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IMPLEMENTING ABACUS MEDIA TO ENHANCE MATHEMATICS SKILLS AND INTEREST IN FIRST GRADE ELEMENTARY STUDENTS

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Abstract
In an effort to improve student learning outcomes and improve the quality of the learning process, teachers are expected to use teaching methods that are fun and can increase student interest in learning. The abacus has been widely researched as a learning tool for mathematics, but previous researchers still pay less attention to the aspect of differences in basic math ability levels and their impact on student learning outcomes. Therefore, this study focused on implementing abacus media to increase the interest and math skills of first-level elementary school students, especially in addition and subtraction operations. Data collection was conducted through pre and post tests, with a sample of 26 students selected based on the diversity of math ability and gender. The Mann Whitney test was used for data analysis because the sample included a small sample and did not meet the prerequisite test of data normality. The findings show that abacus learning media can significantly improve students' numeracy skills, especially for students with low basic numeracy skills, while high ability students have no significant effect. In addition, learning activities using abacus media can also increase students' independence and interest in learning math, especially in counting operations.
Keywords: *abacus; numeracy skills; interest; primary school*

Abstrak
Dalam upaya meningkatkan hasil belajar siswa serta meningkatkan kualitas proses pembelajaran, diharapkan guru menggunakan metode pengajaran yang menyenangkan serta dapat meningkatkan minat belajar siswa. Sempoa telah banyak diteliti sebagai alat pembelajaran untuk matematika, namun peneliti terdahulu masih kurang memberikan perhatian pada aspek perbedaan tingkat kemampuan matematika dasar dan dampaknya terhadap hasil belajar siswa. Oleh karena itu, penelitian ini difokuskan untuk mengimplementasikan media sempoa terhadap peningkatan minat dan kemampuan matematika siswa sekolah dasar tingkat pertama, khususnya pada operasi penjumlahan dan pengurangan. Pengumpulan data dilakukan melalui pre test dan post test, dengan sampel sebanyak 26 siswa yang dipilih berdasarkan keragaman kemampuan matematika dan jenis kelamin. Uji Mann Whitney digunakan untuk analisis data karena ampel termasuk sampel kecil serta tidak memenuhi uji prasyarat normalitas data. Hasil temuan menunjukkan bahwa media pembelajaran sempoa dapat meningkatkan kemampuan berhitung siswa secara signifikan, terutama bagi siswa dengan kemampuan berhitung dasar rendah, sedangkan siswa berkemampuan tinggi tidak memiliki pengaruh yang signifikan. Selain itu, kegiatan pembelajaran dengan menggunakan media sempoa juga dapat meningkatkan kemandirian dan minat siswa dalam belajar matematika khususnya pada operasi hitung.
Kata Kunci: sempoa; kemampuan berhitung; minat; sekolah dasar

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Introduction

Elementary school students have limitations in their counting ability because they are in the concrete operational stage that focuses on real objects that can be sensed through the senses. The biggest challenge for students in learning mathematics is its abstract nature, which is difficult to understand and remember, thus hindering their learning progress. As a result, mathematics education in schools should emphasize more on logical reasoning, forming basic attitudes, and skills in applying mathematics. Unfortunately, there is still a perception among students that mathematics is a difficult and intimidating subject. As Peano stated, mathematics has an abstract nature that makes it difficult to understand and memorize, a view also supported by Chasanah, et al., where their research found that many students find difficulty in learning mathematics and have negative perceptions of this subject, a problem that is still faced by researchers and educators (Chasanah et al., 2020; Peano, 1889).

Difficulty in calculation is a challenge often faced by elementary school students. Students with math difficulties frequently struggle to become proficient in the four basic operations (Cozad & Riccomini, 2016). Unfortunately, the results of the National Assessment (AN) indicate that the mathematical abilities of elementary school students in Indonesia are still low (Pusat Asesmen Pendidikan, 2022). Previous research has revealed that there are many deficits that could potentially cause math difficulties and the existence of specific subtypes. However, the cognitive profile of these subtypes is still not fully understood (Chan & Wong, 2020). Numeracy skills play a crucial role in enhancing problem-solving abilities (Nahdi et al., 2020). Therefore, a deeper understanding of the difficulties in calculation among elementary school students is necessary in order to develop appropriate teaching approaches that can assist these students in achieving the desired mathematical proficiency.

Counting operations are a key element in mathematics that is essential and useful in daily life. According to Krasa & Shunkwiler, the concept of numbers is the foundation for the development of mathematical abilities and as a basis for preparing elementary school students for learning (Krasa & Shunkwiler, 2009). Piaget believed that counting ability is the initial stage in the development of mathematical abilities and is a foundation for understanding further mathematical concepts. He showed that children initially understand numbers as objects that can be counted and then learn how to perform mathematical operations such as addition and subtraction. Piaget also said that counting ability in children aged 7 to 11 years is in the concrete operational stage. Therefore, at that age, children need help in the form of learning media to improve their understanding of counting operations taught by teachers more easily (Piaget, 1997).

Piaget proposed that to overcome students' difficulties in learning mathematics, every mathematical concept or principle should be introduced in a concrete form (Piaget, 1997). Brumbaugh & Rock also agree that students may need concrete representations or physical images to help them understand more abstract mathematical concepts (Brumbaugh & Rock, 2010). Therefore, teachers are expected to utilize instructional media to aid visualization, especially in abstract topics, in order to achieve desired goals. In another study, Faujiah found that elementary school students sometimes struggle to determine appropriate procedures in solving arithmetic problems (Faujiah & Muhammadiyah Hamka, 2022). Instructional media is believed to be one of the necessary solutions to stimulate students' thinking, attention, and learning interest, as well as to strengthen interaction and communication between teachers and students in the classroom. The use of instructional media is crucial in achieving optimal learning outcomes (Puspitarini & Hanif, 2019). Several studies indicate that many students consider mathematics as a boring and intimidating subject (Atteh et al., 2020; Aydoˇgan et al.,

2023; Tanu Wijaya et al., 2020). Therefore, the use of appropriate media can overcome students' difficulties in learning mathematics and improve the quality of the learning process to make it more engaging and effective.

In learning mathematics, the use of media and teaching aids is very important in helping students understand mathematical concepts and principles (Ekowati, 2018). Therefore, specially designed learning media to facilitate students' understanding of mathematical concepts and principles are highly necessary. These media can be in the form of real objects, illustrations, or diagrams. The use of learning media in mathematics allows abstract concepts to be presented in the form of models that can be seen and manipulated, making it easier and more enjoyable for students to learn mathematics. However, there are advantages and disadvantages to each type of learning media. For example, the advantage of using real objects is that students can move or manipulate them, but the disadvantage is the difficulty in presenting them in written form. On the other hand, we can create pictures or diagrams for written forms, but the disadvantage is that they cannot be manipulated.

By considering the characteristics of the problems described, the researcher believes that in learning to count, students need a real learning media. According to several research results, found that the use of instructional media can help improve students' numeracy skills (Rohendi et al., 2017; Valentina & Wulandari, 2022). One alternative mathematics learning media that can be utilized is abacus. When children perform mathematical operations by counting numbers, they indirectly use their imagination to carry out the calculations. Afterwards, children can develop their creativity by using abacus beads to show the results of the calculations, so that the left and right brains can work together. Abacus can be defined as a counting tool consisting of a frame and beads (Sarvari et al., 2015; Stigler et al., 1986), that can be integrated into mathematics education to help students understand mathematical concepts visually and concretely.

In a study conducted by León et al., which focused on cognitive capacity, direct auditory memory, perceptual attitude, and creativity, it was found that the use of an abacus as a learning tool can help students visualize arithmetic operations and strengthen their understanding of mathematical concepts such as addition, subtraction, multiplication, and division (León et al., 2021). In another study, Wijayanti & Suswandari used bibliography annotation analysis and discovered the impact of using an abacus on student engagement, as well as the prevention of boredom and monotony (Wijayanti & Suswandari, 2022). The effectiveness of using an abacus as a concrete learning media is supported by research conducted by Widodo & Wahyudin, which showed that concrete or semi-concrete learning media can be used to improve students' mathematical abilities (Widodo & Wahyudin, 2018). Anam et al., in their study focusing on the learning outcomes of primary school students, found that learning with an abacus is also beneficial in enhancing the mathematical achievement of early-age learners (Anam et al., 2020), including students with dyscalculia (Lu et al., 2021).

This study is of great importance as it addresses significant research gaps in the existing literature. Previous studies have explored the effectiveness of abacus media in elementary school students' learning, specifically in arithmetic operations like addition and subtraction. However, there are two key areas that have not been thoroughly investigated. Firstly, previous studies have not sufficiently examined the influence of abacus on students while considering their basic arithmetic ability characteristics. Understanding how abacus usage affects students with different levels of basic arithmetic skills is crucial for developing tailored teaching strategies and interventions. Secondly, there is a lack of detailed information on the overall

effectiveness of abacus as a mathematics learning tool for elementary school students. This study aims to fill these research gaps by comprehensively examining the effectiveness of abacus in enhancing learning outcomes and by analyzing its impact based on the characteristics of students' basic arithmetic abilities. The findings from this research will contribute significantly to the development of the field by providing valuable insights into the specific benefits and limitations of using abacus as a teaching and learning medium for elementary school students.

Research Methods

This research uses a quantitative research approach to obtain numerical data for statistical analysis. An experimental research design was adopted to identify the intervention's effect on the dependent variable. The study was conducted using a quasi-experimental pretest-posttest design (Cook & Campbell, 1979). This research was carried out with only one group without a comparison group by providing a pretest or initial test to the research subjects to obtain the students' initial scores as a comparison for the final learning outcomes.

Table 1. Quasi-Experimental Research Scheme

O_1	X	O_2
Pretest	Treatment	Posttest

The stages of learning that will be conducted in the implementation of Abacus refer to the demonstration learning stages adopted from Damiani, Thoron & Bunch, which are as follows: Introduction to tools and materials; Demonstration of the use of learning media; Practice of using learning media; Evaluation of student understanding; and Conceptual reinforcement (Damiani et al., 2018).

This study is focused on students in one of the elementary schools located in Sukabumi regency. The population that was taken consisted of 216 students with a breakdown of 97 male students and 119 female students. For sampling, the researcher used non-probability sampling technique using purposive sampling method (Johnson et al., 2020). In this method, sample subjects were selected based on criteria of students who have representative abilities from the population and have problems with their math skills. A total of 34 students were selected as samples but only 26 students successfully completed the entire research process.

The instruments used for data collection are tests and interviews. For the counting ability test instrument, the researcher developed the instrument based on five main material indicators that students are expected to achieve: (1) Able to count addition and subtraction of numbers within the range of 0-10 using concrete objects or pictures; (2) Able to solve simple math problems using addition and subtraction calculation methods; (3) Able to count numbers within the range of 0-20 using concrete objects or pictures; (4) Able to arrange numbers from smallest to largest or vice versa; (5) Able to solve simple math problems using grouping and division of concrete objects or pictures. To ensure that the provided questions can accurately and validly measure students' competencies, the researcher used expert validation with assessment aspects including readability, suitability with material indicators, and difficulty levels. The difficulty level of the questions in this study was divided into three categories, namely easy, moderate, and difficult, with passing percentages in each category of around 75%, 50%, and 25% (Crocker & Algina, 1986). Meanwhile, for interviews, the researcher used student interview instruments as follows: (1) How often do you use Abacus media in learning mathematics?; (2) Do you feel that Abacus media helps you understand the concept of

arithmetic operations?; (3) Does the use of Abacus media make it easier for you to solve math problems?; (4) Do you feel more confident in solving math problems after using Abacus media?; (5) How do you feel about the Abacus media?; (6) Do you enjoy using the media in learning?

The normality test is used to check whether the data distribution pattern follows a normal distribution or not. The purpose of this test is to ensure that the data used meets the normality assumption, and the analysis output will be compared with the predetermined critical value. In this case, the hypothesis and decision-making basis explained by Shapiro and Wilk are used, where the null hypothesis or H_0 states that the sample comes from a population with a normal distribution, while the alternative hypothesis or H_1 states that the sample does not come from a population with a normal distribution (Shapiro & Wilk, 1965). In making a decision regarding normality testing with a significance level of 5%, the basis is as follows: if the probability value (p-value) is greater than the significance level (α), then the data is considered to come from a population with a normal distribution. Conversely, if the p-value is less than α, then the data is considered not to come from a population with a normal distribution. Thus, normality testing of data is essential in performing accurate and reliable data analysis. The Mann-Whitney test is used because the t-test assumptions are not met in this study. Adopted from Wilcoxon (1945), the Mann-Whitney formula is used to test the difference between two independent data groups, namely nominal or ordinal data groups that do not follow a normal distribution. The hypothesis tested with the Mann-Whitney U-test is: H_0 that both data groups come from the same population, and H_1 that both data groups come from different populations (Wilcoxon, 1945). To determine the critical value in the Mann-Whitney test, critical value tables are used at a significance level of 5%. Therefore, the basic principle used in decision making is as follows: If the test statistic value is smaller than the critical value, it can be concluded that there is a significant difference between the two data groups. Conversely, if the test statistic value is greater than or equal to the critical value, it can be concluded that there is no significant difference between the two data groups.

Results and Discussion

This research was conducted with only two tests, namely Pre-test and Post-test, in the experimental class consisting of 26 students. In both Pre-test and Post-test, students were given ten questions with varying weights depending on the difficulty level of the questions. The maximum score that can be obtained by students is 100 for Pre-test and 100 for Post-test.

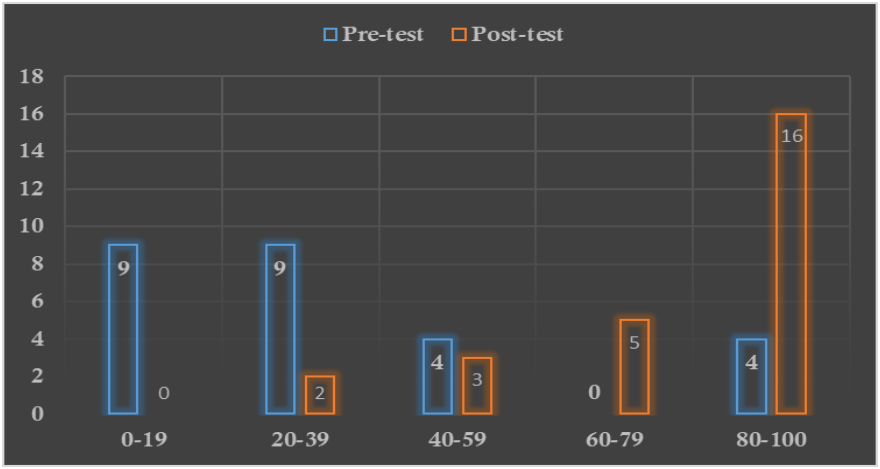

Figure 1. Pre-test and post-test scores

The purpose of using Pre-test and Post-test is to measure the difference in students' abilities to understand the material before and after the application of Abacus media, so that the impact of the use of Abacus media in learning on students' abilities can be determined. However, this research only focused on measuring the difference in Pre-test and Post-test scores in the experimental class, and did not measure in the control class. The results of the Pre-test and Post-test clearly showed a significant decrease in the number of students who obtained scores in the range of 0-19 and 20-39 when compared between the results of Pre-test and Post-test, while there was a significant increase in the range of scores of 60-79 and 80-100 (Figure 1).

Table 2. Normality Test Output

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest Eksperimen	.212	26	.004	.883	26	.007
Postest Eksperimen	.364	26	.000	.702	26	.000

As a prerequisite for performing the t-test, a normality test was first conducted using the One-Sample Shapiro-Wilk test on all research data involving a total of 26 respondents. Since the sample is less than 30, the One-Sample Shapiro-Wilk test was used. Based on the normality Shapiro-Wilk test output table (Table 2), it was found that the pre-test results had a Sig. value of 0.007 and the post-test had a Sig. value of 0.000, which means it is less than 0.05, so H_0 is rejected and it can be concluded that the pre-test and post-test have non-normal data distribution. Next, to determine normal data, the Mann Whitney test will be used for further testing.

Table 3. Mann Whitney Test Output

	Use of the Abacus
Mann-Whitney	95.000
Wilcoxon W	446.000
Z	-4.631
Asymp. Sig. (2-tailed)	.000

Based on the results of the Mann Whitney test as shown in Table 3, it is known that the Asymp, Sig. (2-tailed) value is 0.000 < 0.05. This result can be interpreted as rejection of H_0, according to the decision-making rule in the Mann Whitney test, it can be concluded that there is a significant difference between the use of Abacus in learning math for addition and subtraction operations before (pre-test) and after (post-test). The difference data between the pre-test and post-test also shows a significant difference of 45.47 points, where the average for the pre-test is 41.45 and the average for the post-test is 86.92.

In this study the researchers conducted research for 3 meetings consisting of: the first meeting for observation and needs analysis, the second meeting for giving mathematics lessons to students using Abacus learning media, and the third meeting for strengthening and evaluating student success. During the learning process, students were given math exercises using the Abacus as a counting tool. The researcher observed and recorded the students' math skills during the learning process using observation sheets. In addition, the researcher also gave tests (pretest and posttest) to evaluate the effectiveness of using the Abacus learning media in improving the math skills of students.

In the Preparation stage, the teacher prepares the Abacus learning media and teaches students how to use it. The teacher introduces the Abacus learning media to the students and

gives instructions on how to use it (Figure 2). The teacher also prepares worksheets containing math problems to be solved using the Abacus learning media. In the Demonstration stage, the teacher demonstrates how to use the Abacus learning media and provides examples of its use in solving math problems (Figure 2). The goal of this stage is to clarify the use of the media and provide good knowledge to students on how to solve some examples of math problems using the Abacus.

Figure 2. Introduction and Demonstration of Abacus

In the independent practice stage, students are given the opportunity to practice using the Abacus learning media independently. This is done to enhance students' self-confidence, as found by Barrow, Golding, Redmond & Grima who revealed that the Abacus is designed to foster a confident learning environment for children to master (Barrow et al., 2018). In addition, the goal of this training is to provide knowledge related to the use of this media and improve their skills in solving mathematical problems by completing several math problems prepared by the teacher using the Abacus learning media. During the group training phase, students are divided into several groups and given the opportunity to collaborate in solving various math problems using the Abacus as the main learning tool. The goal is to enhance problem-solving skills and collective teamwork (Figure 3).

Figure 3. Solving problems resulting from group discussions

In the evaluation phase, the teacher evaluated the students' ability to use the Abacus learning media to solve math problems through a post-test. The goal was to evaluate the effectiveness of the Abacus learning media in improving students' calculation skills. Finally, in the reflection phase, the students and teacher reflected together on the learning process using the Abacus learning media to evaluate its success and shortcomings and provide suggestions for future improvement.

Based on classroom observations during the implementation process of all stages (Introduction to tools and materials; Demonstration of the use of learning media; Practice of using learning media; Evaluation of student understanding; and Conceptual reinforcement), several differences were found in the effects both in terms of test results and student attitudes during the learning process. From open interviews with students, several facts were found, including for those who previously only knew and used Abacus as a game without applying it in mathematics learning, they began to realize and understand that Abacus is quite useful especially in addition and subtraction operations. This is consistent with Wang's findings, which explain that skilled Abacus users who have acquired mental calculation abilities based on the Abacus can perform fast and accurate calculations by manipulating imaginary Abacus in their minds (Wang, 2020). Furthermore, based on the interview results related to frequency, assistance, facilitation, confidence, feeling, and enjoyment, it appears that the use of the Abacus in teaching addition and subtraction has different effects on each aspect. Enjoyment has the greatest impact, which is 3.81, followed by confidence 3.69, frequency 2.81, assistance 3.52, facilitation 3.50, and feeling 3.21. This is in line with the interview results, which showed that 7 out of 9 interviewed students felt that using the Abacus made them happy and helped them understand the concept of mathematical operations, made it easier for them to solve math problems, and made them more confident in solving math problems after using the Abacus. In a study conducted by Gera & Kaur, it was also found that when children were asked to learn arithmetic calculations using the Abacus, they felt like they were playing and they learned a lot without getting bored (Gera & Kaur, 2014).

Based on the test results, this study shows that the use of Abacus significantly improves students' learning achievement. This is evident from the pre-test and post-test results, which indicate that the use of Abacus provides a significant increase in students' average scores. These findings are also in line with previous research that shows the use of Abacus can help students better understand mathematical concepts (Altiparmak, 2016). However, there are also students who feel that the use of Abacus has no effect, similar to the use of books and pencils in learning mathematics. This happens especially to students who have better calculation skills. From separate interviews with students who believe that Abacus is not very influential, it was found that the main reason for their opinion is that they have understood the basic concepts and how to perform addition operations well, so they do not need simple calculation tools like Abacus.

Although a small number of students do not consider the abacus to have a significant impact, in terms of affective aspects such as students' independence and interest in learning, it appears to have a significant impact. In terms of independence, the use of the abacus requires students to use the tool themselves and find solutions to each given problem. Thus, the use of the abacus helps to improve students' ability to solve problems independently and encourages them to become more independent learners. During the research process, the researcher also found that the use of the abacus helped to increase students' independence. This is in line with previous research that shows that the use of the abacus can improve students' ability to solve problems independently (McDaniel, 2020). In addition, student responses in interviews related

to their feelings during learning using the Abacus were quite varied, ranging from increased happiness, interest, enthusiasm, and even increased engagement during the learning process, with each of these answers appearing repeatedly by at least 5 students. This is in line with previous research that shows the use of the Abacus as a counting tool can help improve students' learning motivation (Mou et al., 2022). Although it can be concluded overall that the use of the Abacus media has a positive impact on both student learning outcomes and attitudes, particularly in terms of learning outcomes, students with good basic numeracy skills do not experience significant influence. This finding is a specific one that has not been specifically studied in previous research cited in this study (Altiparmak, 2016; Barrow et al., 2018; Gera & Kaur, 2014; McDaniel, 2020; Mou et al., 2022; Wang, 2020). Therefore, elementary school mathematics teachers should consider using different learning media to accommodate the diverse learning needs of students, especially those who already have good basic numeracy skills. Further research is needed at different elementary school levels, with larger sample sizes, and considering the influence of gender differences.

Conclusion

After conducting research and obtaining the results, it is concluded that the use of the Abacus tool has proven to be effective in improving students' mathematical abilities, especially in arithmetic operations. The research findings demonstrate that the use of the Abacus tool can assist students in better understanding the concepts of arithmetic operations. This study indicates that the use of the Abacus tool can help students achieve better learning outcomes. However, the effectiveness of using the Abacus tool to enhance students' calculation abilities can be influenced by several factors, such as the teachers' proficiency in using the Abacus tool, the frequency of its usage, and the quality of the tool. Therefore, further development is required in utilizing the Abacus tool as an effective mathematics learning tool for students. The research also indicates that the use of the Abacus tool has a significant impact on students with low calculation abilities, but it does not have much influence on students who already possess high calculation abilities. Nevertheless, overall, the use of the Abacus tool can improve students' independence and interest in learning. This research has limitations in terms of a small sample size and dependency on teacher instructions. Therefore, future research should involve a larger sample size and evaluate the effectiveness of the Abacus tool on students' calculation abilities independently, without teacher instructions.

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