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REVITALIZATION OF DIGITAL LEARNING: IS *MOBIL MATEMATIKA* WITH SMART APPS CREATOR EFFECTIVE FOR TEACHING NUMBERS?

Hadi Widodo[1*], Jailani[2]

[1,2] Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
**Corresponding author. Jl. Colombo No.1 Karangmalang Yogyakarta, 55281, Yogyakarta, Indonesia.*
E-mail: *hadi.widodo@gmail.com* [1*)]
jailani@uny.ac.id [2)]

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Abstract

The insufficient understanding of number concepts at the elementary school level results in weak numeracy skills, impacting students' logical thinking and problem-solving abilities in higher education. This study aims to examine the effectiveness of an Android-based interactive multimedia, *Mobil Matematika*, in improving the achievement and learning motivation of third-grade elementary school students. Using the Research and Development (R&D) method based on the Multimedia for Learning model by Alessi & Trollip, the study involved third-grade students from SDN Dadaprejo 01 and 02, with 19 students for field trials and 18 students for product testing, as well as one teacher from SDN Pendem 01 and another from SDN Pendem 02 as expert practitioners. Data were collected through interviews, questionnaires, tests, and observations, then analyzed qualitatively and quantitatively. The results indicate that *Mobil Matematika* significantly enhances students' understanding of number concepts and learning motivation by integrating Constructivism Theory and Self-Determination Theory. The interactivity and feedback provided help students build their own understanding, highlighting the potential of interactive educational technology in improving learning outcomes. These findings emphasize the importance of instructional design that supports students' emotional and cognitive aspects, as well as the role of interactive technology in strengthening mathematics comprehension in elementary education.

Keywords: Android; educational technology; learning achievement; motivation; multimedia.

Abstrak

Rendahnya pemahaman konsep bilangan di tingkat Sekolah Dasar mengakibatkan lemahnya kemampuan numerasi siswa, yang berdampak pada keterampilan berpikir logis dan pemecahan masalah di jenjang pendidikan selanjutnya. Penelitian ini bertujuan untuk menguji keefektifan multimedia interaktif berbasis Android, "Mobil Matematika," dalam meningkatkan prestasi dan motivasi belajar siswa kelas 3 Sekolah Dasar. Penggunaan metode pengembangan R&D (Research and Development) berdasarkan model Multimedia for Learning oleh Allesi & Trollip, penelitian ini melibatkan siswa kelas 3 SDN Dadaprejo 01 dan 02 sebagai subjek penelitian dengan jumlah 19 siswa untuk uji coba lapangan dan 18 siswa untuk uji produk, serta satu orang guru dari SDN Pendem 01 dan satu dari SDN Pendem 02 sebagai praktisi ahli. Pengumpulan data dilakukan melalui wawancara, angket, tes, dan observasi, menghasilkan data yang dianalisis secara kualitatif dan kuantitatif. Hasil penelitian ini menunjukkan bahwa Mobil Matematika secara signifikan meningkatkan pemahaman konsep bilangan dan motivasi belajar siswa dengan mengintegrasikan teori Konstruktivisme dan Self-Determination. Interaktivitas dan umpan balik yang disediakan membantu siswa membangun pemahaman sendiri, menegaskan potensi teknologi pendidikan interaktif dalam meningkatkan hasil belajar. Temuan ini menegaskan pentingnya desain pembelajaran yang mendukung aspek emosional dan kognitif siswa serta peran teknologi interaktif dalam meningkatkan pemahaman matematika di Sekolah Dasar.

***Kata kunci**: Android; motivasi; multimedia; prestasi belajar; teknologi pembelajaran.*

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INTRODUCTION

Education is a conscious and planned effort aimed at developing students' potential holistically and in a balanced manner (Fekih Zguir et al., 2021; Intania & Sutama, 2020). Education is not limited to academic knowledge but also includes aspects of spirituality, personality, intelligence, morality, and practical skills (Eryong & Li, 2021; Jamilah, 2021). In the context of skill development, numeracy skills are a fundamental basis that supports daily life and socio-economic development (Faradiba et al., 2023; Wright, 2021). Therefore, education must integrate theoretical learning with practical applications to help students intellectually understand key concepts and apply them in real life.

Mathematics at the elementary school level plays a crucial role in building fundamental numerical understanding, which will continue to the next educational levels. Based on the 2013 Curriculum and the Ministry of Education and Culture Regulation No. 719/P/2020, mathematics learning in the 3rd grade of elementary school targets mastery of whole numbers up to 1000, with an emphasis on early numerical concepts (Rahmadita et al., 2024; Zurqoni et al., 2022). As technology advances, education undergoes transformation with the integration of information technology in the learning process, especially after the Covid-19 pandemic (Acosta et al., 2023; Chatzipanagiotou & Katsarou, 2023; Kim, 2021; K. H. D. Tang, 2023).

Several studies have examined the effectiveness of multimedia in mathematics learning. Chiu et al. (2020) investigated how multimedia design incorporating emotional aspects influences elementary school students' understanding of mathematics. Kenedi et al. (2019) highlighted students' difficulties in understanding mathematical concepts and explored solutions to improve their problem-solving abilities. Meanwhile, Gartika et al. (2019) developed interactive multimedia for geometry topics in the 5th grade of elementary school. All these studies emphasize the importance of interactive learning media in enhancing students' understanding and motivation.

However, previous research has not extensively explored the use of Android-based applications for numerical learning in the 3rd grade of elementary school. Chiu et al. (2020) focused more on the emotional aspects of multimedia design, whereas this study prioritizes the effectiveness of Android applications developed with Smart Apps Creator in improving number concept comprehension. Kenedi et al. (2019) employed a qualitative approach to assess students' mathematical connections, while this study adopts a research and development (R&D) approach to evaluate the effectiveness of Android-based mathematics learning applications. Furthermore, Gartika et al. (2019) focused more on geometry topics for 5th-grade students, different from this study, which focuses on number concepts in the 3rd grade.

Based on initial observations at SDN Karangmulya 02, SDN 01 Kadugede, SDN 2 Sumberejo, and schools in Cluster 3, Junrejo District, Batu City, it was found that 3rd-grade students still face difficulties in understanding number concepts, especially in integer multiplication operations. Many students perceive mathematics as a difficult subject, leading to decreased learning motivation. Interviews with teachers

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revealed that the currently available learning media are ineffective, necessitating more engaging and user-friendly educational media. Survey results showed that 84% of students and 100% of teachers preferred interactive multimedia as a more effective solution, with 97% of students having access to Android devices.

To address this issue, this study develops Android-based interactive multimedia for number concepts in 3rd grade using Smart Apps Creator. This application is expected to enhance students' understanding of number concepts and their learning motivation through an interactive and technology-based approach.

This study aims to develop Android-based interactive multimedia for teaching number concepts in the 3rd grade of elementary school, determine the effectiveness of Android-based interactive multimedia in improving students' conceptual understanding, and evaluate the impact of the application on students' learning motivation. Thus, this research is expected to contribute to mathematics education in elementary schools by offering a technology-based solution that enhances students' understanding of number concepts and their learning motivation.

METHOD

The research employed the Research and Development (R&D) methodology using the Multimedia for Learning development model by Alessi & Trollip. The study was conducted operationally in three main stages: planning, design, and development.

The planning stage began with a needs analysis through initial observations and interviews with teachers and students to understand the problems and learning needs. Subsequently, the objectives of developing Android-based interactive multimedia were determined, along with the identification of user characteristics, specifically third-grade elementary school students, and the learning materials to be developed.

In the design stage, the structure and learning scenarios were designed by creating storyboards and flowcharts to outline the application's interaction flow. The selection of multimedia elements such as text, images, animations, audio, and videos was also carried out to support the effectiveness of learning.

Next, the development stage started with the creation of an initial prototype using Smart Apps Creator 3.2, which was then evaluated by media and content experts in the initial trial (alpha testing). Revisions were made based on expert feedback before proceeding to a limited trial (beta testing) with a small group of students. Afterward, an effectiveness test was conducted through field trials involving a larger group of students to ensure that the developed application truly enhanced the quality of learning.

The product trials involved third-grade students from SDN Dadaprejo 01 and 02, with 19 students participating in the field trials and 18 students in the product trials. Additionally, one teacher from SDN Pendem 01 and one from SDN Pendem 02 served as practitioner experts.

The research employed various instruments and data collection techniques to obtain comprehensive information. Interview guidelines were used to gather insights from teachers regarding the need for learning media, challenges in mathematics instruction, and the effectiveness of the developed multimedia. In addition, learning

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outcome tests were implemented to measure students' understanding of number concepts before and after using the interactive multimedia.

To ensure the validity and effectiveness of the developed media, the study also utilized multiple validation questionnaires. The media expert validation questionnaire assessed the design and technical aspects of the interactive multimedia, while the content expert validation questionnaire focused on curriculum alignment and its effectiveness in supporting students' understanding of mathematical concepts. Furthermore, the student response questionnaire measured the level of engagement and ease of use of the media in learning, whereas the teacher response questionnaire evaluated the applicability and effectiveness of the multimedia in assisting the teaching process.

Apart from these methods, observations were conducted to examine students' activities while using the multimedia, the interactions that occurred during learning, and any obstacles encountered in using the media. Through this combination of instruments, the study obtained more accurate and in-depth data in evaluating the effectiveness of interactive multimedia based on the SETS approach in mathematics learning. The details of the instrument's grid for assessing by expert practitioners and users, and also instrument for assessing student learning motivation can be seen in Table 1 and Table 2.

Table 1. Grid for the Assessment Instrument of Expert Practitioners and Users

No	Aspect	Indicator	Item number
1	The quality of the learning stimulus display	Clarity of instructions for use of the program	1
		Image clarity and animation	2.3
		Clarity of language used	4
		Attractiveness of the display	5
		Readability of letters used	6
		Color match	7
		Music/voice clarity	8
2	Presentation of material	Interesting multimedia components	9
		Clarity of the material	10
		Ease of practice questions	11
Total			**11**

Table 2. Grid for Student Learning Motivation Instrument

No	Statement	Item number	
		Positive	**Negative**
1	There is attention when learning takes place	1.2	3.5
2	Learning carried out in accordance with learning objectives	17.20	18.19
3	Learning is carried out according to the characteristics of students	7.16	6.8
4	There is confidence in material mastery	10.11	9.14
5	There is satisfaction with learning	12.13	4.15
Total		**10**	**10**

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Data analysis techniques produce two types of data: qualitative and quantitative. Both types are obtained through appropriate instruments. Qualitative data is gathered from interviews and observations to understand problems and student needs. Quantitative data is obtained from users during field trials to determine the effectiveness of the developed product.

The effectiveness test is conducted using a one-group pretest-posttest design involving a full class of students to collect data. The data collected include results from the initial test (pretest) and the final test (posttest). The data to be analyzed in the product effectiveness test include, firstly, the analysis of student learning motivation through a questionnaire using a Likert scale, assessing responses to positive and negative statements to determine the product's effectiveness in enhancing learning motivation, with categories ranging from "Highly Effective" to "Ineffective" based on scores.

Table 3. Effectiveness Score Category in Increasing Learning Motivation

Total Score	Category
xi ≥ 84,01	Highly Effective
68,01 ≤ xi ≤ 84,00	Effective
52,01 ≤ xi ≤ 68,00	Quite Effective
36,01 ≤ xi ≤ 52,00	Less Effective
xi ≤ 36	Ineffective

Android-based multimedia number material for grade 3 elementary school students can be said to be effective in reviewing student learning motivation if it reaches a score above 68.00.

Both student achievements are measured through a comparison of preliminary test results and final tests after learning using Android-based multimedia, using the N-Gain formula (1) to assess increased understanding of the material.

$$g = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}} \qquad (1)$$

Keterangan:
g = *gain*
S_{post} = Average Post-test score
S_{pre} = Average Pre-test score
S_{maks} = Maximum score

N-Gain is interpreted and classified based on the gain values in Table 4.

Table 4. Classification of Gain Value Interpretation

Gain value	Category
$g \geq 0{,}70$	High
$0{,}30 < g < 0{,}70$	Medium
$g \leq 0{,}30$	Low

Android-based multimedia developed is said to be effective in improving students' learning achievement if (1) there is an increase in the learning achievement attained by students after engaging with the developed product; and (2) a minimum moderate category gain in learning achievement is achieved.

RESULTS AND DISCUSSION

This research involves the development of an Android-based multimedia, "*Mobil Matematika*," for grade 3 elementary school arithmetic material, aimed at addressing the low understanding of students in arithmetic material through an interactive and attractive approach. The development process began with the planning stage, which included determining the scope of the material, identifying student characteristics, collecting resources, and brainstorming initial ideas.

The design phase involves developing ideas, analyzing concepts and tasks, and creating flowcharts and storyboards. The development phase

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includes visual design, text, colour use, audio, and navigation, all based on learning theories such as constructivism and Multiple Intelligences, integrated using the Smart Apps Creator application. The technical specifications required for this application include the Android 9.0 (Pie) operating system, Octa Core processor, at least 2 GB of RAM, and 2 GB of internal storage, as well as a 5.0-inch IPS LCD screen.

Figure 1. Products that have been developed are reviewed from the main page and the contents page

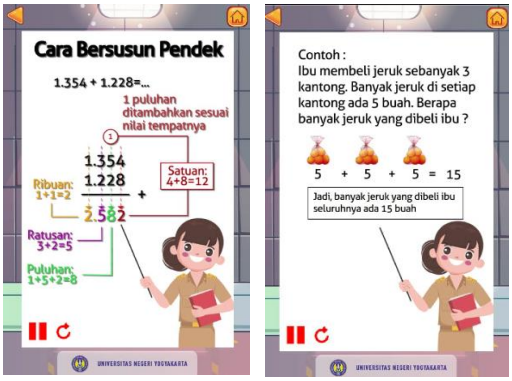

Figure 2. Products that have been developed are reviewed from learning videos in multimedia

1. Assessment from the Teacher's Aspect

Based on the assessment by teachers, as practitioners in the development of educational media products, the results show that out of a maximum score of 130, this product successfully achieved a total score of 118, with an average score of 4.54, which falls into the Practical category. The results are presented in Table 5.

Table 5. Assessment of Teachers as Practitioners

Respondent Number	Display Quality		Presentation	
	Total Score	Average	Total Score	Average
1	40	4	14	4.7
2	49	4.9	15	5
Number of Scores	**118**			
Average Score	**4.54**			
Category	**Practical**			

Therefore, the aspect of Display and Presentation Quality demonstrates the practicality of the product in presenting material in an engaging and easily understood manner. The developed product, which is linked to the Behaviorism theory that emphasizes the importance of stimulus-response in learning, with its attractive display quality, has successfully become an effective stimulus to trigger learning responses from students (Yusra et al., 2022; Yusuf et al., 2024). Meanwhile, Constructivism highlights the importance of students in constructing their own understanding (Bell, 2021; O'Connor, 2022). The clear and interactive presentation of material supports this knowledge construction process, allowing students to actively engage and better understand concepts. The results of this assessment show that

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the product has successfully integrated both theoretical aspects, creating a practical learning environment that meets the needs of elementary school students.

2. Assessment from the Student Aspect

Field trials and product tests were conducted with each on a group of third-grade elementary students. The subjects of this examination were 19 third-grade students from SDN Dadaprejo 02 and 18 third-grade students from SDN Dadaprejo 01. Both elementary schools are located in Cluster 3 of Junrejo District, Batu City, East Java.

Table 6 Assessment from the Student Aspect

		Total	Average	Percentage	Category
Grade 3 Students of SDN Dadaprejo 02 (Field Trial)	Initial	1080	3	60%	Medium
	Final	1789	4	80%	High
Grade 3 Students of SDN Dadaprejo 01 (Product Trial)	Initial	1181	3	82%	High
	Final	1446	4	83%	High

Based on the collected data, it is observed that there has been a significant increase in student motivation. Before the use of "*Mobil Matematika*," the percentage of student motivation at SDN Dadaprejo 02 was in the Medium category at 60%, which increased to High with a percentage of 80% after usage. Trial use at SDN Dadaprejo 01 showed an increase from 82% to 83% as well. Aspects such as attention during learning, learning in line with objectives, alignment with student characteristics, confidence in mastering the material, and satisfaction with learning, all showed positive improvements. This increase can be associated with the Self-Determination Theory proposed by Ryan and Deci, which emphasizes three main aspects of intrinsic motivation: competence, relatedness, and autonomy (Guay, 2022; Tang et al., 2020). The use of Android-based multimedia like "*Mobil Matematika*" offers students the opportunity to feel more competent due to the interactivity and feedback provided by the media. Furthermore, this media provides relatedness, namely the alignment of learning with the characteristics and needs of students, and enhances their autonomy in learning, all of which contribute to the increase in learning motivation. Moreover, the results of student academic achievement also showed a striking improvement. At SDN Dadaprejo 02, the average pretest score of students was 37.78, which increased to 70.56 on the posttest, while at SDN Dadaprejo 01, the score increased from 41.76 to 79.41. This increase indicates that students are not only more motivated but also have a better understanding of number material. The N-Gain, which is in the medium category for both schools, also confirms a significant improvement in academic achievement. The data is presented in Table 7.

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Table 7. Student Learning Achievement Results

	Grade 3 Students of SDN Dadaprejo 02		Grade 3 Students of SDN Dadaprejo 01	
	Pretest	**Posttest**	**Posttest**	**Pretest**
Total	680	1270	710	1350
Average	37.78	70.56	41.76	79.41
Percentage	38%	71%	39%	75%
N-Gain	**0.53 (Medium)**		**0.65 (Medium)**	

Constructivism theory, which emphasizes learning as an active process where students construct their understanding, provides the theoretical foundation for this improvement. "*Mobil Matematika*" encourages students to engage in the learning process actively, facilitating the construction of knowledge through direct interaction with the presented material. This process aligns with constructivist theory, where students are not merely passive recipients of information but are active in constructing their understanding. This is in line with the findings of Iswara et al. (2023), which indicate that Android-based learning media are beneficial as learning aids. Additionally, supported by research from Zulfiani et al., (2021) shows that Android-based media can help improve students' thinking abilities in line with the competencies to be achieved through independent learning.

Therefore, this study demonstrates that the use of "*Mobil Matematika*" as a learning tool for grade 3 elementary school number materials effectively increases both motivation and academic achievement among students. From a motivational aspect, this product successfully meets and enhances the aspects of competence, relevance, and autonomy of students, which are crucial in intrinsic motivation theory. From an academic achievement aspect, students show significant progress in understanding and mastering the material, aligning with the principles of Constructivism theory.

A comparison with previous studies explains the impact of emotional design in multimedia learning Chiu et al. (2020), showing that emotional design can enhance recall ability in students with higher expertise but does not significantly affect the understanding of beginner students. This reflects that the "*Mobil Matematika*" approach, integrating constructivism theory and Multiple Intelligences with an appealing visual design, can serve as an effective stimulus triggering a learning response from students, similar to the findings of that study. However, unlike Study Chiu et al. (2020), this research with the "*Mobil Matematika*" product successfully supports the conceptual understanding of beginner students, indicating alignment with the constructivism theory that encourages students to construct their knowledge actively.

Furthermore, research on elementary school students' mathematical connection abilities. Kenedi et al. (2019) found that students' problem-solving capabilities in mathematics still needed to improve. In this context, "*Mobil Matematika*" offers a contrasting approach, as it successfully improves understanding and academic achievement in a number of materials, showing a contradiction to the findings of Kenedi et al. (2019). This affirms the effectiveness of interactive multimedia in supporting students in gaining a better conceptual understanding.

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Lastly, research on the development of interactive multimedia for solid geometry materials aligns with this study in terms of the goal of developing interactive and engaging learning media for students (Gartika et al., 2019). Both studies underscore the importance of effectively designed learning media to enhance the teaching and learning process, despite the different focus of their learning materials.

Overall, this research aligns with previous findings on the importance of learning design that considers the emotional and cognitive aspects of students and offers a contrast to findings on the low conceptual understanding abilities of elementary school students in mathematics. It confirms the significant potential of using interactive learning technology, like "Mobil Matematika," to strengthen students' understanding and support higher learning outcomes.

The implications of this study are significant for the education sector, particularly in the development of mathematical learning media for elementary students, as based on the results of this study, the developed product can effectively enhance motivation and academic achievement in a number of materials. This proves that the integration of technology in education, especially supporting interactivity, personalized learning, and the use of multimedia, can provide a more engaging learning environment and facilitate better conceptual understanding. Therefore, this study underscores the importance of further development and implementation of technology-based interactive learning media in the education curriculum to enrich student's learning experiences and support individual learning needs. Moreover, this study also provides insights for education policymakers to consider integrating digital learning tools as a main strategy for improving the quality of mathematics education in elementary schools.

CONCLUSION AND SUGGESTION

The development of the Android-based multimedia "*Mobil Matematika*" for a number of materials in 3rd grade elementary school has proven effective in enhancing students' understanding and motivation to learn. The integration of Behaviorism and Constructivism theories, along with a focus on intrinsic motivation through competence, relatedness, and autonomy, creates an interactive and engaging learning environment. This facilitates the construction of knowledge and active student engagement. Evaluations from teachers and students indicate the practicality and effectiveness of this product in enhancing motivation and learning achievement, with a significant increase in scores from the pretest to the posttest. These findings affirm the importance of learning design that considers the emotional and cognitive aspects of students and demonstrates the potential of interactive learning technology in improving mathematical and conceptual understanding among elementary students.

Suggestions for future research emphasize the importance of further exploration regarding the implementation of interactive learning technology across various learning materials and educational levels. This aims to assess the technology's effectiveness on a larger scale. The research focus can also be directed towards the development of new features that support learning personalization and the ability to adapt

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to individual learning needs, as well as conducting long-term evaluations on how learning technology affects students' independent learning skills. For policymakers, these findings imply the necessity of integrating digital learning tools into the educational curriculum. This is considered a key strategy to enhance education quality, particularly mathematics at the Elementary School level, by providing a more engaging learning environment and facilitating deeper conceptual understanding.

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