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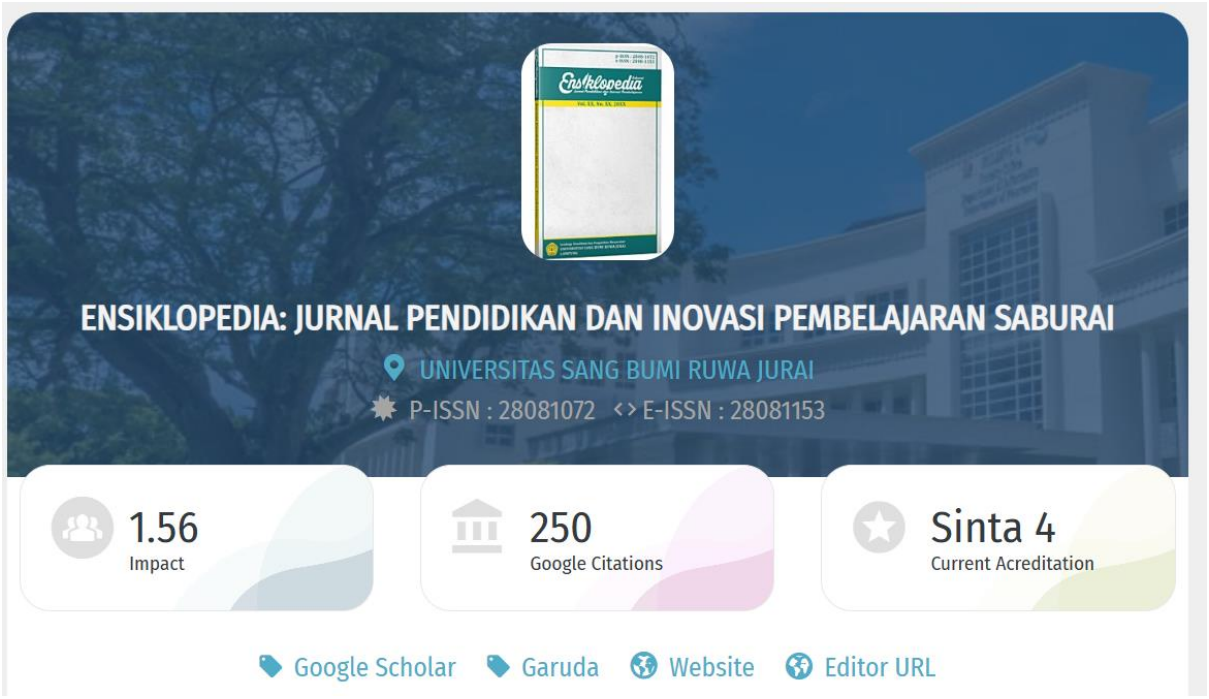

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'MATHUB': Development and Usability Evaluation of an Interactive App for Learning Number Patterns in Middle School

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Abstract

This study aimed to develop and evaluate "MatHub," an Android-based interactive multimedia application designed to support students' understanding of number patterns in middle school mathematics. The research followed the ADDIE model, comprising analysis, design, development, implementation, and evaluation stages. The participants included eighth-grade students and a mathematics teacher from SMP Negeri 4 Bandar Lampung. Data were collected through observations, interviews, and questionnaires. The application was validated by media and content experts, who confirmed its strong visual and linguistic feasibility, as well as the relevance and clarity of its content. Student and teacher feedback highlighted that MatHub featured engaging visuals, user-friendly navigation, and accessible language, which enhanced motivation and comprehension. Revisions were made based on suggestions, particularly to improve multimedia elements. Despite facing limitations related to application size and device compatibility, the product was successfully implemented and received positively. These findings suggest that MatHub is a valid and practical learning tool that can enrich classroom experiences and is recommended for broader application in mathematics education at the junior high school level.

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INTRODUCTION

Mathematics has been a very crucial part in each of the century's invention to make our lives easier or more productive (Hafni et al., 2020), that is why mathematics becomes the foundation in developing modern technology (Tan et al., 2020). As a fundamental subject, mathematics not only supports the understanding of other fields of study but also equips students with logical, analytical, systematic, critical, innovative, and creative thinking skills (Apino & Retnawati, 2017; Widana et al., 2018). These cognitive skills are essential in the modern era, which demands individuals to solve problems rationally and efficiently.

One of the key topics in mathematics education at the junior high school level is number patterns. This topic holds strategic significance as it serves as an entry point for students to understand algebraic thinking (Afonso & Mc Auliffe, 2019) and recognize regularities (Pino-Fan et al., 2015). Number patterns not only provide a foundation for introducing mathematical abstraction but also act as prerequisites for more advanced topics such as sequences, series, and functions.

However, Pratiwi & Isnaningrum (2021) states that in practice, many

students are unable to understand the concept behind number pattern problems.. They often find it difficult to recognize patterns (Aisy & Hakim, 2023), make generalizations (Purwaningtyas, 2020; Yuniarti & Rosyidi, 2024), or determining the next pattern (Ramdani, 2021). This is largely due to the abstract nature of the material and the lack of real-world context, making it hard for students to relate the concepts to their everyday learning experiences.

This issue is further compounded by the limitations and lack of availability of learning media (Hardiansyah & Wahdian, 2023). According to Chimbunde et al. (2023), the use of textbooks often fail to assist students develop their critical thinking abilities, a limitation that is further compounded by issues like the dominance of instructors' authority, repetition of monologues, and the constraints of the physical classroom environment (Shareef & Farivarsadri, 2020; Sweeting, 2014). In addition, these methods may not be appropriate to hold students' attention or concentration for more than 10 - 20 minutes (Allison, 2020; Pllana, 2020). As a result, the learning process becomes less engaging and interactive, leading to poor academic performance and lack of motivation (Ortiz-Bustos et al., 2024).

To address these challenges, the use of interactive multimedia can be an alternative solution to the limitations of the textbook (printed) (Hadaya & Hanif, 2019). With the support of animations, simulations, and other interactive features, interactive multimedia can present learning materials in a more enjoyable and interactive (Jelatu et al., 2019), providing immediate feedback according to responses of students (Taxipulati & Lu, 2021). This greatly aids in building a deeper and more concrete understanding of concepts.

With the growing popularity and widespread student access to Android devices, this platform is ideal for developing practical and efficient learning media. The use of Android-based learning media have been able to provide learners with comfort in learning (González et al., 2015) and build their understanding through continuous and independent simulation and evaluation activities (Arista & Kuswanto, 2018).

One useful tool for developing Android-based educational media is MIT App Inventor (Kurniawan et al., 2024), a free web application that enables users (teachers and student) to develop their own mobile applications with little to no prior experience (Patton et al., 2019). MIT App Inventor is particularly suitable for educational settings as it does not require advanced programming skills, thereby enabling the creative, efficient development of educational apps tailored to learning needs.

On the other hand, 21st-century learning demands a paradigm shift in the teaching and learning process. Moorhouse et al. (2021) stated that teachers and schools are expected to deliver content through digital methods that resonate with students' everyday experiences (White & Wilde, 2024). The integration of technology in education is no longer an alternative but a necessity for creating effective learning environments (Zajda, 2021).

Moreover, junior high school students are in a transitional stage of cognitive development, moving from concrete to abstract thinking. Therefore, they require learning media that can bridge these two modes of thought. Effective educational media should be able to simplify complex concepts and present them in ways that align with the thinking patterns of students at this developmental stage.

Unfortunately, there is still a significant lack of interactive Android-based learning media specifically designed to help junior high school students

understand number patterns. This indicates both a pressing need and a valuable opportunity to develop innovative, contextual, and student-centered learning media that align with current technological advancements.

Based on the above rationale, the objectives of this study are to: 1) develop interactive multimedia learning media using MIT App Inventor for the topic of number patterns for junior high school students; 2) produce a valid interactive multimedia learning product as assessed by media and content experts; and 3) produce a practical interactive multimedia learning product based on MIT App Inventor for number patterns, as evaluated by users (students and teachers).

RESEARCH METHODS

This study employed the Research and Development (R&D) method using the ADDIE model. The model consists of five stages: Analyze, Design, Development, Implementation, and Evaluation. The research subjects were eighth-grade students at SMP Negeri 4 Bandar Lampung. A small-group trial was conducted in a limited setting involving six students, in accordance with recommendations from the mathematics subject teacher.

The data collection instruments used in this study included observation, interviews, and questionnaires. Observations were conducted to identify issues related to learning media at the school. Semi-structured interviews were employed to gather information from teachers regarding the use of instructional media, classroom atmosphere, and teachers' understanding of students' needs and characteristics. Meanwhile, the questionnaires consisted of student needs assessments, media and content validation instruments, as well as student and teacher response questionnaires toward the developed product.

This study utilized both quantitative and qualitative data. Quantitative data were obtained from validation sheets completed by media and content experts, as well as response questionnaires from users (students and teachers). Qualitative data were derived from comments and suggestions provided by media experts, content experts, and users.

Product analysis was divided into two categories: product validity analysis and product practicality analysis. Product validity was assessed based on media and content aspects. The evaluation criteria by media experts were divided into two components: graphical feasibility and linguistic feasibility. The evaluation criteria by content experts were also divided into two components: content feasibility and presentation feasibility. The user practicality assessment involved three indicators: interest, content, and language. The scoring criteria employed a Likert scale, as presented in Table 1.

Table 1. Questionnaire Scoring Scale

No.	Score	Response Option
1.	4	Very Good / Strongly Agree
2.	3	Good / Agree
3.	2	Fair / Disagree
4.	1	Poor / Strongly Disagree

As a basis for decision-making, the criteria for validity and practicality are presented in Table 2.

Table 2. Validity and Practicality Criteria

Quality Score	Criteria Option
$3{,}25 \leq \bar{x} \leq 4{,}00$	Very Valid / Very Practical
$2{,}50 \leq \bar{x} < 3{,}25$	Valid / Practical
$1{,}75 \leq \bar{x} < 2{,}50$	Less Valid / Less Practical
$1{,}00 \leq x < 1{,}75$	Not Valid / Not Practical

Source : Sugiyono (2014)

RESULTS AND DISCUSSION

Development of Interactive Multimedia Based on MIT App Inventor for Number Pattern Material

The development of this interactive multimedia involved two stages, the first of which was the analysis stage. This stage included validating the performance gap, determining instructional goals, analyzing learners, auditing available resources, recommending potential delivery systems, and composing a project management plan.

The analysis stage in this study comprised six main activities aimed at identifying the causes of performance discrepancies in learning and designing appropriate solutions. First, validating the performance gap revealed limited use of technology and monotonous teaching approaches. Second, determining instructional goals was carried out in a specific and focused manner, namely enabling students to identify the next term and derive the general formula for the *n*-th term in number sequences. Third, analyzing learners showed that most students operated at a lower cognitive level, relied solely on textbooks, and had not yet utilized Android devices effectively for learning.

Next, auditing available resources identified the need for relevant instructional materials, technological tools such as MIT App Inventor and design software, as well as the direct involvement of the researcher as both designer and programmer. Potential delivery systems were directed toward the use of Android-based interactive multimedia. Finally, composing a project management plan encompassed steps from goal setting to product testing, taking into account feedback from students and teachers to ensure the practicality of the developed interactive multimedia.

Following the analysis stage, the researcher proceeded to the design stage. In this phase, four main activities were carried out: (1) developing a flowchart for the interactive multimedia to illustrate the sequence and structure of the application; (2) designing a storyboard as a visual guide to help determine the elements and flow of the product; (3) collecting supporting materials for product development, such as texts, images, videos, and others, as well as selecting the appropriate software; and (4) preparing assessment instruments, including validation sheets for media and content experts, and response questionnaires for students and teachers.

Mathub was developed using the MIT App Inventor platform. This platform was selected for the development of the interactive multimedia because it is open-source, easily accessible, and features an intuitive visual interface that facilitates the application design process, particularly for novice developers or educators without a strong background in programming.

Validity of the Interactive Multimedia Based on MIT App Inventor for Number Pattern Material

The validity of MatHub was determined through the development phase in accordance with the ADDIE model. In this phase, the researcher developed an instructional media in the form of interactive multimedia for number

pattern material, which was named "MatHub: Pattern 8 Ed." (hereinafter referred to as ***MatHub***).

In addition to the name, the researcher also designed a logo to represent this interactive multimedia. The name and logo of the interactive multimedia are shown in Figure 1.

Figure 1. Logo and Name of the Interactive Multimedia

The validity of MatHub was assessed during the development phase, in accordance with the stages of the ADDIE model. At this stage, MatHub was designed with several sections or menus. These sections were created with an intuitive layout and visually appealing design to ensure that students feel comfortable and find it easy to navigate each part. The interface of each section/menu is presented in Figure 2.

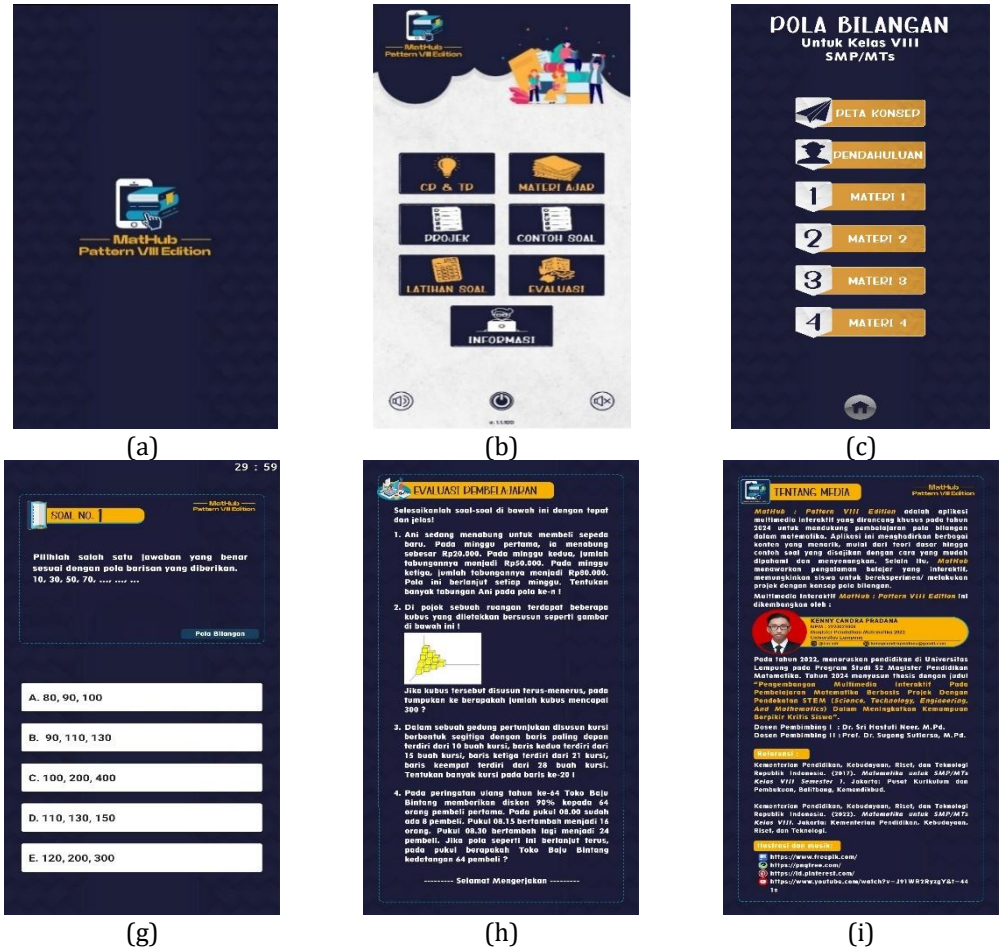

Figure 2. Display of (a) loading screen; (b) main menu; (c) materials menu; (d) practice menu; (e) evaluation menu; and (f) information menu.

MatHub was developed as an Android-based mobile application and can be downloaded via the following link: https://bit.ly/mathubpattern8.

The next step was product evaluation, which involved validation testing by experts, including two media experts and two content experts. The results of the media expert validation are presented in Table 3.

Table 3. Media Expert Validation Results

No.	Assessment Aspect	Number of Items	Validator Score I	Validator Score II
1	Graphical Feasibility	19	62	64
2	Linguistic Feasibility	18	63	65
		Total Score	**125**	**129**
		Operational Test Score	**3,37**	**3,48**
		Total Operational Test Score	**6,85**	
		Final Average Score	**3,425**	
		Criteria	**Very Valid**	

Based on Table 3, the media expert validation yielded a final average score of 3.425, indicating that the media was considered very valid and suitable for use without revision. However, the researcher still made minor revisions in accordance with the comments and suggestions provided by the media experts, particularly by adding media elements such as videos, audio, images, and animations to enhance the quality of the interactive multimedia. The content expert validation results are presented in Table 4.

Table 4. Content Expert Validation Results

No.	Assessment Aspect	Number of Items	Validator Score I	Validator Score II
1	Content Feasibility	16	48	55
2	Presentation Feasibility of the Material	12	37	39
		Total Score	**85**	**94**
		Operational Test Score	**3,03**	**3,3**
		Total Operational Test Score	**6,33**	
		Final Average Score	**3,165**	
		Criteria	**Valid**	

Based on Table 4, the content expert validation resulted in a final average score of 3.165, which falls under the valid category. Under this criterion, the content aspect required revisions in accordance with the suggestions provided by the content expert, one of which was the addition of an answer key page in the practice menu as a form of reflection for students after completing the exercises.

The validation results from both media and content experts indicated that the interactive multimedia is very valid in terms of media and valid in terms of content. Although very valid and valid both suggest that the developed multimedia can be used, the valid category implies that improvements are still needed before the product can be implemented. Based on the feedback from the content expert, the researcher has revised the product accordingly.

This interactive multimedia product has met a good validity standard. This outcome is supported by various factors that contributed to the product's ability to fulfill the required validity criteria.

Practicality of the Interactive Multimedia Based on MIT App Inventor for Number Pattern Material

The practicality of MatHub was evaluated during the implementation phase, in accordance with the ADDIE model. This stage involved both students and a teacher. MatHub was tested by one mathematics teacher and six students (one group), based on the teacher's recommendation.

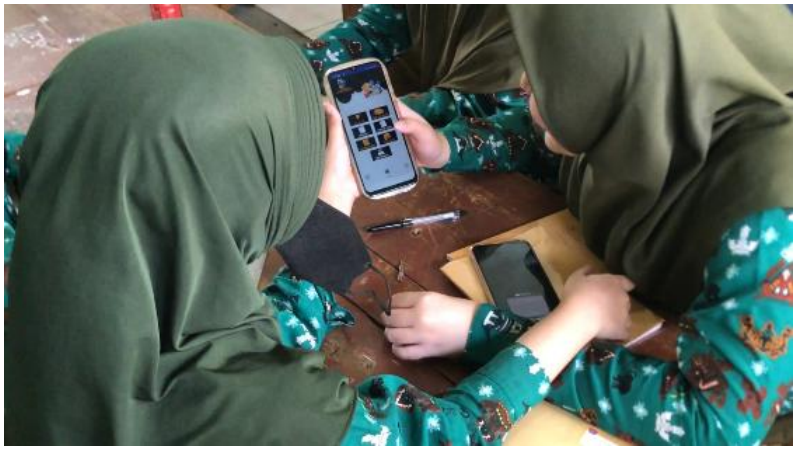

Figure 3. Students Using MatHub

The results of the analysis of student and teacher response questionnaires are presented in Table 5.

Table 5. Recapitulation of Student and Teacher Response Questionnaire Results

Criteria	Student Respondents						Teacher Respondent
	R1	R2	R3	R4	R5	R6	
Number of Items	14						15
Score Obtained	41	40	41	44	46	44	52
Total Score	256						52
Maximum Score	336						60
Practicality Index	3,05						3,47
Classification	**Practical**						**Very Practical**

Based on Table 5, the product trial resulted in a student practicality index of 3.05 and a teacher practicality index of 3.47, which fall under the practical and very practical categories, respectively. The majority of students agreed that MatHub features attractive content, presents materials that are easy to understand, uses comprehensible language, and includes projects that positively influence their learning motivation. However, several comments provided by students noted issues such as unclear video audio and image quality. These aspects have been addressed and revised accordingly. After completing the revisions, the product is considered ready for full implementation and is deemed suitable for use in instructional activities.

Based on the results, the use of MatHub as an interactive learning medium received positive responses from both students and teachers. Students found the application visually appealing, easy to navigate, and appreciated its clear and communicative presentation of the material. The visual and interactive elements were considered effective in increasing student engagement and helping them understand number pattern concepts that were previously perceived as difficult. Teachers also noted that

MatHub supports a more contextual learning process and aligns well with students' current needs, particularly in providing media that is relevant to technological advancements and their digital habits.

However, during its implementation, this study also revealed several technical challenges faced by users. These included the file size limitation of applications developed using MIT App Inventor, which does not allow projects to exceed 30 MB (Marzuki & Rini, 2021), as well as compatibility issues with some students' Android devices. Some students encountered difficulties in installing or running the application due to unsupported Android versions or limited device storage capacity.

Interestingly, despite these challenges, students' enthusiasm for using the application remained high. The researcher implemented solutions such as group-based learning (Abdel-All et al., 2018), allowing students to access the application through their group members' devices. This collaborative approach not only addressed the technical limitations but also enhanced social interaction during the learning process, turning the challenges into opportunities to strengthen students' communication and teamwork skills.

Thus, the positive response to MatHub not only reflects the success of the design and content of the application but also demonstrates that with proper technical handling, implementation obstacles can be minimized without compromising the quality of the students' learning experience. This provides valuable insight for educational media developers, emphasizing the importance of not only focusing on content but also considering technical aspects and mitigation strategies during the implementation process in the field.

CONCLUSIONS AND SUGGESTIONS

The results of this study indicate that MatHub, an interactive multimedia application developed using the ADDIE model, is both valid and practical for use in mathematics learning, particularly on the topic of number patterns. Validation by media and content experts yielded a final average score of 3.425 (very valid) for media and 3.165 (valid) for content, confirming that the application meets the necessary quality standards, with only minor revisions required. Practicality testing involving one teacher and six students showed positive results, with practicality indices of 3.47 (very practical) and 3.05 (practical), respectively. Students reported that MatHub features attractive visuals, easy-to-understand materials, and clear language, while also increasing their motivation to learn.

MatHub is recommended for broader implementation in junior high school mathematics learning due to its proven validity and practicality. Future improvements should focus on enhancing multimedia quality and ensuring better compatibility across Android devices. Schools are advised to provide teacher training for optimal use. For future research, trials should involve larger and more diverse groups, and explore additional features like gamification or adaptive learning to further enrich the media.

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