

## DEVELOPMENT OF AUGMENTED REALITY DIGITAL MEDIA FOR PATTERNS IN SHAPES AND NUMBERS IN ELEMENTARY SCHOOL

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### Abstract

The main issue in teaching patterns in shapes and numbers at elementary schools is the lack of adequate media to support interactive and visual learning. This research endeavors to create educational media using Augmented Reality (AR) to aid fourth-grade students at SDN Kebon Pala 11 Pagi in recognizing patterns in shapes and numbers. In today's digital landscape, the integration of technology into education is paramount for enriching the learning experience. AR seamlessly merges real-world elements with digital overlays, fostering an immersive and interactive educational environment. The Research and Development (R&D) methodology using the 4D model (Define, Design, Development, Disseminate) is employed in this study. Subsequently, the Design phase involves crafting learning materials aligned with the research objectives. In the Development stage, the AR media was tested and validated by media and subject matter experts. Trials with students and teacher feedback indicated the AR media's effectiveness in helping students understand patterns in shapes and numbers. Results show that AR media increases student engagement and motivation, and aids in comprehending abstract mathematical concepts. Expert evaluations yielded excellent ratings: 94% from media experts, 94% from subject matter experts, 92% from fourth-grade A teachers, 100% from fourth-grade B teachers, and student feedback indicating a "Very Good" qualification. This media is expected to be widely adopted and serve as a reference for developing advanced educational technology in the future.

**Keywords:** Augmented reality, digital media, educational media development, number patterns, pattern recognition.

### Abstrak

Masalah utama dalam mengajarkan pola gambar dan pola bilangan di sekolah dasar adalah kurangnya media yang memadai untuk mendukung pembelajaran interaktif dan visual. Penelitian ini bertujuan untuk mengembangkan media pendidikan berbasis Augmented Reality (AR) untuk pengenalan pola pada bentuk dan angka bagi siswa kelas empat di SDN Kebon Pala 11 Pagi. Di era digital ini, integrasi teknologi dalam pendidikan menjadi sangat penting untuk meningkatkan kualitas pembelajaran. AR menggabungkan dunia nyata dengan elemen digital, menciptakan lingkungan belajar yang menarik dan interaktif. Metode Penelitian dan Pengembangan (R&D) dengan model 4D (Define, Design, Development, Disseminate) digunakan dalam penelitian ini. Tahap Define melibatkan analisis kebutuhan untuk menetapkan kriteria media pembelajaran digital. Tahap Design menciptakan materi pembelajaran yang sesuai dengan tujuan penelitian. Pada tahap Development, media AR diuji coba dan divalidasi oleh ahli media dan materi. Uji coba dengan siswa dan umpan balik dari guru menunjukkan bahwa media AR efektif dalam membantu pemahaman siswa terhadap pola pada bentuk dan angka. Hasil penelitian menunjukkan bahwa media AR meningkatkan keterlibatan dan motivasi belajar siswa serta membantu pemahaman konsep matematika yang abstrak. Evaluasi dari para ahli menunjukkan penilaian yang sangat baik: 94% dari ahli media, 94% dari ahli materi, 92% dari guru kelas IV A, 100% dari guru kelas IV B, dan umpan balik siswa yang menunjukkan kualifikasi "Sangat Baik". Media ini diharapkan dapat diadopsi secara luas dan menjadi referensi untuk pengembangan teknologi pendidikan yang lebih maju di masa depan.

**Kata kunci:** Augmented reality, media digital, pengembangan media pembelajaran, pola bilangan, pola gambar.



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## INTRODUCTION

Education plays a central role in shaping individuals and enhancing human capabilities through the acquisition of knowledge and strategies to enrich life values and develop good character (Hermawan & Kusniasari, 2023). The educational process begins at the elementary level, where children grasp core values and character formation (Fatonah & Pranata, 2022). In this context, technology integration is increasingly crucial in the digital era as it provides access to diverse information and offers new tools and methods that support the learning process (Çetin, 2022; Fatasya et al., 2023). Augmented Reality (AR) is one such technology receiving attention in educational contexts, merging the real world with digital elements to create a more immersive and interactive learning environment (Al-Ansi et al., 2023; Ilmawan Mustaqim & Kurniawan, 2022).

Augmented Reality (AR), known as AR, is a technology that enables the integration of real-world elements with digital components, creating an experience that enhances physical reality with additional information or virtual objects using devices such as smartphones, tablets, or specialized glasses (Korkmaz & Morali, 2022; Koumpouros, 2024). AR's primary advantage in education lies in its ability to make abstract concepts more concrete and easily understandable through conventional methods (Khoirina & Adriyani, 2024; Zulfa et al., 2023). The use of AR allows students to learn independently and exploratively, making learning more engaging and improving their academic interest and achievement (Aprilia & Suwandayani, 2025; Redep & Hajdin, 2021).

The development of Augmented Reality (AR) in educational contexts has seen significant growth, reflecting the widespread adoption of digital technology in education. Literature studies underscore the increasing adoption of AR applications in the learning process, enhancing student engagement and learning outcomes (Amanatidis, 2022). However, general efficacy research on AR often emphasizes its integration with gaming elements in education rather than specifically addressing its application for teaching patterns and number sequences at the elementary school level. This gap highlights the need for research focused on innovative ways to implement AR to enhance understanding and interaction with abstract concepts such as patterns and number sequences among elementary school students (Amanatidis, 2022; Redep & Hajdin, 2021).

The study titled "Development of AR-based Movie Learning in vocational schools" focuses on practical and interactive learning experiences (Ilmawan Mustaqim & Kurniawan, 2022). Conversely, research indicates that AR holds significant potential for enhancing teaching processes in primary schools (Adrian et al., 2020). Nevertheless, there remains a gap in research specifically exploring the use of AR to facilitate elementary students' understanding and mastery of pattern recognition and numerical sequences. Therefore, this research aims to address this gap by developing and evaluating AR-based digital media for elementary education, aiming to enhance mathematics learning practices through interactive and visually stimulating approaches (Ilmawan Mustaqim & Kurniawan, 2022).

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Pattern recognition in images and numbers is a fundamental concept in mathematics that is highly useful in daily life and various fields of study. Visual patterns assist students in identifying regularities and similarities in visual forms. This material explains the importance of understanding patterns in images and numbers, which is particularly crucial in art and geometry. Through the analysis of visual patterns, students are involved in identifying and forming repetitive patterns, thereby enhancing their analytical and problem-solving abilities (Sarah Amalia Putri & Khavisa Pranata, 2022).

Pattern recognition in numbers educates students about numerical sequences that follow specific rules. This understanding is crucial for comprehending mathematical concepts such as addition, subtraction, and multiplication. Additionally, recognizing number patterns enhances students' logical reasoning and critical thinking abilities. By mastering these patterns, students can identify numerical relationships, make predictions, and solve mathematical challenges. Number patterns are widely applied in disciplines such as computer science, statistics, and economics for data analysis and model creation.

The primary challenge in teaching image and number patterns in elementary school is the lack of adequate media to support interactive and visual learning. Conventional media often fail to provide deep and engaging learning experiences for students, especially in grasping abstract concepts like these patterns. This limitation can diminish students' interest and hinder their motivation to learn mathematics. Adopting new approaches through digital media like augmented reality

(AR) is expected to enhance student interaction and engagement in the learning process, thereby helping them understand image and number patterns more effectively (Sahronih et al., 2022). Integrating AR is anticipated to create a more dynamic and engaging learning environment that meets students' current learning needs.

Developing digital media using Augmented Reality (AR) for pattern recognition in shapes and numbers in fourth-grade elementary classrooms is an innovative step promising to enhance the quality of elementary education. Leveraging AR technology enables us to create more captivating, interactive, and relevant learning experiences for students (Amanatidis, 2022). Recognizing patterns in shapes and numbers is a fundamental concept in mathematics that helps students understand the regularities and relationships in visual and numerical forms. Integrating AR into teaching these patterns can facilitate students' comprehension and retention of the concepts taught (Aristamy et al., 2024).

Based on this data and potential, the author conducted a study titled "Development of Augmented Reality Digital Media for Image and Number Patterns in Elementary Schools." This research aims not only to have practical impacts in improving the quality of elementary education but also to pave the way for the development of more advanced and inclusive educational technologies in the future. By using AR, students can directly interact with the patterns they are learning, making the learning process more dynamic and engaging, thereby enhancing their understanding and involvement in their studies.

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## RESEARCH METHODS

In this study, the researcher employs the Research and Development (R&D) methodology. The R&D method is an approach used to develop new products or enhance existing ones (Salim & Haidir, 2019). The development of this Augmented Reality learning media is carried out by applying the 4D model. This approach involves a series of stages, starting from Define, Design, Development, and Disseminate. By using the R&D method, the researcher aims to create effective Augmented Reality learning media that meet the needs of lower-grade students at SDN Kebon Pala 11 Pagi. The steps taken in this research ensure that the resulting product meets the desired quality standards and can positively contribute to the learning process.

The first stage, definition, is part of the process that establishes criteria and outlines the requirements for developing digital learning media, while considering the educational needs of students. The second stage, design, aims to develop and organize learning materials that align with the research's learning objectives. The third stage, development, aims to create the planned learning media. This phase is divided into two activities: expert appraisal and developmental testing. The final stage, dissemination, involves introducing the developed learning media to teachers in other schools (Nugroho & Sukirman, 2023; Sari et al., 2025).

This research was conducted at SDN KP 11 Pagi with the research subjects consisting of 11 lower-grade students, 26 upper-grade students, 2 fourth-grade homeroom teachers, 1 subject matter expert, and 1 media expert.

The instruments used in this research were questionnaires filled out by the media expert, subject matter expert, students, and teachers. Below are the instrument analysis techniques used in this research:

1. The scores and qualifications on the questionnaire instruments are based on the Likert scale (Table 1):

Table 1. Score and qualification

Score	Qualifications
1	Very Poor
2	Poor
3	Fair
4	Good
5	Very Good

2. Questionnaire data were calculated using the following formula:

$$P = \frac{f}{n} \times 100\% \quad (1)$$

Description :

P = Validation Percentage

f = Total score received

n = Highest possible score

3. Descriptive quality criteria with rating scale as in Table 2.

Table 2. Criteria for Assessment

Score (%)	Qualifications
$80 < P \leq 100$	Very Good (VG)
$60 < P \leq 80$	Good (G)
$40 < P \leq 60$	Fair(F)
$20 < P \leq 40$	Poor (P)
$0 P \leq 20$	Very Poor (VP)

## RESULTS AND DISCUSSION

In today's digital age, integrating technology into education has become increasingly common, with Augmented Reality (AR) being a notable example. This study aims to develop AR-based digital media specifically designed for teaching pattern recognition in shapes and numbers to fourth-grade students at

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SDN Kebon Pala 11 Pagi. The primary goals are to create effective AR learning tools that facilitate students' comprehension of these concepts and to evaluate the practicality and impact of AR media in educational settings.

#### 1. Define Phase

- a. Initial Analysis: Identifying what pattern images and number patterns are, and how AR technology can aid in learning. The analysis results show that the concepts of pattern images and number patterns require good visualization to be clearly understood by students.
- b. Learner Analysis: Observations of student characteristics reveal that they prefer learning with visual media. They have a better understanding when abstract concepts are explained through visualization.
- c. Task Analysis: Written tasks created for students indicate that the use of visual media can enhance their understanding of pattern images and number patterns.
- d. Concept Analysis: Researchers determine how to deliver the material using AR to make the concepts of pattern images and number patterns clearer and easier to understand.
- e. Learning Objectives Analysis: The set objective is for students to demonstrate an understanding of the concepts of pattern images and number patterns with the help of AR digital media.

#### 2. Design Phase

At this stage, researchers design the AR learning media with the following steps:

- a. Creating Standard Tests: Standard tests are developed within the AR media to measure students' understanding.
- b. Selection of Teaching Media: Visual elements that can aid in the visualization of pattern image and number pattern concepts are selected to facilitate student comprehension.
- c. Selection of Format: Determining the devices used in the research, such as worksheets, laptops, and smartphones.
- d. Design of Learning Tools: An initial prototype of the AR media is designed for use in learning.

#### 3. Development Phase

In the development phase, the following steps are undertaken:

- a. Initial Testing: The AR media is tested on the POGA-POBI application to ensure its functionality.
- b. Expert Evaluation: Validation is conducted by media and content experts to ensure that the developed media and materials meet the expected standards. The result of expert evaluation can be seen in Table 3.

Table 3. Expert panel evaluation results

Questionnaire	Total Score	Score %	Qualification
Media experts	47	94%	Very Good
Content experts	47	94%	Very Good

Based on Table 3, there are the presentation results from assessments by media experts and subject matter

experts, both rated as "excellent". The media expert rated clarity in visual elements, accuracy in media writing,

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proper use of colors, and appropriateness in using image and number patterns as "excellent". Meanwhile, the subject matter expert also gave an "excellent" rating, noting that the material supports deep understanding when presented to both small and large groups. The material includes exercises aligned with learning objectives, preceded by relevant examples and illustrations. Sentence structure, language, and numerical clarity are considered easy to understand.

- a. Improvement and Evaluation: Based on feedback from experts, the researchers make adjustments and improvements to the AR media.
- b. Testing with Students and Teacher Responses: The AR media is tested with students and teachers to assess how effective it is in helping them understand pattern images and number patterns. The result of teacher's responses can be seen in Table 4.

Table 4. The percentage results of grade IV teachers' responses

Classroom Teacher	Total Score	Score %	Qualification
Grade IV Teacher A	83	92%	Very Good
Grade IV Teacher B	90	100%	Very Good

Based on Table 4, the results of the 4th-grade homeroom teachers' responses are categorized as "excellent". In this excellent rating, the teachers assessed that the visual elements in this media are clear with quality animations or effects, and the use of colors, composition, and design are appropriate. Therefore, this media is

suitable for 4th-grade elementary school classes in delivering materials both in small and large class settings. This is because the sentence structure, language, and numerical aspects are easy for teachers to understand and effectively convey to students with systematic content.

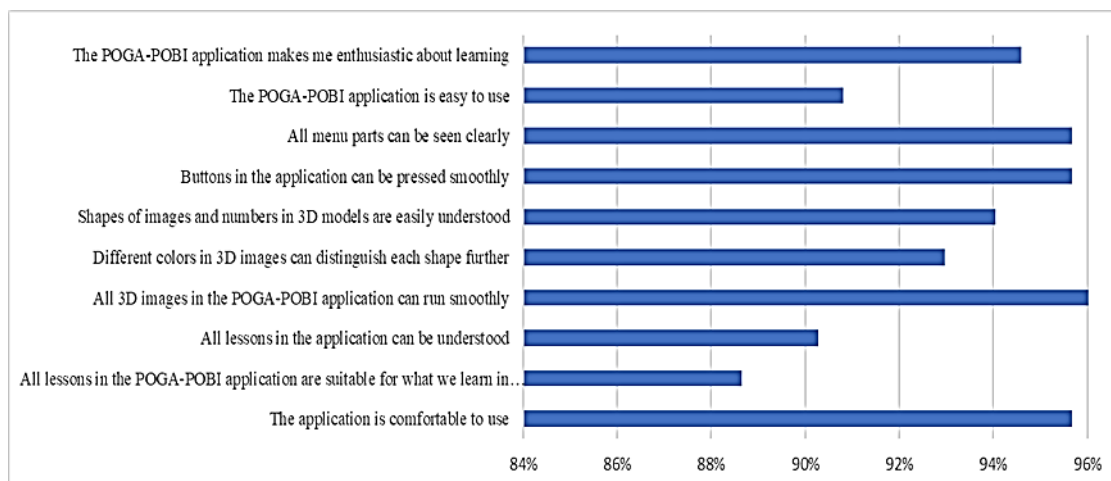


Figure 1 The test results to the students

The statement 'The application is comfortable to use' received a 96% rating, which means it is excellent,

indicating that the POGA-POBI application is comfortable to use. The statement 'All lessons in the POGA-

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POBI application are suitable for what we learn in class' received an 89% rating, also excellent, indicating that the POGA-POBI application is suitable for learning in class. The statement 'All lessons in the application can be understood' received a 90% rating, again excellent, indicating that the learning materials in the POGA-POBI application can be understood. The statement 'All 3D images in the POGA-POBI application can run smoothly' received a 96% rating, once more excellent, indicating that the 3D elements run smoothly when played in the POGA-POBI application. The statement 'Different colors in 3D images can distinguish each shape further' received a 93% rating, which is excellent, indicating that the colors in the POGA-POBI application can distinguish each image from one another. The statement 'Shapes of images and numbers in 3D models are easily understood' received a 94% rating, again excellent, indicating that the shapes of images and numbers in the POGA-POBI application can be easily understood. The statement 'Buttons in the application can be pressed smoothly' received a 96% rating, once more excellent, indicating that the buttons in the application run smoothly. The statement 'All menu parts can be seen clearly' received a 96% rating, also excellent, indicating that each menu can be seen clearly and is not blurry when read. The statement 'The POGA-POBI application is easy to use' received a 91% rating, which is excellent, indicating that the POGA-POBI application is easy to use. The statement 'The POGA-POBI application makes me enthusiastic about learning' received a 95% rating, again excellent, indicating that the POGA-POBI application makes me enthusiastic about learning.

#### 4. Dissemination Phase

The final stage involves disseminating the AR media. This media is distributed to classroom teachers and published in journals to serve as a reference for other researchers. The application can be downloaded via Google Drive due to the limited cost of downloading it through the Play Store.

The data obtained indicates that this augmented reality digital media serves as an instructional tool that aids students in the teaching and learning process. This aligns with validation from media experts, subject matter experts, student responses, and teachers.



Eti Santiana (2009025008)

Figure 2 Main display

Figure 2 The main menu display of the Augmented Reality digital media consists of three main components: Learning Objectives Flow, Material, and Worksheets (LKPD).



Eti Santiana (2009025008)

Figure 3 Learning objectives flow menu

Figure 3 includes the learning objectives flow to help teachers and students understand the learning goals for the patterns in images and numerical sequences.



Figure 4 Material menu display

Figure 4 The material menu display contains the content of patterns in images and numerical sequences. Enlarging patterns involve several images progressing from the first term to subsequent terms with increasing quantities. Conversely, diminishing patterns depict a reverse progression from enlarging patterns. The numerical patterns follow a similar structure, using numbers exclusively.



Figure 5. The worksheet LKPD

Figure 5 The worksheet (LKPD) menu display includes five group-based exercises for students. This aims to promote interactivity and enjoyable comprehension among peers before students proceed to independently complete assessment tasks.

In order to expand the implementation of augmented reality (AR) in education, particularly through AR games, a literature review highlights the growth and sustainability of digital technology over recent decades (Amanatidis, 2022; Ilmawan Mustaqim & Kurniawan, 2022; Redep & Hajdin, 2021). This review examines the effectiveness of AR in enriching

knowledge and skills, the role of teachers, relevant theories, and pertinent evaluation techniques. From an analysis of 78 articles, it is concluded that AR can significantly enhance the learning process by improving student interaction and engagement, albeit facing challenges such as infrastructure limitations, curriculum alignment, AR integration into classroom instruction, and educator acceptance and involvement.

The development of AR-based learning media is increasingly recognized in educational contexts, especially at the vocational school level, emphasizing practical experiences (Ilmawan Mustaqim & Kurniawan, 2022). AR enables the fusion of real-world environments with digital elements, enhancing learning experiences through engaging animations, colors, and appealing designs. These studies foster innovation in education, particularly in subjects requiring strong visualization and interactive capabilities, such as English language teaching (Nugraha et al., 2021). However, the use of AR in education still needs to address various technical challenges and broader integration into educational curricula (Redep & Hajdin, 2021).

The results of the study "Development of Augmented Reality Digital Media for Patterns in Shapes and Numbers in Elementary School" show that this media is very effective in learning. This media attracts students' interest in learning, especially grade 4 elementary school mathematics lessons because the elements are clear and visually appealing, so the content is easy to understand. In addition, this media helps students understand abstract concepts from picture pattern and number pattern materials because it makes learning more concrete or real.

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## CONCLUSION AND SUGGESTION

The development of digital media using Augmented Reality for pattern images and number patterns was successfully carried out in the fourth grade of SDN Kebon Pala 11 Pagi. This media made learning more interesting and interactive, helping students understand the concepts of pattern images and number patterns better. The Augmented Reality digital media for Pattern Images and Number Patterns was deemed suitable for use as a learning medium, supported by expert evaluations: 94% from media experts, 94% from subject matter experts, 92% from fourth-grade teacher A, 100% from fourth-grade teacher B, and student feedback indicating a "Very Good" qualification after testing the augmented reality digital media on pattern images and number patterns.

Suggestions for future research include developing more interactive and engaging AR media and comparing its effectiveness with more varied learning methods. Additionally, research should explore how AR can enhance digital literacy and apply various learning theories to make students more engaged and improve their learning outcomes..

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