Effectiveness of Digital-Based Smart Math Diagram on Students' Interest and Learning Outcomes in Data and Diagram Material

Nur Mahmudah Munawwaroh [1a], Wahyuni Suryaningtyas [1b], Febriana Kristanti [1c], Sandha Soemantri*[1d]

[1]Universitas Muhammadiyah Surabaya, Jl. Raya Sutorejo No.59 Surabaya, 60113, Indonesia
e-mail: [a]nurmahmudahm1@gmail.com, [b]wahyuni.pendmat@fkip.um-surabaya.ac.id,
[c]febriana.pendmat@fkip.um-surabaya.ac.id, [d]sandha.pendmat@fkip.um-surabaya.ac.id
* Corresponding Author.

Abstract: This study aims to describe the effectiveness of digital-based *DIAGRAM SMART MATH* on students' interest and learning outcomes in the material of data and diagrams. The type of research used is pre-experimental with a quantitative approach. The research design employs a one-group pretest-posttest. The population in this study consists of all seventh-grade students at SMP Mujahidin Surabaya. The sample was selected using purposive sampling, with a total sample of 25 students, comprising 9 males and 16 females. Data collection techniques in this study used pretests, posttests, and questionnaires. The data analysis techniques used were the One Sample T Test and N-gain. The results of the study indicate that the influence of digital-based *DIAGRAM SMART MATH* on the material of data and diagrams has a significant effect on students' interest and learning outcomes. This is evident from the analysis of the questionnaire used to measure students' interest, which yielded an average of 86%, falling into the very high criteria. Furthermore, the N-gain analysis results obtained a value of 0.7409, which is categorized as high. Additionally, based on the One Sample T Test analysis, the significance value obtained was 0.000 < P-value 0.05; thus, H_1 is accepted. Therefore, it can be concluded that there is an influence of digital-based *DIAGRAM SMART MATH* on students' interest and learning outcomes in the material of data and diagrams.
Keywords: DIAGRAM SMART MATH; student learning outcomes; student learning interest

Introduction

The digital era has brought about significant changes in various aspects of life, including education and the learning process. With the increasing digitalization of education, understanding the relationship between student engagement in Technology-Enhanced Learning (TEL) and the digital skills required for effective participation in these environments is crucial. Although some studies have explored this relationship, it remains largely underexplored (Bergdahl et al., 2020). According to

(Sandrasyifa & Nugraheni, 2024), leveraging digital technology in the learning process not only enhances access and the quality of education but also improves students' problem-solving skills. Learning in the digital era demands the implementation of contemporary learning models and media with interactive, innovative, and collaborative concepts to deliver material effectively and meaningfully to students (Nuraeni et al., 2023).

Education is a planned and deliberate effort to create an enjoyable learning environment where students can actively develop their potential. This allows them to acquire spiritual and religious strength, self-control, personality, intelligence, noble character, and the skills required by society and themselves (Pristiwanti et al., 2022). Education encompasses not only the provision of specific skills but also deeper aspects, such as imparting knowledge, judgment, and wisdom. Various approaches and methods are applied throughout this process to ensure that education proceeds as expected and achieves its learning objectives effectively.

The learning process itself is a systematic series in which teachers deliver information or messages to students in a structured manner, designed, implemented, and evaluated. This process takes place both inside and outside the school environment, with interactions between the two. Teachers play a crucial role as both organizers and facilitators of the learning process. In practice, teachers often need to conduct remedial activities to address challenges in the learning process. Research by (Nuraeni et al., 2023) indicates that students' interest in learning mathematics can be enhanced through engaging and interactive learning media. Digital media can serve as an effective tool in increasing students' interest, particularly in mathematics education.

Student learning outcomes are an important indicator of academic success, attained through assignments, exams, and active participation in classroom discussions, such as asking and answering questions that support their progress. In academic circles, it is often argued that academic achievement is not solely determined by grades on report cards or diplomas (Putri et al., 2022). However, student learning outcomes remain a crucial indicator for measuring cognitive success. According to (Rahardian, 2022), the lack of supporting media in learning leads to difficulties in problem-solving, ultimately affecting students' interest and performance in mathematics. Several applications can be used for assessment design, including Quizizz, Kahoot, and SAC (Smart Apps Creator) (Almukarramah et al., 2023). Therefore, the presence of appropriate learning media is essential to facilitate students' understanding of the subject matter, one of which is SAC (Smart Apps Creator). (Fahri, 2022) explains that SAC (Smart Apps Creator) is an application that includes various features that reduce learning fatigue.

Based on this, the researcher modified SAC (Smart Apps Creator) into DIAGRAM SMART MATH, an audiovisual mathematics learning media designed for students, particularly at the elementary and junior high school levels. This media aims to help students understand mathematical concepts, especially in the topics of data and diagrams, in a more engaging way. It also serves as a teaching aid for educators, enhancing the effectiveness of classroom learning. The development of this learning media utilizes SAC (Smart Apps Creator), an application that offers various features to reduce learning fatigue. By leveraging technology, SAC (Smart Apps Creator) stimulates students' cognitive processes and includes analytics tools that assist teachers in assessing student learning outcomes and making effective instructional decisions (Fahri, 2022). The process of creating DIAGRAM SMART MATH involves several stages: designing the layout, developing content, integrating technology, conducting trials, and

evaluating its effectiveness. Figures 1 and 2 illustrate the initial interface and menu display of the application.

Figure 1: Initial Display of DIAGRAM SMART MATH

Figure 2: Menu Display of DIAGRAM SMART MATH

Based on observations conducted by the researcher at SMP Mujahidin Surabaya, the researcher identified issues in the mathematics learning process. During learning activities, teachers often use a one-way lecture method, resulting in a lack of variation in the learning process. This method often makes students feel bored as they only sit, stay silent, listen, take notes, and memorize the material, leading to minimal interaction between students and teachers. This can cause low interest in the learning process, which may result in unsatisfactory learning outcomes due to incomplete understanding of the material, preventing students from achieving the expected learning objectives. Therefore, the aim of this study is to determine the influence of Digital-Based DIAGRAM SMART MATH on students' learning interest in the topic of Data and Diagrams and to examine its impact on students' learning outcomes in the same topic.

The evolution of education in the digital era, particularly through Technology-Enhanced Learning (TEL), has created substantial shifts in student engagement and the digital skills necessary for effective participation in these environments. The relationship between student engagement in TEL and digital skills is a critical area that warrants further exploration, as existing literature suggests strong interconnections between these elements that significantly influence educational outcomes.

Research indicates that the digital competence of students is closely linked to their attitudes toward using information and communication technology (ICT). These attitudes drive active participation in the learning process. For instance, the findings of (Daniela et al., 2018) underscore that a positive attitude towards ICT correlates strongly with cognitive readiness necessary for managing the complexities of digital learning environments, reflecting students' motivation and engagement in TEL settings. Similarly, studies by (M. S. Kim & Sohn, 2019) show that students demonstrating high levels of digital readiness, confidence in their digital skills, experience improved academic achievements in e-learning environments. This suggests that digital skills are not merely facilitating tools but pivotal capabilities that enhance overall academic success.

Furthermore, the transformative potential of TEL is evidenced by its ability to engage students through a pedagogical lens that emphasizes active learning and exploratory research practices. (Aşıksoy, 2019) highlights the importance of creating supportive environments that blend pedagogical strategies with technological tools to foster deeper concept learning within TEL. This integration is crucial, as technology does not function in isolation; it needs to be embedded within a well-defined educational framework that enables students to take initiative and engage in self-directed learning (Tsai, 2017).

Moreover, the correlation between digital skills and engagement is notably evident in the context of digital literacy. Research indicates that students possessing strong digital literacy skills, such as effectively navigating online platforms and utilizing digital tools, are more engaged in TEL. This is supported by (Ukwoma et al., 2016), which emphasizes that a significant number of students exhibit competence in digital skills necessary for academic tasks, enhancing their participation in TEL. Conversely, a lack of these skills may hinder engagement and lead to disengagement and poorer academic outcomes, as discussed by (Bergdahl et al., 2020).

While the link between engagement, motivation, and digital skills is crucial, it is also essential to recognize broader contextual factors affecting this relationship. Cultural backgrounds, personal beliefs, and socioeconomic status can significantly impact students' engagement levels and their access to requisite digital skills (Khlaif et al., 2021). As (H. J. Kim et al., 2018) note, family perceptions of technology and educational practices can create barriers that may prevent students from fully engaging in TEL environments.

In conclusion, the interplay between student engagement, digital skills, and the effectiveness of TEL is a multifaceted issue that reflects the changing landscape of education in the digital era. Continued research is vital to unravel the complexities of these relationships and to develop strategies that can enhance student engagement through targeted digital skill development, ultimately leading to improved educational outcomes in Technology-Enhanced Learning contexts.

Based on the results of observations conducted by the researcher at SMP Mujahidin Surabaya, the researcher identified issues in the mathematics learning process. During the learning activities, teachers often use a one-way lecture method, resulting in a lack of variation in the learning process. The use of this method often makes students feel bored as they only sit, stay silent, listen, take notes, and memorize the presented material, leading to minimal interaction between students and teachers. This can cause students to have low interest in the learning process and may result in unsatisfactory learning outcomes due to their incomplete understanding of the material, preventing them from achieving the expected learning objectives. The purpose of this study is to determine the influence of Digital-Based *DIAGRAM SMART MATH* on students' learning interest in the topic of Data and Diagrams and to examine its impact on students' learning outcomes in the same topic.

Method

Based on the research problem, this study employs a *pre-experimental* method with a quantitative approach. Quantitative research is characterized by an objective approach, involving the collection and analysis of quantitative data as well as the application of statistical methods for testing.

This study uses a *Pre-Experimental* design, in which external variables influence the dependent variable due to the absence of variable control. The *Pre-Experimental* design employed is the One

Group *Pre-test Post-test*, where measurements are taken before and after the treatment is given to the research subjects (Sugiyono, 2018).

Pre-tes	Treatment	Post-tes
O_1	X	O_2

Explanation:

O_1 = Pre-test score (before being given the DIAGRAM SMART MATH media treatment)

X = Treatment given to students using the DIAGRAM SMART MATH media

O_2 = Post-test score (after being given the DIAGRAM SMART MATH media treatment)

This research was conducted at SMP Mujahidin Surabaya in Grade VII during the even semester of the 2023/2024 academic year. The school is located at Jl. Perak Bar. No.275 003, RT.003/RW.03, Perak Utara, Pabean Cantikan District, Surabaya, East Java 60165. The population of this study consists of Grade VII students at SMP Mujahidin Surabaya. The research sample includes a portion of the Grade VII students at SMP Mujahidin Surabaya. Therefore, the sampling technique used in this study is purposive sampling, in which the sample selection is based on specific considerations aligned with the research objectives. In this study, the sample consists of 25 students, including 9 male and 16 female students at SMP Mujahidin Surabaya. The sample selection was made based on the recommendation of the mathematics teacher at SMP Mujahidin Surabaya.

Results

The Implementation of Digital-Based *DIAGRAM SMART MATH* Media in Data and Diagram Topics

This study aims to describe students' interest and learning outcomes after learning using the digital-based *DIAGRAM SMART MATH* media in Grade VII, consisting of 9 male and 16 female students at SMP Mujahidin Surabaya. The topics taught include Data and Diagrams, which were implemented through digital-based *DIAGRAM SMART MATH* media over two meetings. Before using this media, students took a pre-test to measure their initial learning outcomes. After two meetings, a post-test was conducted to assess students' learning outcomes after using the digital-based *DIAGRAM SMART MATH* media. The following is documentation of the implementation of the digital-based *DIAGRAM SMART MATH* media.

Phase 1 Orientation of Students to the Problem

The teacher begins by introducing a contextual problem relevant to everyday life, "How can we present the sales data of oranges over a week in the easiest way to understand?" Students are asked to think about possible ways to present the data. The teacher then introduces the *DIAGRAM SMART MATH* application as the tool that will be used to solve this problem.

Figure 3. The teacher presents a contextual problem and introduces the *DIAGRAM SMART MATH* application

Phase 2 Organizing Students for Learning

The teacher divides the students into small groups and provides them with LKPD (Student Worksheets) to work on. Each group is asked to discuss which type of diagram is most appropriate to use (e.g., bar chart, pie chart, or line chart). After the discussion, students are asked to begin exploring the features of *DIAGRAM SMART MATH* to understand how their data can be transformed into a diagram.

Figure 4. The teacher divides the students into groups and provides them with LKPD

Phase 3 Guiding Individual and Group Investigations

The teacher acts as a facilitator, guiding and providing direction, ensuring that each student works independently or in small groups using *DIAGRAM SMART MATH* to choose the type of diagram that makes the data more engaging. During the investigation, students are expected to discuss, exchange ideas, and help each other in understanding the concepts as well as compiling their investigation reports. The final results of the investigation will be presented by each group.

Figure 5. The teacher accompanies students as they learn independently and in groups using *DIAGRAM SMART MATH*

Phase 4 Developing and Presenting the Work Results

After the students finish creating their diagrams, they present the results in front of the class, explaining the process of creating the diagram and interpreting the data. They also answer questions from other students to enhance their technical skills and visual communication abilities.

Figure 6. The students present their work results in front of the class

Phase 5 Analyzing and Evaluating the Problem-Solving Process

After the presentation of the discussion results, the teacher, along with the other students, provides feedback on the work of each group. A class discussion is held to evaluate the effectiveness of the chosen diagram, the accuracy of data interpretation, and the problem-solving process that was carried out. Students are also asked to reflect on what they have learned from this experience, including new skills in using the *DIAGRAM SMART MATH* application.

Figure 7. The teacher provides feedback to the students

Learning the topic of Data and Diagrams using the digital-based *DIAGRAM SMART MATH* media presents an introduction through engaging visualizations. For example, to introduce the concept of data, this media can display various data examples taken from everyday life, such as the number of parents' professions in the class or weekly sales data.

One of the challenges encountered during the study was during the installation of the application. The use of smartphones as a learning tool became an issue because some smartphones did not support the application. As a result, those whose phones could not install the application had to join their peers.

The Influence of Using Digital-Based *DIAGRAM SMART MATH* Media on Students' Learning Interest in Data and Diagram Topics

Referring to the data from the learning interest questionnaire, it was found that 86% of students responded positively to learning using the digital-based *DIAGRAM SMART MATH* media. This high percentage indicates that the majority of students feel more engaged and have a greater interest when learning with the aid of this digital media. The use of *DIAGRAM SMART MATH* media allows students to participate more actively in the learning process, significantly increasing their interest in the material being taught.

Students can be said to demonstrate interest in learning during Phase 3, which is when they conduct investigations, both in groups and individually. At this stage, students with a strong learning interest actively seek information, engage in discussions, and deeply involve themselves in the

problem-solving process. Learning interest is often reflected in their activeness, curiosity, and efforts to understand the given problem, as shown in the image below.

Figure 8. Students actively seek information, engage in discussions, and deeply involve themselves in the problem-solving process

Based on the percentage criteria of interest and the questionnaire data, students' interest in learning using the digital-based *DIAGRAM SMART MATH* media falls into the very high category. This category indicates that the media has successfully achieved its main goal, which is to increase students' learning interest. Thus, the use of digital-based *DIAGRAM SMART MATH* is not only effective in capturing students' attention but also facilitates their understanding of complex material. This media enables a more creative and innovative presentation of learning content, ultimately encouraging students to develop greater interest and enthusiasm for learning. The results of this study have significant implications for the field of education, particularly in the development and implementation of digital learning media that can enhance the quality and effectiveness of the learning process across various educational levels.

The Influence of Using Digital-Based *DIAGRAM SMART MATH* Media on Students' Learning Outcomes in Data and Diagram Topics

Based on the data obtained from the pre-test and post-test, there was a significant improvement in students' learning outcomes after the implementation of the digital-based *DIAGRAM SMART MATH* media. In the pre-test, no students met the Minimum Mastery Criteria (KKM), and all 25 students were still below the KKM. However, after using the digital-based *DIAGRAM SMART MATH* media, the post-test results showed a positive change, with all 25 students successfully reaching the KKM and none remaining below it.

Tabel 1. Average N-Gain Test Results

Mean	Kategori
0,74	Tinggi

The data obtained from Table 1 of the N-Gain Test shows a significant improvement in students' learning outcomes after using the digital-based *DIAGRAM SMART MATH* media. In this case, the average N-Gain score is 0.74, which falls into the high category. This N-Gain value represents the extent of improvement from the pre-test to the post-test scores. With a high N-Gain score, it can be concluded that the implementation of digital-based *DIAGRAM SMART MATH* media has a significant positive impact on students' understanding of data and diagram topics.

Tabel 2. Normality Test Results

Asymp. Sig. (2-tailed)	Kategori
0,200	Berdistribusi Normal

To ensure the validity of the data, a normality test was conducted on the pre-test and post-test data. The results of the Kolmogorov-Smirnov test in Table 2 of the Normality Test show an Asymp. Sig. (2-tailed) value of 0.200 for both the pre-test and post-test. This significance value is greater than 0.05, indicating that the pre-test and post-test data are normally distributed. This allows for the use of parametric statistical tests for further analysis.

Tabel 3. One Sample T-Test Hypothesis Test Results

Sig. (2-tailed)	Kategori
0,000	Berpengaruh

After being confirmed as normally distributed, a t-test was conducted using the One Sample T-Test. The results of the One Sample T-Test in Table 3 show a significance value of 0.000 for the post-test, which is less than 0.05, thus H_1 is accepted and H_0 is rejected. This indicates that there is an effect after using the digital-based *DIAGRAM SMART MATH* media on students' learning outcomes. Overall, the data analysis results demonstrate that the digital-based *DIAGRAM SMART MATH* media significantly contributes to improving students' learning outcomes in data and diagram topics. The implementation of this media not only enhances learning outcomes quantitatively but also improves students' understanding of the material being taught. *DIAGRAM SMART MATH* provides exercises and simulations that make learning more engaging and help students better understand the concepts. Additionally, students can access the material anytime and anywhere, offering the opportunity for more independent learning and revisiting material they have not fully understood. Therefore, the use of digital-based *DIAGRAM SMART MATH* media can be recommended as an effective learning tool to improve students' learning outcomes.

Discussions

The Implementation of Digital-Based *DIAGRAM SMART MATH* Media in Data and Diagram Topics

Learning the topic of Data and Diagrams using the digital-based *DIAGRAM SMART MATH* media introduces the material through engaging visualizations. For example, to introduce the concept of data, the media can display various data examples taken from everyday life, such as the number of parents' professions in the class or weekly sales data. These visualizations help students connect abstract concepts to their real-life experiences, making it easier for them to understand what data is. They no longer hesitate when learning mathematics and become more focused on studying each subtopic during group discussions. According to (Nurfadhillah et al., 2021), if the media used is appropriate, students will feel enthusiastic about learning. Additionally, according to (Hasibuan et al., 2024), the use of applications influences students' ability to understand mathematical concepts.

The Influence of Using Digital-Based *DIAGRAM SMART MATH* Media on Students' Learning Interest in Data and Diagram Topics

The results of this study have significant implications for the field of education, particularly in the development and implementation of digital learning media that can enhance the quality and effectiveness of the learning process across various educational levels. This aligns with the opinion of

(Septiani & Zakaria, 2022) that learning media with Smart Apps Creator (SAC) can increase students' learning interest. Additionally, according to (Rahmawati, 2023) students actively participate in class and find the environment enjoyable. The number of students answering the teacher's questions after the animated educational video was shown indicates an increase in students' learning interest.

The Influence of Using Digital-Based *DIAGRAM SMART MATH* Media on Students' Learning Outcomes in Data and Diagram Topics

Overall, the data analysis results indicate that the digital-based *DIAGRAM SMART MATH* media significantly contributes to improving students' learning outcomes in data and diagram topics. The implementation of this media not only enhances learning outcomes quantitatively but also improves students' understanding of the material being taught. *DIAGRAM SMART MATH* provides exercises and simulations that make learning more engaging and help students better understand the concepts. Additionally, students can access the material anytime and anywhere, offering opportunities for more independent learning and revisiting material they have not fully understood. Therefore, the use of digital-based *DIAGRAM SMART MATH* media can be recommended as an effective learning tool for improving students' learning outcomes. This aligns with the opinion of (Azkia et al., 2023) that digital-based learning media has a positive impact on mathematics learning outcomes. Additionally, according to (Mihee & Nam, 2025) emphasize that a supportive digital educational environment significantly influences students' academic achievement.

Conclusion

The use of digital-based *DIAGRAM SMART MATH* significantly increases students' interest in learning data and diagram topics. The data obtained from the questionnaires indicate a positive increase in students' interest after the implementation of this digital media. The questionnaire used to measure students' interest reflects increased enthusiasm, engagement, and motivation in participating in the lessons, with an average score of 86, which falls under the very high category. Additionally, the use of digital-based *DIAGRAM SMART MATH* also has a positive impact on students' learning outcomes. Data analysis shows a significant improvement in students' learning outcomes after using this media. The use of digital tools allows students to better understand the concepts of data and diagrams, which is reflected in the improvement of pretest and posttest scores. This is evident from the N-gain analysis results, which obtained a value of 0.7409, categorized as high. Based on the One Sample T Test analysis, the significance value is $0.000 < 0.05$, leading to the acceptance of H_1 and rejection of H_0. Therefore, it can be concluded that the use of digital-based *DIAGRAM SMART MATH* media has an effect on students' learning outcomes in data and diagram topics.

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