. The test aimed to assess students' creative thinking skills in solving 5 questions related to the topic of plane figures, referring to the indicators of fluency, flexibility, originality, and elaboration. From the questions given to the fourth-grade students, only 7 students were able to complete the creative thinking tasks out of a total of 24 students who took the test, with a mastery percentage of 0.29% and a non-mastery percentage of 0.70%. The test results conducted by the researcher prove that the students' creative thinking ability is still very low.

Based on the results of the needs analysis conducted at MI Negeri Kota Cirebon, 80% of students stated that mathematics is difficult, 85% experienced difficulty in understanding plane figure materials, 85% agreed that visualization would help them learn better, and 90% supported the use of AR-based media in mathematics learning. These findings indicate the necessity for developing more

interactive and visually engaging media that can help students think more creatively in solving mathematical problems.

In line with these findings, the researcher also conducted interviews with the classroom teacher, which revealed that the learning media used by the teacher did not support the development of students' creative thinking skills. These findings indicate that there are many other factors contributing to the low level of students' creative thinking skills. Among these factors is the use of origami paper as a medium in mathematics learning, which may not be effective enough in stimulating creativity (Ahmad & Khasawneh, 2024). The method most often applied by the teacher is the lecture method, which tends to make students passive in the learning process. Furthermore, the teacher's limited knowledge of various applications that could be utilized as learning media also poses its own challenge. Lastly, the lack of teacher understanding regarding technological developments in the modern era also affects students' ability to think creatively (Cerbin, 2018). Therefore, it is necessary to conduct evaluation and improvement in teaching methods as well as the selection of more relevant media to enhance students' creative thinking skills (Bhuttah et al., 2024).

However, although various previous studies have proven the benefits of Augmented Reality (AR) in learning, most of them have been conducted at the secondary or higher education levels. Studies specifically focusing on the integration of AR-based media in Islamic elementary schools (Madrasah Ibtidaiyah) are still limited. Moreover, previous research has rarely emphasized the improvement of mathematical creative thinking skills through AR media developed using Assembler Studio. Therefore, there is a clear research gap in the application of AR technology in primary mathematics learning, especially in Islamic education contexts where technological exposure remains relatively low (Richardo et al., 2023).

Based on this gap, the present study aims to examine how the development process of AR-based learning media using Assembler Studio can enhance the mathematical creative thinking skills of fifth-grade students, as well as to determine the validity, practicality, and effectiveness of the developed media when implemented in mathematics learning within Islamic elementary schools. In line with these objectives, this research focuses on developing AR-based learning media using Assembler Studio, evaluating its validity and practicality, and assessing its effectiveness in improving students' creative thinking abilities in mathematics.

The novelty of this study lies in the integration of Augmented Reality through Assembler Studio within the Islamic elementary school context, conducted without the use of physical learning aids. This innovative approach not only introduces an interactive and immersive learning experience but also emphasizes the development of students' creative and analytical thinking abilities in understanding mathematical concepts.

Additionally, this study adopts the theoretical framework of Guilford (1950) and Torrance (1974), who stated that creative thinking involves fluency, flexibility, originality, and elaboration. These components are essential for developing mathematical creative thinking skills, as they train students to generate multiple solutions, explore diverse strategies, and produce original ideas during problem-solving (Sisk, 2021).

Ho wever, most previous studies on AR-based learning focused on secondary or higher education, while its application in Islamic elementary school contexts remains underexplored. Therefore, this study seeks to fill that gap by developing AR learning media using Assembler Studio for elementary students. Based on the description above, learning media that can develop students' creative thinking skills are

needed, namely Augmented Reality (AR) learning media. Augmented Reality (AR) is a field of computer research that integrates 3D graphic data with the real world, or in other words, adds real-world elements to a medium. This media can be paper, markers, or markers scanned through certain input devices (Sari et al., 2022). Augmented Reality (AR) is a technology that combines the real world and the virtual world by presenting an object in the form of a video or image in three dimensions. This technology can also be used through devices such as smartphones, tablets, and many more (Alfitriani et al., 2021).

Augmented Reality (AR)-based learning media plays an important role in the learning process, as the material is presented in a more dynamic, varied, and interactive form. Students not only listen to the teacher's explanations but can also see, touch, and interact with objects virtually (Alfitriani et al., 2021). This Augmented Reality (AR) learning media can strengthen students' understanding of the material being taught, as well as encourage their creative thinking skills in discovering new and varied possibilities (Tohir et al., 2024). Research by Arifuddin et al., (2022) also emphasizes that the use of augmented reality media plays a significant role in realizing and visualizing abstract concepts according to the students' level of understanding.

One of the applications used to support the development of Augmented Reality (AR)-based learning media is Assembler Studio. Assembler Studio itself is an application that enables teachers to easily create new, collaborative, and engaging student learning activities through Augmented Reality (AR) (Mardinawan et al 2023). In other words, Assembler Studio helps teachers easily develop AR-based content without requiring special skills. However, the drawback of Assembler Studio is that most of its features are paid, with only a few available for free.

This is evidenced by the research conducted by Anggraeni et al., (2020), which stated that the development of Augmented Reality (AR) learning media is highly feasible to be used as one of the learning media options for educators, as it can serve as something new for teachers in the teaching and learning process, especially in face-to-face learning. It makes learning more engaging, prevents students from feeling bored, and helps to make the learning process more effective.

Several researchers have found that Augmented Reality (AR) media is highly effective in the learning process. In their study, Jumaena et al., (2024) discovered that Augmented Reality (AR) media was very effective in learning, particularly in mathematics. This was evidenced by the research findings, which showed that before using the media, student performance was categorized as very low (27.4%), low (36.3%), and medium (36.3%) with an average score of 60. Meanwhile, after using the media, there was significant improvement: low (9.1%), medium (18.3%), and high (36.3%) with an average score of 80. Furthermore, Wibowo et al., (2022) reported a score of 84.54% from media experts and 86.5% from subject matter experts, indicating that the media was valid. The student response questionnaire also received a score of 95%, and the teacher response 92%, both in the "very practical" category, while the posttest results of 87.5% met the criteria for effectiveness.

Meanwhile, other studies have obtained similar results, namely that Augmented Reality (AR) media is feasible, practical, and effective to use. Research conducted by Hidayah et al., (2024) showed that 89% of media experts, 92% of material experts, and 94% of practitioners with very suitable and very practical qualifications, 85% of media effectiveness based on class calculations, and 66% effective based on N-Gain calculations were categorized as effective. Meanwhile, Irawan & Yatri, (2022) showed results of 97.49% of media experts and 94.44% of material experts, and the trial results obtained 93.16%. Thus,

Augmented Reality (AR) media is very effective and makes students very enthusiastic in learning. And research by Maziyah & Zumrotun, (2025) shows that augmented reality media is effective for use in the learning process; this is reinforced by the results of material and media validation tests, namely 90% and 92%.

Based on the description, this research aims to develop Augmented Reality (AR)-based learning media using Assembler Studio on the topic of plane figures as an effort to foster students' interest in learning mathematics, thereby improving each elementary school student's mathematical creative thinking skills. It is expected that the developed AR media can serve as an innovative solution for mathematics learning that promotes students' creative and analytical thinking skills

RESEARCH METHOD

This study employed the Research and Development (R&D) method using the ADDIE model (Analyze, Design, Develop, Implement, Evaluate). This model was chosen because it is systematic and suitable for producing learning products that are feasible, practical, and effective in improving students' mathematical creative thinking skills (Hapsari & Zulherman, 2021).

The subjects of this research were 20 fifth-grade students of Public Islamic Elementary School Cirebon City, Indonesia and the teacher as the learning facilitator. The selection of this location was based on the initial problems identified, namely the students' low mathematical creative thinking ability and the limited learning media used. The research was conducted at Public Islamic Elementary School Cirebon City, Indonesia. The number of 20 students was considered appropriate for the small-scale trial stage of the ADDIE development model, which focuses on testing the feasibility of the product rather than generalizing the results.

The research procedure followed the five stages of the ADDIE model. In the analysis stage, the researcher identified students' needs, problems, and characteristics. The needs analysis showed that 80% of students considered mathematics a difficult subject, 85% had difficulty understanding plane figures, 85% required visual assistance, and 90% agreed that AR-based media should be applied in learning. The design stage was carried out by designing Augmented Reality (AR)-based learning media according to the topic of plane figures. Next, in the development stage, the product was validated by subject matter experts, media experts, and language experts. The validation process used the Content Validity Ratio (CVR) technique, while instrument reliability was tested using Cronbach's Alpha, which yielded a coefficient value of 0.87 indicating high reliability. The implementation stage was conducted through a limited trial with fifth-grade students, while the evaluation stage was used to assess the quality of the product and make revisions based on the findings (Hidayat & Nizar, 2021).

Data collection techniques include questionnaires and tests, as well as observation and interviews. Questionnaires are used to obtain data on media validity from experts and practicality responses from teachers and students. Tests in the form of pretests and post tests are used to measure the effectiveness of the media on students' mathematical creative thinking skills. Observations and interviews are conducted to strengthen the data related to the learning process.The instrument items were developed based on indicators of creative thinking ability, including fluency, flexibility, and originality. Each item was reviewed by experts to ensure clarity and relevance to the learning objectives.

The data obtained were analyzed both quantitatively and qualitatively. The questionnaire results were analyzed using percentages to determine the categories of validity and practicality. The test data were analyzed using descriptive statistics, a normality test, a homogeneity test, and a paired t-test. The normality and

homogeneity tests were conducted to ensure that the data met the statistical requirements before the paired sample t-test was applied. In addition, the improvement of students' mathematical creative thinking skills was calculated using N-Gain to determine the category of learning outcome improvement after the use of AR media. All quantitative data analysis was performed using SPSS 25.0 software, while qualitative data from observations and interviews were analyzed descriptively to support quantitative findings.

RESEARCH RESULTS AND DISCUSSION

Research Results

The research and development carried out aimed to produce a learning medium in the form of 3D or augmented reality to enhance students' creative thinking skills, particularly in class VB for the mathematics subject. The research and development process employed the Research and Development (R&D) method using the ADDIE model, which consists of five stages as follows:

Analysis

The initial step the researcher took was to conduct interviews and observations in grade 5 of MI Negeri Cirebon City. Based on the interviews, several issues emerged in mathematics learning, particularly regarding plane geometry. The teacher had explained this material, but in practice, many students still struggled to understand the concepts of the properties of plane geometry and how to calculate circumference and area. Observations in grade 5 revealed that teachers had never provided problems or activities that encouraged students to develop their ideas freely. A needs analysis revealed that 80% of students found mathematics difficult. Eighty-five percent of students stated that plane geometry was one of the most difficult topics to understand, suggesting the need for more innovative learning media to increase student motivation. Furthermore, 85% of students believed that images in learning media would significantly assist them in understanding the material. Furthermore, 90% of students agreed that Augmented Reality (AR)-based media should be implemented in the classroom.

Design

The design stage is a crucial step in developing Augmented Reality (AR)-based learning media. Researchers design product concepts to meet the needs of teachers and students. This stage analysis's basic 5th-grade mathematics competencies related to plane figures (introduction, properties, perimeter, and area), designs contextual materials related to everyday life to promote originality, flexibility, and fluency, and develops storyboards and flowcharts to guide the media's display and navigation. The design is kept simple with a plain-figure menu, interactive 3D objects, and explanatory text and audio. Supporting elements include illustrations, narration, and brief instructions to enhance interactive learning. Research instruments are also developed, including expert validation sheets, teacher response questionnaires, and a mathematical creative thinking ability test to assess the media's validity, practicality, and effectiveness.

Development

At this stage, the researcher begins to develop the design that was previously prepared and proceeds with creating the Augmented Reality (AR) media using *Assembler Studio*. The augmented reality media that has been developed is then subjected to a validation process by media experts and subject matter experts. The results of this validation are used to determine the level of validity of the augmented reality media based on *Assembler Studio*.

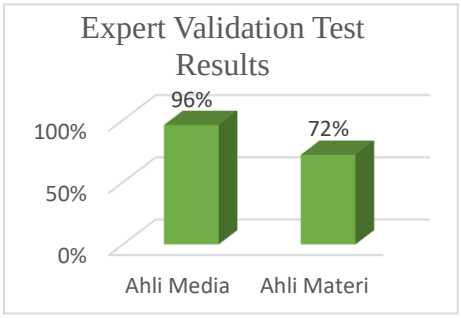
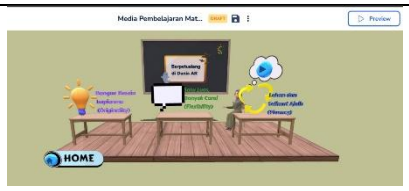


Figure 1

Expert Validation Test Results

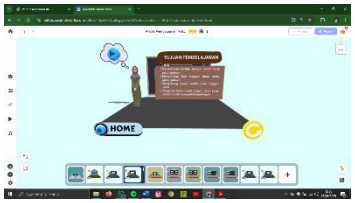
Based on the data above, it can be concluded that the results of the media expert validation reached 96% with the category of "very valid," while the material expert validation obtained 72% with the category of "valid." Furthermore, revisions from the experts were made in the development of the AR media.

Table 1
Media Expert Revision Results

Revision	Before Revision	After Revision
The color of the flat shape triangle is made more contrasting as a differentiator.		
Name the indicators of creative thinking		
Use mathematical equations.		
The size color was changed because it clashed with the background color.		

Correct the calculation on the fluency indicator		
Reflection on the Use of AR	**No material**	

Table 2
Results of Material Expert Revisions

Revision	Before Revision	After Revision
Replace the learning outcomes of the Merdeka Curriculum with those of the latest curriculum	**No material**	
Change the learning objectives from the Merdeka Curriculum to the Latest Curriculum	**No material**	

Implementation

At the implementation stage, the Augmented Reality (AR) media that has been declared feasible by expert validators is applied in the learning process. The researcher implemented the Augmented Reality (AR) media in the learning activities of class 5B at MI Negeri Kota Cirebon over two meetings, with each session lasting 2x30 minutes.

Table 3
AR Media Implementation Meeting Schedule

Meeting	Number of JP	Day/Date/Year
1	2 x 30 minutes	Tuesday, August 12, 2025
2	2 x 30 minutes	Wednesday, August 13, 2025

The implementation stage was carried out after the Augmented Reality (AR) learning media assisted by Assembler Studio was declared valid by experts. The media was then trialed in Grade V at MI Negeri Kota Cirebon, involving 20 students and the class teacher as the learning facilitator. The trial was conducted in two sessions, each lasting 2 × 30 minutes, with the topic of plane figures.

Before the lesson began, students were given a pretest to measure their initial mathematical creative thinking skills. Next, the teacher used AR media during the learning activities by projecting 3D geometric objects that could be observed

interactively through digital devices. The learning process became more engaging, as students could directly see the geometric shapes virtually, interact with the models, and discuss the properties and calculations of the geometric figures.

After the learning activities were completed, students were given a posttest to determine their learning outcomes. Additionally, a response questionnaire was given to teachers and students to assess the practicality of the media. Teachers played an active role in managing the learning process and providing guidance on the use of AR media, while students appeared enthusiastic, motivated, and more engaged compared to conventional learning.

The implementation results showed that AR media received a positive response. Teacher responses reached 80% with the practical category, while student responses were 93% with the very practical category. In terms of effectiveness, the test analysis results showed an average pretest score of 40.00 increased to 80.00 in the posttest. Normality and homogeneity tests were met, and the paired sample t-test produced a significance value of 0.000 < 0.05, which means there was a significant difference between the pretest and posttest results. In addition, the N-gain calculation of 0.661 indicates a moderate improvement category.

Thus, the implementation of AR media assisted by Assembler Studio is not only valid in terms of content and practical use, but also proven to be effective in improving students' mathematical creative thinking skills in flat shape material

Evaluation

The development of Augmented Reality (AR)-based learning media using Assembler Studio was evaluated through several stages, including validity testing, practicality testing, and effectiveness testing. Effectiveness was further analyzed through descriptive statistics, normality testing, homogeneity testing, a paired sample t-test, and an N-gain analysis. All analyses were performed using SPSS version 25.

Figure 1.
Comparison of Students' Pretest and Posttest Average Scores

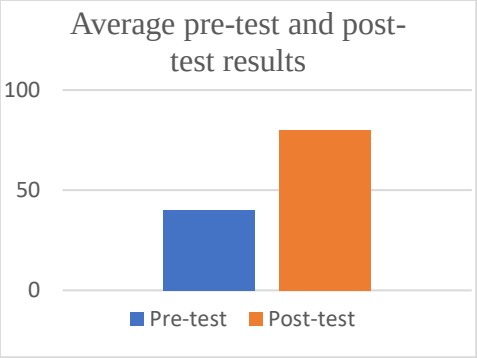


Table 4
Descriptive Statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	20	25	55	40.00	7.609
Posttest	20	55	95	80.00	9.597
Valid N (listwise)	20				

Based on the descriptive statistical analysis (Table 4), the students' average pretest score was 40.00, with a minimum score of 25 and a maximum score of 55, and

a standard deviation of 7.609. Meanwhile, the average posttest score increased to 80.00, with a minimum of 55, a maximum of 95, and a standard deviation of 9.597. This increase of 40 points demonstrates a substantial improvement in students' mathematical creative thinking ability after using the AR media.

Table 5
Data Normality Test

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
pretest	.200	20	.035	.934	20	.182
posttest	.200	20	.035	.931	20	.159

Normality testing was performed using the Shapiro–Wilk method. The results showed a significance value of 0.182 for the pretest data and 0.159 for the posttest data. Since both significance values are greater than 0.05, it can be concluded that both datasets are normally distributed. Therefore, the data met the assumption of normality, allowing for further parametric testing using the paired sample t-test.

Table 6
Homogeneity Test

Result	**Lavene Statistic**	**df1**	**df2**	**sig.**
Based on Mean	.676	1	38	.416
Based on Median	.676	1	28	.416
Based on Median and With Adjusted df	.676	1	36.285	.416
based on trimmed mean	.732	1	38	.397

The homogeneity of variance test was conducted using Levene's test. The results showed a significance value of 0.416 (based on the mean) and 0.397 (based on the trimmed mean). Both values are greater than 0.05, indicating that the variances between the pretest and posttest data are homogeneous. Thus, the assumption of equal variances is met, and the data are suitable for further analysis.

Table 7
Paired Sample T-test

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pretest – Posttes	-40.000	11.002	2.460	-45.149	-34.851	-16.259	19	.000

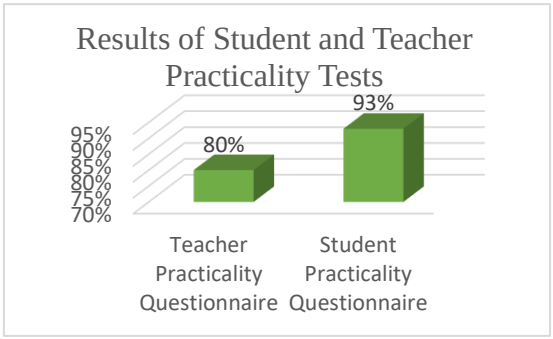
The paired sample t-test was used to determine the significance of the difference between the pretest and posttest results. The analysis produced a mean difference of -40.000 with a standard deviation of 11.002. The significance value (Sig. 2-tailed) was 0.000, which is less than 0.05. This result indicates that there is a significant difference between the pretest and posttest scores, confirming that the implementation of the augmented reality media had a significant positive effect on students' learning outcomes..

Table 8
N-Gain Score Trial Results

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain Score	20	.31	.93	.6661	.14833
Ngain Persen	20	30.77	92.86	66.6102	14.83303
Valid N (listwise)	20				

To measure the level of improvement in students' mathematical creative thinking, the N-Gain test was used. The calculation showed an **average N-Gain score of 0.661**, which falls into the *moderate* category. This means that the developed AR media was moderately effective in enhancing students' creative thinking abilities. Although the improvement was not classified as high, it still demonstrates that the AR-based learning environment successfully supported student understanding and creativity.

Figure 2
Teacher and Student Practicality Test Results



To evaluate the practicality of the developed AR media, the researchers distributed questionnaires to both teachers and students during the implementation phase. The results showed that the teacher practicality questionnaire reached 80%, categorized as practical, and the student practicality questionnaire reached 93%, categorized as very practical. These results indicate that the AR media assisted by Assembler Studio is easy to operate, engaging, and effectively supports learning objectives. Teachers stated that the media helped clarify abstract concepts in mathematics, while students expressed enthusiasm and enjoyment while using it. This aligns with Anggraeni et al. (2020), who found that AR-based learning media increase students' motivation and engagement.

Discussion

This study produced Augmented Reality (AR)-based learning media assisted by Assembler Studio, developed to enhance elementary school students' mathematical creative thinking skills. The development process was carried out through the ADDIE model stages, ensuring that the resulting media is not only innovative but also tested in terms of validity, practicality, and effectiveness.

In terms of development, the media was designed based on the results of a student needs analysis. Data shows that 80% of students find mathematics a difficult subject, 85% of students stated that plane geometry was one of the most difficult topics to understand, and 85% of students believed that images or visualizations would greatly help them understand concepts. Furthermore, 90% of students agreed that AR-based media should be implemented in learning. This fact provides a strong basis for designing media that can present plane geometry in the form of interactive 3D objects. The media developed through the Assembler Studio

application allows students to observe plane geometry from various perspectives in real time, complete with explanatory text and audio. This allows students not only to passively receive the material but also to interact directly with digital objects. These findings align with Arifuddin et al., (2022), who stated that AR media can connect abstract concepts with concrete experiences, and Tohir et al., (2024), who emphasized that the use of AR can encourage students' creativity through visual exploration. Thus, the development of this AR media aligns with student needs and the principles of 21st-century learning that emphasize interactivity, collaboration, and creativity.

In addition, this development reflects Guilford's (1956) theory of creative thinking, which includes fluency, flexibility, and originality as key components. The 3D interactive exploration process allows students to practice generating multiple ideas (fluency) and different representations (flexibility) in understanding geometric forms. According to Mayer's Cognitive Theory of Multimedia Learning (2009), the combination of visual and auditory stimuli through AR minimizes extraneous cognitive load and strengthens meaningful learning, which explains the increase in students' understanding (AlAli et al., 2025).

In terms of validity, the material expert test results obtained a score of 72% with a valid category, while the media expert achieved 96% with a very valid category. This indicates that the material content presented is in accordance with the curriculum and learning objectives, although there are still some improvements to be made in the presentation of questions and examples. From a technical aspect, the media is considered very good because it is able to present an attractive visual display and simple navigation. These results are consistent with research by Wibowo et al., (2022), which showed that AR media received a validity score of more than 80% from both material and media experts, making it suitable for use. Similarly, Hidayah et al., (2024) found that AR media in mathematics learning obtained high validity and met the requirements for implementation in the classroom. Therefore, it can be concluded that the AR media assisted by Assembler Studio in this study has met the feasibility standards both in terms of content and technical aspects.

The practicality aspect is demonstrated through teacher responses of 80% (practical category) and 93% (very practical category) from students. Teachers considered AR media helpful in delivering material because it was able to clarify concepts of plane figures that were difficult for students to understand. Meanwhile, students felt more enthusiastic because they could interact directly with the digital objects displayed. These results are in line with research by Anggraeni et al., (2020), which stated that AR makes learning more interesting and motivates students to be actively involved. A similar finding was found by Maziyah & Zumrotun, (2025), who proved that student responses to AR media reached more than 90% with the very practical category. Thus, this media is not only suitable for use but also easy to integrate into daily learning.

Furthermore, these findings support the idea that AR increases students' engagement and motivation, consistent with Dede et al. (2021), who found that immersive learning environments promote active participation and self-efficacy. In the context of Islamic elementary education, such motivation aligns with holistic education principles that integrate cognitive and affective aspects of learning.

The effectiveness of the media is seen from the comparison of the pretest and posttest results of students' mathematical creative thinking abilities. The average pretest score of 40.00 increased to 80.00 in the posttest, with a difference of 40 points. The paired sample t-test showed a significance value of $0.000 < 0.05$, which means there is a significant difference between abilities before and after using the

media. This proves that AR media has a positive impact on student learning outcomes. These results are supported by Jumaena et al., (2024), who reported a significant increase in understanding of geometric concepts after implementing AR media, and Irawan & Yatri, (2022), who found that the use of AR increased the enthusiasm and academic achievement of elementary school students.

From a theoretical perspective, these results also reinforce Torrance's concept (1974) that creativity can be cultivated through environments that encourage exploration and imagination. The visualization features in AR trigger divergent thinking, allowing students to generate new solutions to mathematical problems. This aligns with the findings of Lin et al. (2023), who noted that AR-based tasks enhance students' flexibility and originality in STEM learning contexts.

Furthermore, the N-gain calculation result of 0.661 is included in the moderate category. This means that the use of AR media is quite effective in improving creative thinking skills, although it has not yet reached the high category. Factors that influence this include limited learning time, differences in students' initial abilities, and adaptation to new technology. A similar study by Hidayah et al., (2024) showed an average N-gain of 0.66 in the moderate category, which supports the results of this study. Meanwhile, Sanusi et al., (2020) also confirmed that interactive media-based learning can improve creative thinking skills, although the results of the improvement varied between students. Thus, AR media remains effective in encouraging students to think creatively, although the improvement still needs to be optimized through more intensive learning planning.

Additionally, it is important to note that the small number of participants (20 students) and the limited scope of the topic (plane figures) may have affected the generalizability of the findings. Future research should involve a larger and more diverse sample, include other mathematical concepts such as solid geometry or measurement, and investigate long-term effects on creative thinking. Nevertheless, the findings contribute significantly to the growing body of research on AR-assisted learning in Islamic elementary education, showing that AR can be implemented effectively without additional physical tools.

Overall, the findings of this study indicate that the AR media supported by Assembler Studio is able to fulfill four main aspects of media development, namely validity, practicality, effectiveness, and suitability for students' needs. This aligns with the opinion of Alfitriani et al., (2021), who stated that AR enriches the learning experience by presenting interactive 3D objects, as well as the research by Widia et al., (2020), which emphasizes the importance of creativity in technology-based learning. Therefore, AR media can serve as an innovative solution to address students' difficulties in understanding geometric concepts while also enriching the variety of teaching methods in the digital era.

In conclusion, this discussion highlights both theoretical and practical implications. Theoretically, the study supports the role of AR in promoting higher-order thinking, particularly creative fluency and flexibility. Practically, it provides an example for teachers in Islamic elementary schools to integrate AR in mathematics instruction without the need for additional tools. The findings thus contribute to both pedagogical innovation and educational technology advancement in 21st-century learning

CONCLUSION

This study concludes that Augmented Reality (AR)-based learning media assisted by Assembler Studio is feasible for use in elementary school mathematics learning. This is because AR-based learning media has met the criteria of being valid, practical, and effective in improving students'

mathematical creative thinking skills in Islamic elementary schools. Therefore, AR learning media can be an innovative solution to enhance students' mathematical creative thinking skills on the plane figure material. Furthermore, this study recommends that future research apply the developed AR-based learning media to other mathematical topics and broader populations to examine its consistency and scalability. The findings also imply that AR-based learning media can be effectively implemented in other elementary schools to improve students' engagement, creativity, and understanding of mathematical concepts

BIBLIOGRAPHY

Acesta, A. (2020). Pengaruh Penerapan Metode Mind Mapping Terhadap Kemampuan Berpikir Kreatif Siswa. *NATURALISTIC : Jurnal Kajian Penelitian Pendidikan Dan Pembelajaran*, *4*(2b), 581–586. https://doi.org/10.35568/naturalistic.v4i2b.766

Aflah, A. N., Ananda, R., Surya, Y. F., Syafari, O., & Sutiyan, J. (2023). *Upaya Meningkatkan Kemampuan Berpikir Kreatif Menggunakan Model Project Based Learning Pada Siswa Sekolah Dasar*. 57–69. https://doi.org/https://doi.org/10.36379/autentik.v7i1.276

Ahmad, M., & Khasawneh, S. (2024). *The Role Of Using Origami In Improving Geometric Skills Among Students With Learning Disabilities In The Elementary Stage*, *Educational Administration: Theory and Practice*. *2024*(1), 348–358. https://doi.org/10.53555/kuey.v30i1.1316

AlAli, R., Wardat, Y., Aboud, Y. Z., & Alhayek, K. A. (2025). The effectiveness of using augmented reality technology in science education to enhance creative thinking skills among gifted eighth-grade students. *Eurasia Journal of Mathematics, Science and Technology Education*, *21*(6), em2644–em2644. https://doi.org/10.29333/ejmste/16416

Alfitriani, N., Maula, W. A., & Hadiapurwa, A. (2021). Jurnal Penelitian Pendidikan Penggunaan Media Augmented Reality dalam Pembelajaran. *Jurnal Penelitian Pendidikan*, *38*(1), 30–38. https://journal.unnes.ac.id/nju/index.php/JPP%0APenggunaan

Anggraeni, R., Andrian, E., & Syachroji, A. (2020). Pengembangan Media Pembelajaran Augmented Reality Untuk Meningkatkan Penguasaan Materi Sistem Pernapasan Manusia Pada Pembelajaran IPA Kelas V SDN Serdang Kulon IV. *Journal GEEJ*, *7*(2), 161–170. https://doi.org/https://doi.org/10.31316/esjurnal.v11i1.4245

Arifuddin, A. (2019). Students' Critical and Creative Thinking Skills on Mathematics Learning in Madrasah Ibtidaiyah. *Auladuna: Jurnal Pendidikan Dasar Islam*, *6*(1), 38–49. https://doi.org/https://doi.org/10.24252/auladuna.v6i1a5.2019

Arifuddin, A., Wahyudin, W., Prabawanto, S., Yasin, M., & Elizanti, D. (2022). The Effectiveness of Augmented Reality-Assisted Scientific Approach to Improve Mathematical Creative Thinking Ability of Elementary School Students. *Al Ibtida: Jurnal Pendidikan Guru MI*, *9*(2), 444. https://doi.org/10.24235/al.ibtida.snj.v9i2.11647

Bhuttah, T. M., Xusheng, Q., Abid, M. N., & Sharma, S. (2024). Enhancing student critical thinking and learning outcomes through innovative pedagogical approaches in higher education: the mediating role of inclusive leadership. *Scientific Reports*, *14*(1), 1–13. https://doi.org/10.1038/s41598-024-75379-0

Cerbin, W. (2018). Improving student learning from lectures. *Scholarship of*

Teaching and Learning in Psychology, *4*(3), 151–163. https://doi.org/10.1037/stl0000113

Dewi, A. C. (2023). Peran Teknologi Dalam Meningkatkan Kualitas Hidup Manusia Di Era Digital. *Online Scholarship Competition (OSC)*, *3*(3), 165–170. https://doi.org/https://doi.org/10.62388/jrgi.v3i3.473

Fitriana, E., Ramalisa, Y., & Pasaribu, F. T. (2024). Pengembangan E-Modul Berbasis Pjbl Berbantuan Video Animasi Untuk Meningkatkan Kemampuan Berpikir Kreatif Siswa Smp. *Jurnal Ilmiah Matematika Realistik*, *5*(1), 64–73. https://doi.org/10.33365/ji-mr.v5i1.4841

Hapsari, G. P. P., & Zulherman, Z. (2021). Pengembangan Media Video Animasi Berbasis Aplikasi Canva untuk Meningkatkan Motivasi dan Prestasi Belajar Siswa. *Jurnal Basicedu*, *5*(4), 2384–2394. https://doi.org/10.31004/basicedu.v5i4.1237

Hendrawati, T. (2017). Peningkatan Kemampuan Berpikir Kritis dan Kreatif Matematis Melalui Model Pembelajaran Problem Posing. *Jurnal Pendidikan Matematika*, *1*(2), 33–42.

Hidayah, S., Mailani, E., Sitohang, R., & Gandamana, A. (2024). *Pengembangan Media Pembelajaran Matematika Materi Luas Bangun Ruang Sisi Datar Berbasis Augmented Reality berbantuan Unity 3D Untuk Meningkatkan Hasil Belajar Siswa Kelas V Sekolah Dasar*. *4*, 95–111. https://doi.org/https://doi.org/10.31004/innovative.v4i5.14781

Hidayat, F., & Nizar, M. (2021). Model Addie (Analysis, Design, Development, Implementation and Evaluation) Dalam Pembelajaran Pendidikan Agama Islam Addie (Analysis, Design, Development, Implementation and Evaluation) Model in Islamic Education Learning. *Jurnal UIN*, *1*(1), 28–37. https://doi.org/https://doi.org/10.15575/jipai.v1i1.11042

Irawan, L., & Yatri, I. (2022). Pengembangan Media Pembelajaran Augmented Realty pada Materi Struktur Tumbuhan Sekolah Dasar. *Ideas: Jurnal Pendidikan, Sosial, Dan Budaya*, *8*(3), 971. https://doi.org/10.32884/ideas.v8i3.890

Jumaena, Salmilah, & Munir, N. P. (2024). Efektivitas Media Pembelajaran Augmented Reality (AR) Pemodelan Bangun Ruang Terhadap Pemahaman Konsep Geometri Siswa Kelas V Sekolah Dasar Pendahuluan. *Refleksi*, *12*(3), 149–160. https://doi.org/https://www.p3i.my.id/index.php/refleksi/article/view/292/282

Khairiah, L., & Amir, Z. (2021). Kemampuan Berpikir Kreatif dalam Setting Model Pembelajaran Treffinger. *Jurnal Pendidikan Matematika Dan Sains*, *7*(2), 54–58. https://doi.org/10.21831/jpms.v7i2.25595

Maziyah, H. N., & Zumrotun, E. (2025). *Pengembangan Media Pembelajaran Kartu Ajaib Berbasis Augmented Reality pada Materi Ekosistem Kelas 5 Sekolah Dasar*. *5*, 25–38. https://doi.org/https://doi.org/10.53299/jagomipa.v5i1.1079

Nurdiana, A., & Caswita, C. (2024). Analisis Kemampuan Berpikir Kreatif Siswa dalam Menyelesaikan Masalah Matematika pada Materi Trigonometri Berdasarkan Prestasi Siswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *8*(1), 315–325. https://doi.org/10.31004/cendekia.v8i1.2548

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

Sanusi, A. M., Septian, A., & Inayah, S. (2020). Kemampuan Berpikir Kreatif Matematis dengan Menggunakan Education Game Berbantuan Android pada Barisan dan Deret. *Mosharafa: Jurnal Pendidikan Matematika*, *9*(3), 511–520. https://doi.org/10.31980/mosharafa.v9i3.866

Sari, I. P., Batubara, I. H., Hazidar, A. H., & Basri, M. (2022). Pengenalan Bangun Ruang Menggunakan Augmented Reality sebagai Media Pembelajaran. *Hello World Jurnal Ilmu Komputer*, *1*(4), 209–215. https://doi.org/10.56211/helloworld.v1i4.142

Sisk, D. A. (2021). J.P. Guilford: A Pioneer of Modern Creativity Research. *Celebrating Giants and Trailblazers: A-Z of Who's Who in Creativity Research and Related Fields*, 171–185. https://kiecon.org/creativity-books/

Tohir, A., Handayani, F., Sulistiana, R., Wiliyanti, V., Arifianto, T., & Husnita, L. (2024). Analisis Penerapan Augmented Reality dalam Proses Pemahaman Pembelajaran. *Jurnal Review Pendidikan Dan Pengajaran*, *7*(3), 8. https://doi.org/https://doi.org/10.31004/jrpp.v7i3.30132

Tri Abdi Mardinawan, & Imelda Free Unita Manurung. (2023). Pengembangan Media Assemblr Studio Berbasis 5e Untuk Meningkatkan Hasil Belajar Siswa Kelas V Sekolah Dasar Negeri 111923 Bulusari T.A 2023/2024. *Jurnal Manajemen Dan Bisnis Ekonomi*, *2*(1), 146–161. https://doi.org/10.54066/jmbe-itb.v2i1.1065

Wibowo, V. R., Eka Putri, K., & Amirul Mukmin, B. (2022). Pengembangan Media Pembelajaran Berbasis Augmented Reality pada Materi Penggolongan Hewan Kelas V Sekolah Dasar. *PTK: Jurnal Tindakan Kelas*, *3*(1), 58–69. https://doi.org/10.53624/ptk.v3i1.119

Widia, W., Syahrir, S., & Sarnita, F. (2020). Berpikir Kreatif Merupakan Bagian Terpenting dalam Meningkatkan Life Skills di Era Industri 4.0. *Jurnal Pendidikan Ilmu Pengetahuan Alam (JP-IPA)*, *1*(02), 1–6. https://doi.org/10.56842/jp-ipa.v1i02.6