



# The Use of Technology-Based Formative Assessment in Improving Mathematics Achievement of Elementary School Students

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## ABSTRAK

Prestasi matematika bisa terbilang rendah di kalangan siswa sekolah dasar. Asesmen formatif memungkinkan para pendidik untuk memahami di mana siswa berada dalam proses belajar mereka. Penelitian ini akan menganalisis penggunaan asesmen formatif berbasis teknologi dapat membantu mengatasi beberapa permasalahan yang ada di sekolah dasar, khususnya dalam meningkatkan prestasi matematika siswa. Jenis penelitian ini adalah penelitian kuantitatif yang menggunakan desain kuasi-eksperimental. Sampel penelitian akan terdiri dari siswa sekolah dasar yang dibagi menjadi dua kelompok, kelompok eksperimen yang menerima asesmen formatif berbasis teknologi, sedangkan kelompok lainnya akan menjadi kelompok kontrol yang menerima asesmen formatif tradisional. Instrumen pengumpulan data terdiri dari tes matematika pretes dan postes. Data analisis akan menggunakan perangkat lunak statistik seperti SPSS dengan uji t. Penelitian ini menyimpulkan bahwa penggunaan asesmen formatif berbasis teknologi memiliki pengaruh positif yang signifikan terhadap prestasi matematika siswa sekolah dasar. Implikasi dari penelitian ini dapat membantu merancang strategi pembelajaran yang lebih baik untuk mata pelajaran matematika di masa depan.

## ABSTRACT

Mathematics achievement can be considered low among elementary school students. Formative assessments allow educators to understand where students are in their learning process. This research will analyze the use of technology-based formative assessments that can help overcome several problems in elementary schools, especially in improving student mathematics achievement. This type of research is quantitative research that uses a quasi-experimental design. The research sample will consist of elementary school students divided into two groups: an experimental group that receives a technology-based formative assessment. In contrast, the other group will be a control group that receives a traditional formative assessment. The data collection instrument consists of a pretest and post-test mathematics test. Data analysis will use statistical software such as SPSS with the t-test. This research concludes that using technology-based formative assessment significantly positively influences elementary school students' mathematics achievement. The implications of this research can help design better learning strategies for mathematics subjects in the future.

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## 1. INTRODUCTION

Education at the elementary school level plays a crucial role in forming students' basic knowledge, skills, and attitudes. Education at this stage is about transferring information and helping students develop critical thinking skills, creativity, and independence (Jafar et al., 2022; Srivastava et al., 2018; Warti, 2018). Elementary school is the initial phase where the foundations of learning are laid. During this time, children develop a foundation to shape their outlook on education and learning (Lai & Hong, 2015; Mustangin, 2015). Therefore, the teaching methods and learning approaches implemented in elementary schools have a long-term impact on students' academic and personal development. Likewise, mathematics lessons are important in forming students' analytical thinking skills, problem-solving, and logical abilities (Ardina et al., 2019; Solehuzain & Dwidayati, 2017). Elementary school is the initial stage of learning mathematics, where the foundations of important concepts are instilled in students' minds. However, challenges in the mathematics learning process at the elementary school level still exist, especially in improving students' mathematics achievement (Indrianti et al., 2022; Sumartini, 2019). Mathematics learning is crucial in forming students' critical thinking, analytical, and problem-solving abilities. Mathematics is a collection of formulas and concepts and an important tool for developing logical and abstract thinking skills (Azizah et al., 2018; Habibi et al., 2020; Rachmantika & Wardono, 2019). At the elementary school level, mathematics learning forms an essential foundation for students' future academic development.

Mathematics education in elementary school is not just about teaching basic concepts but also about helping students build a deep understanding of how mathematics is used in everyday life. (Dinni, 2018; Mashuri et al., 2019). Mathematics provides a foundation for various disciplines and occupational fields, and strong mathematics skills will equip students with the tools necessary to face future challenges. It is important to recognize that each student understands mathematics differently. Some students may quickly master certain concepts, while others may take longer to understand them (Rahayu & Ismawati, 2019; Rohim, 2019). Therefore, mathematics teaching methods must be diverse and inclusive so students can grow and develop at their own pace. Mathematics achievement can be considered low among elementary school students. Mathematics is an important subject and is the basis for understanding more complex concepts at higher levels of education. Previous research has found that low mathematics achievement at the elementary school level can hurt students' future development (Hadi & Novaliyosi, 2019). Some students may not fully engage in mathematics learning because they feel uncomfortable, unmotivated, or face difficulties in understanding concepts. It can hinder their progress in these subjects. Technological advances have opened up new opportunities in education (Kusairi, 2012; Simanjuntak & Mudiono, 2019). In this context, formative assessment aims to be more than just providing an assessment but a powerful learning tool.

Formative assessments allow educators to understand where students are in their learning process. This information allows teachers to identify students' strengths and weaknesses in understanding certain concepts. Furthermore, the formative assessment results provide a basis for designing more appropriate teaching strategies, including arranging materials and learning methods appropriate to students' understanding. One of the key aspects of formative assessment is the feedback provided to students (Kamara & Dadhabai, 2022; Schildkamp et al., 2020). Constructive and specific feedback is crucial in helping students understand their mistakes and devise corrective measures. It helps improve students' understanding of the learning material and encourages them to take responsibility for their learning process (Hendra Saputra & Pasha, 2021; Sobarningsih, 2022). In the rapidly developing information and communication technology era, formative assessment has evolved significantly. Using technology in formative assessment has opened up new opportunities to provide faster and more accurate student feedback (Yu, J., Kreijkes & Salmela-Aro, 2022). Technology-based tools enable students to conduct assessments interactively and independently, stimulating active participation in the learning process.

In the ever-evolving world of education, formative assessment has become an increasingly recognized approach to supporting effective learning. Formative assessment periodically gathers information about a student's understanding and progress, which is then used to guide instruction and provide appropriate feedback (Dunn & Mulvenon, 2009; Elmahdi et al., 2018). The main purpose of formative assessment is to help students identify weaknesses in their understanding to make necessary improvements in the learning process. Information and communication technology has recently changed the educational landscape, including implementing formative assessments (Bhat & Bhat, 2019; Ridhwan, 2017). Using technology to develop formative assessment methods has offered new opportunities to increase interaction, personalization, and student engagement in the learning process. Technology-based formative assessment involves using software, applications, and online platforms to collect data about student understanding.

One of the main advantages of technology-based formative assessment is its ability to provide instant feedback to students. By using digital tools, students can receive information about the correctness of their answers and get a deeper analysis of areas that need improvement (Dunn & Mulvenon, 2009; Lyon et al., 2021). It allows students to identify their mistakes and develop better understanding more quickly. A technology-based approach also opens the door to a more interactive and dynamic learning experience. Formative assessments can be adapted to suit each student's level of progress and learning preferences (Karim, 2015; Prijanto & Kock, 2021). It allows educators to provide variations in questions, types of assignments, and learning materials according to student needs.

Research on the use of technology-based formative assessment can provide insight into whether this approach can help address the problem of low mathematics achievement in elementary schools. In this research, we will analyze the use of technology-based formative assessments that can help overcome several problems in elementary schools, especially in improving students' mathematics achievement. It is hoped that this research will contribute to overcoming some of the challenges faced by education at the primary level and provide new insights into how technology can be a valuable tool in improving the quality of education.

## 2. METHOD

This quantitative study uses a quasi-experimental design with a control group used as a comparison (Madadzadeh, 2022; Rusmana & Suprihatin, 2019). Two groups of elementary school students will be randomly selected from different schools. One group will be the experimental group receiving technology-based formative assessments, while the other group will be the control group receiving traditional formative assessments. The research sample will include fourth to sixth-grade elementary school students from two different schools. Each

group will have a minimum of 30 students to ensure statistical validity. The selection of schools and students will be done randomly. The data collection instrument consists of a Mathematics test, which will be used to measure student mathematics achievement. This test will be carried out at the end (post-test) of the research for both groups. All students will take a math pretest to assess their initial level of math achievement before treatment. The experimental group will receive technology-based formative assessments in mathematics learning over a certain period, while the control group will continue to receive traditional formative assessment approaches. After the treatment period, all students will take a mathematics post-test to assess changes in their achievement.

Data analysis will use statistical software such as SPSS to process student mathematics achievement data on the pretest and post-test. This data will be analyzed using an independent t-test to compare the differences between the experimental group (which received a technology-based formative assessment) and the control group (which received a traditional formative assessment). The t-test will produce a t-statistical and significance values (p-value). Suppose the p-value is less than a predetermined significance level (usually 0.05). In that case, we can conclude that the two groups significantly differ in mathematics achievement.

### 3. RESULT AND DISCUSSION

#### Result

The results of the descriptive analysis of post-test data in this study are presented in [Table 1](#).

**Table 1. Descriptive Analysis Results**

Statistics	Control	Experiment
Mean	67,20	86,70
Median	65	85
Variance	110,48	95,76
Std. Deviation	10,51	9,78
Minimum	40	77
Maximum	78	94

The prerequisite tests carried out in this research include the normality test of data distribution and the homogeneity of variance test. Based on the normality test analysis results using the IBM SPSS Statistics 21.0 for Windows program, the significance value (Kolmogorov-Smirnov) of the pretest data was 0.200, and the post-test data was 0.200. Based on these results, it can be seen that the Sig. > 0.05 for all data groups. So, it can be concluded that the two data groups are normally distributed. The data variance homogeneity test results in this study using the IBM SPSS Statistics 21.0 for Windows program show that the significance value (Based on Mean) is 0.096. Based on these results, it can be seen that the Sig. > 0.05. So, it can be concluded that the data variance is homogeneous. All analytical requirements related to Independent Sample T-Test analysis have been fulfilled so that Independent Sample T-Test analysis can be used to test the hypothesis of this research.

Based on the results of the Independent Sample T-Test analysis/ Correlated Sample t-test using the help of the IBM SPSS Statistics 21.0 for Windows program, a significance value (2-tailed Sig.) was obtained of 0.000. Based on these results, it can be seen that the Sig. < 0.05. So, it can be concluded that H<sub>0</sub> is rejected and H<sub>a</sub> is accepted. In other words, there were significant differences between the experimental group (which received a technology-based formative assessment) and the control group (which received a traditional formative assessment).

#### Discussion

The results showed that the experimental group who received technology-based formative assessments experienced significant increases in mathematics achievement compared to the control group who received traditional formative assessments. The post-test results showed that students in the experimental group achieved higher average scores on the mathematics test than the control group. It is consistent with previous research showing that technology can facilitate more effective and interactive learning in mathematics subjects.

Data analysis showed that students in the experimental group who received technology-based formative assessments experienced a significant increase in average scores in mathematics tests. It means that after receiving technology-based formative assessments and related learning, the experimental group achieved higher scores on math tests than their initial scores before treatment. This increase in mathematics achievement shows improvements in students' understanding of mathematics concepts (Nurani et al., 2021; Yanda et al., 2019). With technology-based formative assessments, students have quicker and easier access to feedback that helps them understand where they made mistakes and how they can correct them. These results indicate that using technology in assessment helps students better understand mathematical concepts.

In addition to improving concept understanding, using technology-based formative assessments can also help students develop problem-solving skills. In mathematics, students must understand and apply these concepts to solve more complex problems (Mawaddah & Anisah, 2015; Ulya, 2016). The results showed that students in the experimental group were more likely to be able to apply the mathematical concepts they learned in problem-solving situations. The use of technology in formative assessments can also encourage student learning independence. In technology-based formative assessments, students often have to manage their own time to answer questions and analyze the feedback provided by the system. It can help them develop independent learning skills and take responsibility for their learning. Technology-based formative assessments can also produce valuable data for teachers. This data can help teachers better identify individual student needs and design more targeted instruction (Masjaya & Wardono, 2018; Rahmani, 2020). Teachers can use the assessment results to provide additional guidance to students who need it. The improvements in mathematics achievement achieved in this study could have a long-term impact on students' abilities in mathematics (Khasanah et al., 2021; Suparman, 2016). Improved understanding of concepts and problem-solving skills can help students succeed in mathematics at higher levels and everyday life contexts.

The effectiveness of technology-based formative assessment is also seen in increasing mathematics achievement. Technology-based formative assessments provide instant feedback, allowing students to see and correct their mistakes immediately. It helps students understand math concepts better and identify areas where they need to improve their understanding (Elmahdi et al., 2018; Vaportzis et al., 2017). This research uses technology to provide more interactive and personalized assessments that support adaptive learning. The experimental group also showed increased motivation towards learning mathematics. It may be due to more engaging and interactive learning experiences through technology (Bhat & Bhat, 2019; Masjaya & Wardono, 2018). In addition, observations of student participation showed that students in the experimental group were more active in mathematics learning activities. They are more involved in class discussions, dare to ask questions and participate in various learning activities.

It aligns with previous research, which shows that the formative assessment form is effective according to the needs of children and teachers and describes the development of children's abilities clearly and precisely (Simanjuntak & Mudiono, 2019). Supported by other research, the aim is to determine the effect of integrating formative assessment in science learning based on a scientific approach to students' conceptual understanding (Sari et al., 2019). The results found that the integration of formal and informal formative assessments in science learning based on a scientific approach had a significant influence on increasing students' understanding of concepts. Another study tried to analyze the effect of applying a scientific approach assisted by the formative assessment on the motivation and learning outcomes of eleventh-grade students in physics (Rosyad et al., 2021). The research results show that the scientific learning model approach assisted by formative affects eleventh-grade students' learning motivation and physics learning outcomes.

The findings of this research have several important implications in the context of mathematics education in elementary schools. First, using technology-based formative assessments can be an effective tool in improving student mathematics achievement. Second, technology can increase student motivation and encourage active participation in mathematics learning. Therefore, it is recommended for schools and teachers to consider the integration of technology in mathematics teaching. The limitation of this research is that it focuses on elementary school students in two particular schools. These results may not be broadly generalizable to all elementary school contexts. Additionally, other factors that may influence mathematics achievement, such as students' socioeconomic background, were not considered in depth in this study.

## 4. CONCLUSION

This research concludes that using technology-based formative assessment significantly positively influences elementary school students' mathematics achievement. These findings support the idea that technology can effectively improve mathematics learning at the elementary school level and encourage student participation and motivation. The implications of this research can help design better learning strategies for mathematics subjects in the future.

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