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Development of Android-Based Interactive Mathematics Learning Media Assisted by Articulate Storyline in Junior High School

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Abstract

This study aims to develop an android-based interactive mathematics learning media assisted by articulate storyline for junior high school students. We developed the medium using the ADDIE methodology, which encompassed the phases of analysis, design, development, implementation, and evaluation. The validation of the materials, questions, and media products yielded highly valid results, with validity percentages of 94.7%, 98.1%, and 92.9%, respectively. The practicality assessment conducted with students and instructors indicates that the media is highly effective, yielding an average practicality score of 83.5% for students and 90% for teachers. The efficacy of the medium was evaluated through instruction in two distinct courses utilizing algebra teaching materials with a counterbalanced design. We conducted the study to compare the learning outcomes with and without the use of learning media. The analysis results indicate a substantial disparity between the two groups, with the average N-gain of learning utilizing learning media (0.475) surpassing that of learning without media (0.352). The results show that the android-based interactive mathematics learning media assisted by articulate storyline helps improve students' math learning and is suitable for use as an educational innovation in the digital era.

Keywords: Android-based interactive; learning media; articulate storyline.

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1. Introduction

The improvement of mathematics education quality in schools has been the focus of numerous studies, utilizing various approaches ranging from instructional models and media to the integration of local culture through ethnomathematics. A notable contribution stems from research on geometric concepts embedded in the traditional pottery-making of Kenda in Abar Village, Papua [1]. These pottery products not only represent cultural artifacts but also contain geometric elements such as symmetry, spatial forms, and rotational patterns. This cultural context can be leveraged to introduce mathematical concepts in ways that are familiar and meaningful to students, thereby promoting contextual and engaging learning experiences. Other studies have highlighted the traditional number system of the Mee ethnic group in Papua [2]. This system goes beyond mere numerical representation and embodies cultural values and philosophical perspectives. Through an ethnomathematical approach, educators can connect this system to numerical topics in the curriculum while simultaneously contributing to the preservation of indigenous knowledge. Similarly, research on traditional art practices among the Teluk Ampimoi community in Yapen has identified geometric and measurement concepts embedded in their ornaments and traditional patterns [3]. Ethnographic approaches in these studies reveal that mathematical elements are embedded within various cultural practices, and they offer valuable opportunities for curricular integration to enhance relevance and student interest in mathematics learning.

In addition to culturally-based approaches, several studies have explored the role of innovative instructional models. The Problem-Based Learning (PBL) model has demonstrated effectiveness in enhancing students' critical thinking and problem-solving skills, particularly in topics such as systems of linear equations in two variables [4]. Although the overall student performance remained within a moderate range, the implementation of PBL encouraged greater student engagement in seeking solutions and developing logical reasoning abilities.

From a psychological standpoint, research on Adversity Quotient (AQ) has shown that students' problem-solving and deductive reasoning skills are positively correlated with their AQ levels [5]. Students classified as "Climbers," characterized by high perseverance and resilience, exhibited superior performance compared to those in the "Quitter" or "Camper" categories. These findings underscore the importance of affective factors in supporting academic achievement.

In terms of learning media, comparative studies between GeoGebra and PowerPoint have revealed that GeoGebra is more effective in enhancing student learning outcomes, particularly in geometry and algebra content [6]. The interactive and exploratory visualizations provided by GeoGebra significantly support students' conceptual understanding. This emphasizes the crucial role of appropriate technological tools in facilitating meaningful mathematics instruction.

Overall, diverse approaches cultural integration, instructional models, psychological insights, and digital technologies collectively contribute to the advancement of mathematics education quality. A synergistic integration of these strategies can foster mathematics learning environments that are not only effective but also contextual, engaging, and grounded in students' lived experiences.

In the current era of digitalization, the mathematics learning process is shifting toward more interactive and dynamic approaches. Learning is no longer confined to face-to-face classroom settings but increasingly relies on digital technologies capable of visualizing abstract mathematical concepts in more concrete forms. This shift also supports the development of self-directed learning, which is flexible and unrestricted by time or place. Therefore, mathematics instruction must be intentionally designed to facilitate student access to various online digital media, thereby enhancing both understanding and engagement in the learning process.

Education's success depends on the learning process's ability to maximize student potential. Educational innovation is essential in the digital age to improve learning and prepare a global workforce. Technology helps teachers communicate curriculum and motivates students. Kozma [7] explores how media support learning by shaping mental representations and cognitive processes, emphasizing the interaction between media features, instructional design, learners, and tasks. Government programs like EduTech 2023 use ICT to improve education in Indonesia, including teacher training and digital content development. Technology allows students to learn at their pace and style and access various learning resources without geographical restrictions. Innovations that improve learning quality can make learning more engaging, interactive, and successful, maximizing students' potential and preparing them for future difficulties.

These advancements not only foster a more profound understanding of subject matter but also equip students with the essential skills needed in a rapidly changing world. By integrating technology into the classroom, educators can create a more dynamic and inclusive learning environment that caters to diverse student needs. This approach not only enhances collaboration among students but also encourages critical thinking and creativity. As educators harness the power of various digital tools, they can better prepare learners for the complexities of modern life, ensuring they are not only consumers of information but also creators and innovators.

One of the obstacles often faced in learning is the lack of effective use of learning media. This condition has an impact on the low quality of student learning outcomes, especially in understanding abstract material, such as algebra. This problem often arises due to limited teaching methods and minimal innovation in the use of learning media. Less interesting and less appropriate media can cause students to lose focus and feel bored, which ultimately affects their learning outcomes [8]. Therefore, it is important for teachers to optimize the use of learning media that can facilitate student understanding, increase interaction between students and materials, and make the learning process more interesting and effective. Effective learning media can include interactive technology, visual aids, and collaborative tools that cater to various learning styles. By embracing these innovative approaches, teachers can create a more dynamic classroom environment that engages students and enhances their overall academic performance.

Technology-based learning materials are the ideal way to raise the standard of education in tandem with the quick advancement of technology, particularly information and communication technology (ICT). In addition to increasing students' access to knowledge, technology in education makes it possible to adopt more participatory teaching strategies, including media based on Android. By engaging students' senses through music, video, pictures, and animation, interactive learning materials have the added benefit of making learning enjoyable [9].

The creation of learning materials based on Android is becoming more and more important since students are accustomed to using Android devices, which can greatly enhance their educational experience [10]. This shift towards mobile technology fosters greater engagement and allows for personalized learning experiences tailored to individual student needs. As educators embrace these tools, the potential for improved academic outcomes and a more profound understanding of complex concepts becomes increasingly attainable.

Previous studies indicate that technology-driven interactive learning media, exemplified by those created with Articulate Storyline, can enhance the efficacy of the educational process and positively influence student learning outcomes, particularly in intricate subjects such as algebra [11]. Moreover, the media facilitates the incorporation of engaging elements, such as quizzes and uncomplicated games, which enhance student involvement and promote autonomous learning [12]. Autonomous learning is particularly beneficial in fostering critical thinking and problem-solving skills, which are essential for mastering complex topics. As educators continue to integrate these innovative tools into their curricula, it is likely that we will see further refinements in student engagement and academic performance across various subjects.

The mathematics learning process in schools predominantly depends on traditional media, such as textbooks and whiteboards, with minimal integration of technology in instruction. This scenario illustrates a disparity between the potential of accessible technology and its implementation in the classroom. A viable way to address this issue is the creation of Android-based interactive learning media that enhances students' comprehension of algebraic concepts in a more engaging and effective manner. Consequently, the creation of android-based interactive learning media utilizing articulate storyline is anticipated to substantially enhance the quality of mathematics education at the junior high school, particularly in algebra, which serves as a foundation for advanced mathematical studies.

2. Research Methods

2.1. Research Methods

This developmental research uses the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model as its methodological framework. This approach facilitates the incremental development of educational media, according to [11]. We conduct validity assessments on instructional materials, inquiries, and educational media. Learning media products undergo validity testing, assessing their practicality and effectiveness. We deliver a questionnaire instrument to students and teachers to evaluate its validity and practicality. To test the media's effectiveness, the researcher implements it in the learning process throughout four face-to-face sessions in two distinct classrooms using a counterbalanced design. The data on learning progress is changed into N-gain to compare and analyze the effectiveness of learning with and without media. Since the N-gain data is normally distributed and homogeneous, the analysis is done using parametric statistics, specifically the paired sample t-test, along with other appropriate statistical tests.

2.2. Sample

Two seventh-grade students from SMP Islam Terpadu Insan Cendekia Jayapura, Papua Province, participated in

the study. We selected the classes using a purposive sampling technique. The sample comprised all students from both classes, precisely 22 students from class VII-A and 31 students from class VII-B. Furthermore, three mathematics instructors participated in evaluating the efficacy of learning media beyond grade VII students.

2.3. Research Design

This research employs a developmental framework utilizing the ADDIE model. As stated by [13], this model is a procedural research and development framework, which demonstrates the importance of consistency in each phase of the ADDIE model employed. The ADDIE paradigm interconnects each phase. Researchers can apply the ADDIE research and development approach based on their specific needs, with one example being the field of education. The research and development process for learning media follows the ADDIE framework, which comprises five stages: analyze, design, develop, implement, and evaluate. Table 1 delineates the stages as follows:

Table 1: Description of Each Research Phase in the ADDIE Model

ADDIE Model Phases	Explanation
Analysis	At this phase, the researcher conducted a needs assessment to evaluate the technology equipment and learning environments in the classroom.
Design	The researcher captures the concepts for media development at this phase and presents them in a flowchart. This stage produces flowcharts and drafts of content and queries.
Development	At this phase, the researcher validates the material, questions, and learning media. At this stage, the results include approved content and questions from experts, suggestions for improving the content and questions, interactive educational media that has been checked by media specialists, advice for improving the media from those specialists, and the final version of the media product.
Implementation	At this phase, the researcher performs the validation procedure for the content, questions, and learning media. This stage results in validated content and questions created by subject matter experts, along with their recommendations for enhancing these materials. It also produces interactive learning media products that have been validated by media specialists, including their suggestions for improvement, as well as the revision and finalization of the media product.
Evaluation	The objective of the final phase is to assess the validity, practicality, and efficacy of the learning media utilized. The outcomes achieved at this step summarize the validity, practicality, and efficacy of the generated media goods, as well as their publishing.

3. Analysis of Data

We conducted an examination of the data to assess the validity, practicality, and efficacy of the created learning media. The material's validity was checked using a formula:

$$V = \frac{F}{NIR} x100\%,$$

where V is the validity percentage, F is the total score from all respondents for each indicator (r), N is the number of indicator items, I is the highest possible score, and R is the number of respondents.

The questions were checked for validity using a formula:

$$V_i = \left(\frac{S_i}{MxVxP}\right) x100\%$$

where V_i is the validity percentage of question i, S_i is the total score given by the validator for question i, M is the highest score for the questionnaire statement, V is the number of validators, and P is the total number of questionnaire statements. The validity of the generated learning media product was assessed using the percentage score derived from the disseminated validation questionnaire.

The practicality of the developed medium was measured using a formula from [11]:

$$P = \frac{TSe}{TSh}\ x\ 100\%,$$

where P is the practicality percentage, TSe is the total score received, and TSh is the highest possible score.

To evaluate the efficacy of the new learning model, the disparities in learning outcomes between students instructed with media and those instructed without media were initially assessed, followed by an analysis of their effectiveness. The analysis is based on the N-gain learning outcomes of students from two distinct classrooms.

4. Results

The development of interactive mathematics learning material for android, facilitated by articulate storyline, adheres to the flowchart provided below.

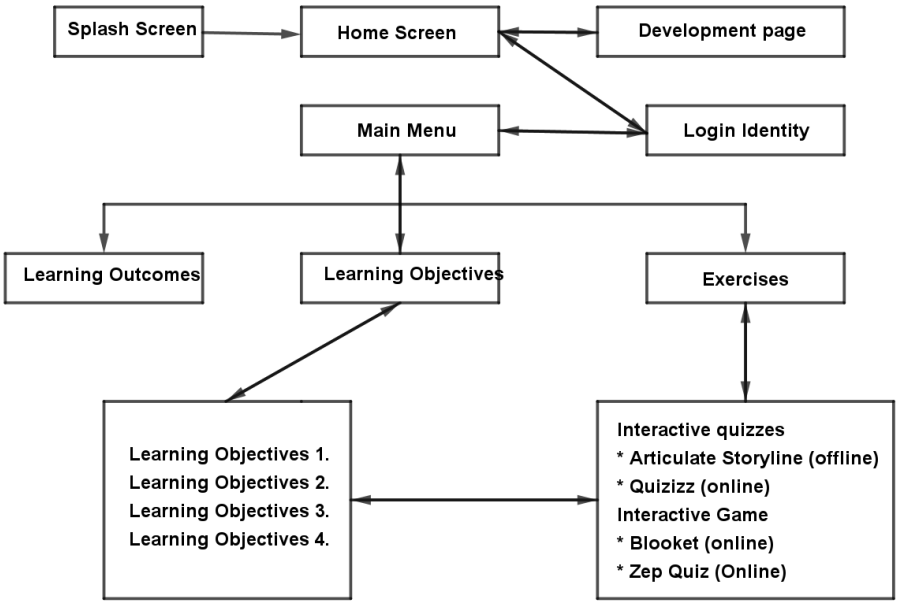

Figure 3: Flowchart of the Design Process for Interactive Learning Media

The outcomes of the material validity assessment are highly valid, with an average validity percentage of 94.6%. The table below illustrates the validity of material content distribution.

Table 2: Mean Assessment of Educational Material Content

Indicator	NIR	F				V	Criteria
		r_1	r_2	r_3	r_4		
Curriculum	48	12	11	12	12	97.9%	Highly Valid
Materials and learning	128	30	27	30	31	92.1%	Highly Valid
Grammar	32	8	8	8	6	93.7%	Highly Valid
Total	208	50	46	50	49	94.6%	Highly Valid

The outcome of the question validation is highly valid, with an average validity rate of 98.1%. The table below demonstrates the accuracy of the question distribution.

Table 3: Mean assessment of questions

Learning Objectives	M *x* V *x* P	S_i	V_i	Criteria
I	2,400	2,363	98.4%	Highly Valid
II	2,400	2,349	97.8%	Highly Valid
III	2,400	2,351	97.9%	Highly Valid
IV	2,400	2.367	98.3%	Highly Valid
Total	9,600	9,430	98.1%	Highly Valid

The validation results of the learning media package were highly valid, with an average percentage of 92.9%. The table below demonstrates the mean assessment of educational media product.

Table 4: Mean assessment of the educational media product

Aspect	Number of Indicators	Sore	Percentage	Criteria
Appearance	5	20	100%	Highly Valid
Command	6	24	100%	Highly Valid
Prototype	6	22	91.6%	Highly Valid
Animation and Sound	5	17	80%	Highly Valid
Total	22	83	92.9%	Highly Valid

Based on the results of the practicality test regarding the utilization of learning media, it was discovered that the average practicality score from students was 83.5%, while the average practicality score from teachers was 90%. This demonstrates that the learning media produced is very practical. Moreover, the researchers solicited feedback from both educators and students concerning the utilization of the educational media platforms. Subsequently, the researchers offered updates and suggestions for enhancement.

You can view the final outcomes of the generated learning media at the following URL: https://masgurudigital.github.io/simba/story.html. The following image exhibits several different displays that illustrate the outcomes of the development of learning media.

Figure 1: Learning Objectives Display

Figure 2: Initial View of Introduction to Material

Furthermore, to evaluate the efficacy of the learning media, the researcher implemented it during the instructional process on the subject of mathematics. Instruction occurred in two distinct classes. The instructional design employed a counterbalanced approach, wherein both classes were exposed to identical learning experiences, specifically learning with and without the use of instructional media [6], [14], and [15]. We conducted the instruction alternately in a varied sequence, ensuring that both classes engaged in both forms of learning in a distinct order. The N-gain data from student learning outcomes, regardless of the use of a learning medium, exhibited normal distribution and homogeneity. The t-test with $\alpha = 0.05$ assessed the differences in learning outcomes between the two educational programs. The data analysis results indicated a substantial difference between learning with media and learning without media, with $\rho = 0.000$. Moreover, it was determined that the average N-gain learning results with learning media surpassed the average N-gain learning outcomes achieved without media. The implementation of android-based interactive mathematics learning supported by articulate storyline is effective. The table below displays the N-gain scores from media-assisted learning compared to non-media-assisted learning.

Table 5: N-gain scores for learning with media versus learning without media

Learning Session	Using Learning Media	Without Using Learning Media
Learning session 1	0.55	0.42
Learning session 2	0.44	0.34
Learning session 3	0.43	0.33
Learning session 4	0.48	0.32
Mean	0.475	0.352

The data in the table above indicate that N-gain with learning media consistently exceeds N-gain without learning media.

5. Discussion

This study effectively created an interactive mathematics learning media for android assisted articulate storyline. The development process adheres to a methodical design framework as delineated in the stages of the ADDIE model. The researchers guarantee that every phase, including analysis, design, development, implementation, and assessment, is executed in a systematic and comprehensive manner.

The validation results of the learning material indicate a substantial level of validity, with an average validity percentage of 94.6%. This status signifies that the generated material aligns with the curriculum, contains accurate and pertinent content, and employs suitable grammar. Exceptional validity signifies that the content contained in the created media is appropriate for utilization as a quality educational resource [16].

The validation of the questions demonstrates highly valid results, with an average validity of 98.1%. The formulated questions satisfy the standards of precision and coherence with educational objectives. It is crucial to guarantee that the assessment performed via these questions can precisely gauge students' competency accomplishments [9].

The evaluation of the instructional media product for appearances, commands, prototypes, animations, and sound yielded highly valid results, with an average score of 92.9%. The visual and navigational elements achieved a score of 100%, signifying that this media is appealing and user-friendly for pupils. The elements of animation and music, however somewhat diminished (80%), remain within a legitimate category, indicating that this medium is already very interactive and facilitates the learning process [17].

The practicality assessment indicates that this educational media is highly practical, achieving an average score of 83.5% from students and 90% from teachers. This rating signifies that the medium is user-friendly and may be efficiently utilized in the educational process. We utilize input from educators and learners for enhancements, indicating an ongoing development cycle [12].

We evaluated the efficacy of the media through a counterbalanced design in two classes that underwent learning interventions with and without media. Statistical analysis employing the t-test revealed a significant difference ($\rho = 0.000$) in the learning results of students utilizing learning media compared to those who did not. The mean N-gain in learning with media was 0.475, surpassing the 0.352 observed without media. The implementation of the developed android-based interactive mathematics learning media assisted by articulate storyline can markedly enhance students' mathematics learning outcomes [18].

6. Limitation

This research possesses several limitations. Firstly, the selection of sample classes and learning materials remains confined to the subject of algebra. Secondly, the implementation of this learning model necessitates an internet connection and a computing device or an android-based mobile phone. Consequently, additional investigation is requisite.

7. Conclusion

This study concludes that the interactive android-based mathematics learning media developed with articulate storyline demonstrates excellent validity, high practicality, and effectiveness in enhancing students' learning outcomes. This media fulfills both the quality standards of the content and the inquiries while offering an intriguing and dynamic learning experience for students.

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