

## THE IMPACT OF MATHIGON MEDIA ON STUDENTS' LEARNING OUTCOMES IN INTEGER OPERATIONS: A QUASI-EXPERIMENTAL STUDY

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### ABSTRACT

Mathematics learning on integer topics often faces challenges, such as low learning outcomes due to abstract teaching methods and limited student engagement. To address this, interactive digital learning media like Mathigon may be used. This quasi-experimental study aims to assess the impact of Mathigon media on students' mathematics learning outcomes in integer operations. The study used a nonequivalent control group design with 64 seventh-grade students selected through purposive sampling. One class (n=32) was assigned as the experimental group, receiving instruction using Mathigon media, while the control group (n=32) was taught using traditional methods. A validated learning outcomes test was used as the instrument. The results, analyzed using an independent sample t-test, indicated a significant difference in learning outcomes between the experimental and control groups ( $p < 0.05$ ). The experimental group had an average score of 75.71, while the control group had an average of 65.00. Thus, Mathigon media significantly improved students' learning outcomes on integer topics.

**Keywords:** integers; learning outcomes; mathigon.

### ABSTRAK

Pembelajaran matematika pada materi bilangan bulat masih menghadapi berbagai tantangan, seperti rendahnya hasil belajar siswa akibat metode pembelajaran yang abstrak dan keterbatasan keterlibatan siswa. Salah satu solusi untuk mengatasi permasalahan ini adalah dengan menggunakan media pembelajaran digital interaktif seperti Mathigon. Penelitian kuasi-eksperimental ini bertujuan untuk menilai pengaruh penggunaan media Mathigon terhadap hasil belajar matematika siswa pada materi operasi bilangan bulat. Penelitian ini menggunakan desain kelompok kontrol pretest-posttest yang tidak setara dengan sampel sebanyak 64 siswa kelas VII yang dipilih menggunakan purposive sampling. Satu kelas (n=32) dijadikan sebagai kelompok eksperimen yang diajarkan menggunakan media Mathigon, sedangkan kelompok kontrol (n=32) menggunakan metode pembelajaran tradisional. Instrumen yang digunakan adalah tes hasil belajar yang telah divalidasi. Hasil analisis menggunakan uji t sampel independen menunjukkan adanya perbedaan signifikan pada hasil belajar antara kelompok eksperimen dan kelompok kontrol ( $p < 0.05$ ). Rata-rata hasil belajar kelompok eksperimen adalah 75,71, sementara kelompok kontrol 65,00. Dengan demikian, dapat disimpulkan bahwa media pembelajaran Mathigon memiliki pengaruh signifikan terhadap hasil belajar matematika siswa pada materi operasi bilangan bulat.

**Kata kunci:** bilangan bulat; hasil belajar; mathigon.



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## **Introduction**

Mathematics plays a critical role in developing logical reasoning and supporting technological advancement across various disciplines (Saila, Alam, Inayati, Bella, & Faizah, 2023; Widiani, 2019). However, students often face difficulties in learning mathematics, especially in understanding integer operations, due to the abstract nature of these concepts and limited engagement in traditional learning settings. Effective mathematics instruction involves several components, including instructional design, organization, teaching activities, student performance assessment, and evaluation (Gemnafle & Batlolona, 2021). Among these components, learning outcomes are a key aspect, reflecting the effectiveness of the learning process and are typically expressed in numerical scores, symbols, or verbal assessments (Suratman, Afyaman, & Rakhmasari, 2019).

In the Merdeka Curriculum for Grade VII junior high school students, mastering integer operations is foundational as it serves as a prerequisite for more advanced topics such as algebra and systems of linear equations (Gusteti & Neviyarni, 2022). A lack of understanding in this area can significantly hinder students' ability to grasp more complex mathematical topics (Astriani, Rochaminah, & Sugita, 2021), making it essential to improve learning outcomes in this foundational subject.

The integration of technology into mathematics education has been increasingly recognized as an effective approach to engage students and deepen their conceptual understanding (Salmina & Fadlillah, 2017). Digital tools such as smartphones, laptops, and web-based platforms can provide more interactive and accessible learning experiences (Salsabila, Rohmadani, Mahmudah, Fauziyah, & Sholihatien, 2022). Media innovation can improve students' ability to apply theoretical concepts in real-world situations (Suprihatin et al., 2025). Learning media that suits the character and needs of students in learning mathematics will make it easier for students to understand and remember the material given by the teacher (Syamil et al., 2024).

Based on observations made in August 2024 at Assa'adah Modern Islamic Boarding School, it was noted that several students had difficulties with integer operations, particularly in performing calculations. These difficulties were reflected in the students' daily assignment scores, further supported by statements from the mathematics teacher at the school. Based on these initial observations, the researcher identified the need for a media tool to better facilitate the delivery of the material.

One such tool is Mathigon, a web-based interactive platform that functions both as a textbook and a virtual tutor, designed to foster active, personalized learning (Mathigon, 2024). Previous research, such as (Tuntunan & Sugiman, 2024), has shown that Mathigon-based learning significantly enhances students' problem-solving abilities, mathematical connections, and self-efficacy when compared to traditional methods. However, these studies mainly focused on broader mathematical skills and did not explore Mathigon's impact on specific foundational topics like integer operations.

There is a significant gap in research concerning the use of Mathigon specifically for improving students' learning outcomes in integer operations at the junior high school level. While much of the existing research has focused on general mathematical topics, the potential of Mathigon to address the learning challenges associated with integer operations remains underexplored. This gap emphasizes the novelty of the current study, which aims to investigate the effectiveness of Mathigon in enhancing students' conceptual understanding and learning outcomes in integer operations.

Supported by cybernetic learning theory, which emphasizes the role of technology in processing information for effective learning (Telaumbanua, Gulo, Lahagu, Gulo, & Gulo, 2022), this study seeks to bridge the gap by assessing how Mathigon media can improve junior high school students' learning outcomes in integer operations. Using a quasi-experimental design, the research compares the outcomes of an experimental group (X1) using Mathigon media with a control group (X2) receiving conventional instruction based on the number line. Good media can be an innovative solution to increase student engagement and the effectiveness of mathematics learning (Putri et al., 2026). By evaluating the effectiveness of Mathigon in this context, the study aims to contribute both theoretically and practically to the development of technology-based mathematics education, offering valuable insights for educators on implementing interactive digital media to improve students' learning outcomes.

## **Research Methods**

### *Research Design*

This study employs a quasi-experimental design with a nonequivalent pretest-posttest control group design to evaluate the impact of Mathigon media on students' learning outcomes. The research involves two groups: an experimental group (X1) using Mathigon media through student worksheets (LKPD), and a control group (X2) using number line media in student worksheets. Both groups underwent a pretest (O1) before the treatment and a posttest (O2) afterward to assess their cognitive learning outcomes. The pretest served to measure the initial cognitive ability of the students in both groups. Following the pretest, the experimental group was exposed to Mathigon-assisted worksheets, while the control group engaged with number line-assisted worksheets. After the treatment, the posttest was administered to measure any changes in learning outcomes. The data analysis involved comparing the pretest and posttest scores to assess the effectiveness of Mathigon media in improving students' cognitive learning outcomes.

The use of a quasi-experimental design is particularly appropriate in this setting, as it allows for a controlled comparison between the two groups, despite the lack of random assignment (Amna, Hardiansyah, & Armadi, 2024). This method is widely recognized in educational research to evaluate the impact of teaching interventions. Additionally, integrating Mathigon as a digital learning tool is consistent with recent studies that show how technology can enhance student engagement and conceptual understanding (Suratman et al., 2019). The research design is presented in Table 1.

Table 1. Research Design

class	Pretest	Treatment	Posttest	Final Result
Experimental	$O_1$	$X_1$	$O_2$	$Y_2$
control	$O_1$	$X_1$	$O_2$	$Y_2$

Description:

$O_1$  = pretest;  $O_2$  = posttest;  $X_1$  = experimental treatment (Mathigon media);  $X_2$  = control treatment (Number line media);  $Y_1$  = final result of experimental class;  $Y_2$  = final result of control class.

#### *Research Subjects and Location*

The study was conducted at SMP Plus Assa'adah during the 2025/2026 academic year. The population consisted of all seventh-grade students. A total of two classes were selected as the sample using purposive sampling, based on the following criteria: (1) same grade level, (2) same mathematics teacher, and (3) identical learning material. This purposive sampling technique ensures comparability between the experimental and control groups while considering practical constraints, such as class assignments and scheduling (Montolalu & Langi, 2018). The experimental group consisted of the Makkah class ( $n = 32$ ), while the control group consisted of the Mina class ( $n = 32$ ).

#### *Research Variables*

This study investigated two primary variables: (1) Independent Variable: Mathigon media, used to support learning through student worksheets, and (2) Dependent Variable: Students' cognitive learning outcomes on integer operations, measured using the Revised Bloom's Taxonomy, which includes cognitive levels from C1 (remembering) to C6 (creating) (Silva, Garak, & Udil, 2023).

#### *Data Collection Procedure*

The data collection was carried out in three main stages. The preparation stage included a literature review, classroom observation, obtaining research permits, developing and validating research instruments, preparing lesson plans based on the Problem-Based Learning (PBL) model, and developing student worksheets (LKPD) and learning resources. The lesson plans and worksheets were carefully designed to manage students' cognitive load and ensure effective delivery of material within the allocated learning time. This preparation ensured that both content and instructional design were pedagogically sound and ready for implementation.

During the implementation stage, the experimental group received instruction using LKPD assisted by Mathigon media, while the control group used LKPD assisted by number line media. Each group participated in two 80-minute learning sessions, a duration chosen to optimize student attention and allow sufficient time for Problem-Based Learning activities, including identifying problems, analyzing and discussing solutions in groups, applying problem-solving strategies using the assigned media, and presenting results with reflection. Students completed a pretest before the first session and a posttest after the final session. In the final stage, the collected pretest, posttest, and N-gain data were systematically processed and analyzed to evaluate the effectiveness of Mathigon-assisted learning, and conclusions were drawn to compile the final research report.

### Data Analysis Techniques

Data analysis was conducted using both descriptive and inferential statistics with the assistance of SPSS version 29. Descriptive statistics were applied to calculate the mean, median, mode, standard deviation, and variance for the pretest, posttest, and N-gain data from both the experimental and control groups (Malay, 2022). Learning improvement was measured using the N-gain value, calculated as follows:

$$N - gain = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}}$$

Description:

Pretest Score = the score obtained by the student before the intervention;  
Posttest Score = the score obtained by the student after the intervention; Maximum Score = the highest possible score on the test.

The interpretation criteria for N-gain are as follows: high ( $0.7 \leq g \leq 1.0$ ), medium ( $0.3 \leq g < 0.7$ ), low ( $g < 0.3$ ), and failed ( $g \leq 0$ ) (Wahab, Junaedi, & Azhar, 2021). This standardized metric allows comparison of learning gains between students with different initial knowledge levels, providing both statistical and practical insight into the effectiveness of the intervention.

To assess the differences between the experimental and control groups, the Mann-Whitney U test was used due to the non-normal distribution of the data. This non-parametric test was chosen because the data did not meet the assumption of normality, making it more suitable for comparing the learning outcomes between the two groups (Usmadi, 2020). The Mann-Whitney test allowed for the assessment of whether the differences in posttest scores between the experimental group (X1) and the control group (X2) were statistically significant, without assuming a normal distribution of scores.

Inferential statistical analysis included:

Inferential statistical analysis included several tests to evaluate the data. First, the *Normality Test* was conducted using the *Shapiro-Wilk test*, with a significance level of  $\alpha = 0.05$ . Data are considered normally distributed if the significance (Sig.) is greater than 0.05.

Next, the *Homogeneity Test*. Levene's test was used; variance is homogeneous if Sig. > 0.05. For the *Hypothesis Test*, the independent sample t-test was used to evaluate the differences between the experimental and control groups. The decision criterion for the t-test is as follows:  $H_a$  is accepted if Sig. (2-tailed)  $\leq 0.05$ , indicating a significant difference in cognitive learning outcomes between the groups.

Additionally, the Mann-Whitney U-Test was applied to further determine improvements between the groups, using the decision criterion:  $H_a$  is accepted if asymptotic significance (2-tailed)  $\leq 0.05$ .

Two hypotheses were tested:

- Hypothesis 1

$H_0: \mu_1 = \mu_2$  (there is no difference in final cognitive learning outcomes between the two classes),  $H_a: \mu_1 \neq \mu_2$  (there is a significant difference)

- Hypothesis 2

$H_0: \mu_1 \leq \mu_2$  (the improvement of the experimental class is not better than the control class),  $H_a: \mu_1 > \mu_2$  (the improvement of the experimental class is significantly better)

Where  $\mu_1$  represents the average cognitive learning outcome of the experimental class and  $\mu_2$  represents that of the control class.

## Results and Discussion

### *Descriptive Statistics of Pretest Data*

Pretest data for both the experimental and control classes were collected prior to treatment using a 7-item test that had been validated for content and reliability. The test required approximately 60 minutes for completion. Analysis of the pretest results provides important insights into the baseline knowledge and variability among students before the intervention. The data show that, while both classes had similar mean scores, the experimental class exhibited slightly higher variability, suggesting differences in prior understanding and problem-solving strategies among students. This baseline information is crucial, as it ensures that subsequent comparisons of posttest results can be attributed to the effects of the instructional intervention rather than pre-existing disparities in student knowledge. The descriptive statistics of pretest scores, analyzed using SPSS version 29, are presented in Table 2.

Table 2. Descriptive Statistics of Pretest Data

Class	N	Min	Max	Mean	Std. Deviation
Experimental	32	13	100	53,65	19,51
Control	32	23	94	53,71	17,55

Based on Table 2, the experimental class had a mean score of 53.65 and a standard deviation of 19.51, while the control class had a mean of 53.71 and a standard deviation of 17.55. These results indicate that the two classes started at a comparable baseline, with no significant difference in students' initial understanding of integer addition and subtraction. The slightly higher standard deviation in the experimental class suggests a greater variation in pretest performance, which may reflect differences in prior knowledge and learning experiences among students. The Pretest Scores Comparison Between Experimental and Control Groups are presented in figure 1.

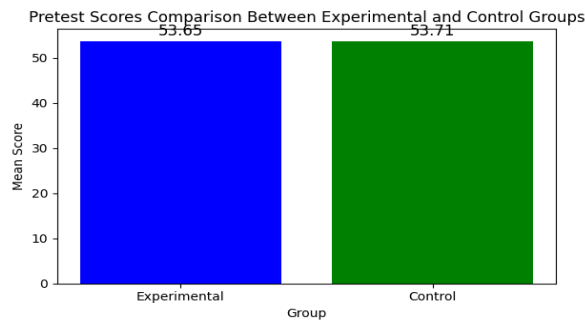


Figure 1. Pretest Scores Comparison Between Experimental and Control Groups

Figure 1 illustrates the distribution of pretest scores for both the experimental and control classes. The graph reveals that the mean scores of both groups are very close, with the experimental group having a mean of 53.65 and the control group having a mean of 53.71. This indicates that there was no significant difference in the initial cognitive learning outcomes between the two groups.

#### *Descriptive Statistics of Posttest Data*

Posttest data were collected to determine students' ability to solve mathematical problems related to integer addition and subtraction material. This was conducted to provide a clear description of students' cognitive learning outcomes. The descriptive analysis results of the posttest data from both classes are presented in Table 3.

Table 3. Descriptive Statistics of Posttest Data

Class	<i>N</i>	Min	Max	Mean	Std. Deviation
Experimental	32	37	100	75,71	17,41
Control	32	35	100	65	16,82

Based on Table 3, the experimental class achieved a higher mean score (75.71) than the control class (65.00), with standard deviations of 17.41 and 16.82, respectively. The difference in mean scores was statistically significant ( $p < 0.05$ ). The effect size (Cohen's *d*) was calculated as 0.63, indicating a medium practical effect. This result suggests that Mathigon-assisted learning had not only a statistically significant impact but also a meaningful educational effect, enhancing students' problem-solving ability and conceptual understanding of integer operations. The slightly higher standard deviation in the experimental class indicates that while most students improved, there were variations reflecting differences in prior knowledge, learning pace, and engagement. The Posttest Scores Comparison Between Experimental and Control Groups are presented in figure 2.

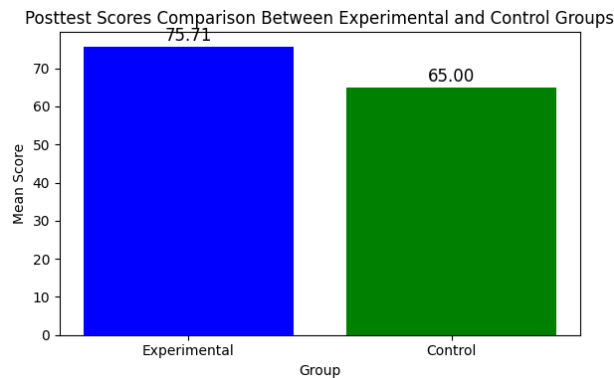


Figure 2. Posttest Scores Comparison Between Experimental and Control Groups

As shown in Figure 2, the experimental group achieved a mean posttest score of 75.71, compared to 65.00 for the control group, demonstrating a substantial improvement in learning outcomes. This visual and quantitative evidence confirms that integrating Mathigon as a digital learning medium can increase students' motivation and engagement, resulting in higher cognitive achievement. The findings emphasize that interactive digital media, when implemented using the Problem-Based Learning model, can effectively enhance learning outcomes beyond conventional instruction (Novianti, Sadipun, & Balan, 2020).

#### *Descriptive Statistics of N-Gain Data*

N-gain data analysis was conducted to assess the growth of students' cognitive abilities after the learning treatment. N-gain is also useful to evaluate the effectiveness of Mathigon media in improving students' cognitive learning outcomes. The descriptive analysis results of N-gain data are presented in Table 4.

Table 4. Descriptive Statistics of N-Gain Data

Class	N	Min	Max	Mean	Std. Deviation
Experimental	32	0,0	1,0	0,53	0,22
Control	32	0,2	1,0	0,31	0,19

As shown in Table 4, the experimental group achieved a mean N-gain of 0.53, while the control group had a mean of 0.31. Both groups fall into the medium category of learning improvement according to Wahab (Wahab et al., 2021). The difference between the groups indicates that the use of Mathigon media had a notable effect on enhancing students' cognitive learning outcomes in integer addition and subtraction. This suggests that interactive digital media, when integrated with the Problem-Based Learning model, can foster greater student engagement and more effective learning compared to conventional instruction (Srintin, Setyadi, & Mampouw, 2019).

#### *Inferential Statistics of Pretest Data*

Normality, homogeneity, and t-tests were used in this study. For pretest data, the test results are presented in Tables 5, 6, and 7.

Table 5. Normality Test Results of Pretest Data

Class	Shapiro-Wilk			Conclusion
	Statistic	df	Sig.	
Experimental	0,975	32	0,641	Normal
Control	0,950	32	0,141	Normal

Based on Table 5, the normality test results of the pretest data presented in the table above, the significance value of the experimental class was 0.641 and that of the control class was 0.141. Both significance values are greater than 0.05 (Sig. > 0.05), indicating that both classes were normally distributed shows in Table 6.

Table 6. Homogeneity Test Results of Pretest Data

Data	df <sub>1</sub>	df <sub>2</sub>	Sig.	Conclusion
Pretest	1	62	0,699	Homogen

As shown in Table 6, the homogeneity test results of the pretest data presented in the table above, the degrees of freedom for the smallest variance was 1 and for the largest variance was 62. The significance value was 0.699, which means Sig. > 0.05. Thus, it can be concluded that the pretest data of students' cognitive learning outcomes on integer addition and subtraction material were homogeneous.

Since the pretest data were normally distributed and had homogeneous variance, a t-test was then applied for hypothesis testing and conclusion drawing as follows:

$H_0$  : There is no difference in initial ability (mathematics learning outcomes) of students on integer addition and subtraction material before implementation between the experimental and control classes.

$H_a$  : There is a difference in initial ability (mathematics learning outcomes) of students on integer addition and subtraction material before implementation between the experimental and control classes.

Statistical hypotheses:

$$H_0 : \mu_1 = \mu_2$$

$$H_a : \mu_1 \neq \mu_2$$

Description:

$\mu_1$  : Mean initial ability (mathematics learning outcomes) of the experimental class (using Mathigon media).

$\mu_2$  : Mean initial ability (mathematics learning outcomes) of the control class (using number line media).

Decision criteria:

$H_0$  is accepted if Sig. (2-tailed) > 0.05.

$H_a$  is accepted if Sig. (2-tailed) ≤ 0.05.

The test result can be seen in Table 7

Table 7. T-Test Results of Pretest Data

Sig (2 - tailed)	Description	Conclusion
0,989	$H_0$ accepted	No difference

As shown in Table 7, the t-test results of the pretest data presented in the table above, the significance value was 0.989, which meets the criterion Sig. (2-tailed) > 0.05. This indicates that  $H_0$  is accepted. Therefore, it can be concluded that there was no significant difference between the two classes.

*Inferential Statistics of Posttest Data*

Normality, homogeneity, and t-tests were used in this study. For posttest data, the test results are presented in Tables 8, 9, and 10 shows in Table 8.

Table 8. Normality Test Results of Posttest Data

Class	Shapiro-Wilk			Conclusion
	Statistic	df	Sig.	
Experimental	0,941	32	0,079	Normal
Control	0,951	32	0,152	Normal

Based on Table 8, the normality test results of the posttest data presented in the table above, the significance value of the experimental class was 0.079 and that of the control class was 0.152. Both significance values are greater than 0.05 (Sig. > 0.05). Thus, it can be concluded that both classes were normally distributed shows in Table 9.

Table 9. Homogeneity Test Results of Posttest Data

Data	df <sub>1</sub>	df <sub>2</sub>	Sig.	Conclusion
Pretest	1	62	0,773	Homogen

Based on Table 9, the homogeneity test results of the posttest data presented in the table above, the degrees of freedom for the smallest variance was 1 and for the largest variance was 62. The significance value was 0.773, which means Sig. > 0.05. Therefore, it can be concluded that the posttest data of students' cognitive learning outcomes on integer addition and subtraction material were homogeneous.

Since the posttest data were normally distributed and had homogeneous variance, a t-test was then applied for hypothesis testing and conclusion drawing as follows:

$H_0$  : There is no difference in final ability (mathematics learning outcomes) of students on integer addition and subtraction material after implementation between the experimental and control classes.

$H_a$  : There is a difference in final ability (mathematics learning outcomes) of students on integer addition and subtraction material after implementation between the experimental and control classes.

Statistical hypotheses:

$H_0 : \mu_1 = \mu_2$

$H_a : \mu_1 \neq \mu_2$

Description:

$\mu_1$  : Mean final ability (mathematics learning outcomes) of the experimental class (using Mathigon media).

$\mu_2$  : Mean final ability (mathematics learning outcomes) of the control class (using number line media)

Decision criteria:

$H_0$  is accepted if *Sig. (2 – tailed)* > 0,05.

$H_a$  is accepted if *Sig. (2 – tailed)* ≤ 0,05.

The test result can be seen in Table 10

Table 10. T-Test Results of Posttest Data

Sig (2 – tailed)	Description	Conclusion
0,015	$H_a$ accepted	There is a difference

Based on Table 10, the t-test results of the posttest data presented in the table above, the significance value was 0.015, which meets the criterion *Sig. (2-tailed)* ≤ 0.05. This indicates that  $H_a$  is accepted. Therefore, it can be concluded that there was a significant difference between the two classes.

#### *Inferential Statistics of N-Gain Data*

Normality, homogeneity, and t-tests were used in this study. For n-gain data, the test results are presented in Tables 11.

Table 11. Normality Test Results of N-Gain Data

Class	<i>Shapiro-Wilk</i>			Conclusion
	<i>Statistic</i>	<i>df</i>	<i>Sig.</i>	
Experimental	0,914	32	0,014	Not Normal
Control	0,567	32	0,00	Not Normal

Based on Table 11, the normality test results of the N-gain data presented in the table above, the significance value of the experimental class was 0.014 and that of the control class was 0.000. Both significance values are less than 0.05 (*Sig.* < 0.05). Therefore, it can be concluded that both classes were not normally distributed, so a homogeneity test was not required and a non-parametric test was directly applied.

Since the N-gain data were not normally distributed, a non-parametric test in the form of the Mann–Whitney test was applied for hypothesis testing and conclusion drawing as follows:

$H_0$  : The improvement in mathematics learning outcomes of students on integer addition and subtraction material in the experimental class (using Mathigon media) is not better than that of the control class (using number line media).

$H_a$  : The improvement in mathematics learning outcomes of students on integer addition and subtraction material in the experimental class (using Mathigon media) is better than that of the control class (using number line media).

Statistical hypotheses:

$H_0$  :  $\mu_1 \leq \mu_2$

$H_a$  :  $\mu_1 > \mu_2$

Description:

$\mu_1$  : Improvement in mathematics learning outcomes of the experimental class (using Mathigon media).

$\mu_2$  : Improvement in mathematics learning outcomes of the control class (using number line media).

Decision criteria:

$H_0$  is accepted if Asymp. Sig. (2-tailed) > 0.05.

$H_a$  is accepted if Asymp. Sig. (2-tailed)  $\leq$  0.05. N-Gain data show in Table 12.

Table 12. Mann-Whitney Results of N-Gain Data

Asymp.Sig (2 - tailed)	Description	Conclusion
0,001	$H_a$ accepted	Better Improvement

The Mann-Whitney U test results presented in Table 12 show that the significance value for the N-gain data was 0.001, which is less than the threshold of 0.05. This indicates that the null hypothesis ( $H_0$ ) is rejected, and the alternative hypothesis ( $H_a$ ) is accepted. In other words, there was a statistically significant difference between the experimental and control groups. The experimental group, which used Mathigon media, demonstrated better improvement in their learning outcomes on integer addition and subtraction compared to the control group, which used traditional number line media. This result suggests that Mathigon media is more effective in improving students' mathematics learning outcomes, highlighting the potential of interactive digital tools to enhance student engagement and understanding in mathematics education (Hidayana, 2021; Nahdi & Alfiani, 2020). Previous studies have shown that digital media like Mathigon can create a more engaging and dynamic learning environment, helping students overcome the challenges associated with abstract mathematical concepts (Saila et al., 2023). Furthermore, integrating such digital platforms within a Problem-Based Learning (PBL) framework has been identified as an effective approach to fostering deeper student involvement and improving learning outcomes (Tuntunan & Sugiman, 2024).

## Discussion

The results of this study indicate that the use of Mathigon media in teaching integer addition and subtraction is more effective than the use of number line media in improving the cognitive learning outcomes of seventh-grade students at SMP Plus Assa'adah. Before the implementation of Mathigon media, the learning process was often monotonous, which led to student boredom and difficulties in understanding the material, resulting in errors in mathematical concepts (Anggoro & Putra, 2021). However, when Mathigon media was integrated with the Problem-Based Learning (PBL) method, students became more engaged. The PBL method, consisting of stages such as problem orientation, student organization, discussion guidance, presentation of results, and analysis and evaluation, allowed students to actively participate and become more creative in problem-solving (Suhartini, 2018). This active involvement significantly improved their understanding of integer addition and subtraction (Hasan, Milawati, Darodjat, Khairani, & Tahrir, 2021).

Observations showed an increase in student engagement in the experimental class. Initially, students had some difficulty adapting to Mathigon media as a learning tool. However, over time, students became more interested and enthusiastic about applying Mathigon in learning the material, which led to better results in understanding the concepts. In contrast, students in the control group, who used number line media, were less active and involved in critical thinking, resulting in

lower enthusiasm for the subject and less effective cognitive outcomes. While the control group did show improvement, it was not as significant as the experimental group.

The statistical analysis, including the t-test for posttest data and the Mann-Whitney test for N-gain data, confirmed these findings. The analysis showed that the average scores of the experimental and control groups were significantly different, with the experimental group showing a greater improvement in average scores. These results align with the study by (Tuntunan & Sugiman, 2024), which found that Mathigon-based learning was more effective in enhancing students' problem-solving and mathematical connections, as well as with (Kurnia & Mizan, 2023), who found that the use of smart path number line media improved learning outcomes, though to a lesser extent.

The effect size for this study, calculated using Cohen's  $d$ , was found to be moderate ( $d = 0.62$ ), suggesting that the use of Mathigon media had a meaningful impact on students' cognitive learning outcomes. This effect size indicates that the improvement in the experimental class was not just statistically significant, but also practically relevant, making Mathigon a highly effective tool in improving learning outcomes in integer operations (Silva et al., 2023).

In conclusion, the study demonstrates that Mathigon media, when integrated with the PBL approach, offers an engaging and effective learning experience that enhances students' understanding of integer addition and subtraction. The integration of interactive digital media provides an innovative way to foster active learning and improve cognitive outcomes in mathematics education.

### **Conclusion and Suggestion**

The results of this study conducted at SMP Plus Assa'adah for seventh-grade students in the 2025/2026 academic year indicate that Mathigon media, when integrated with Problem-Based Learning (PBL), significantly improves students' cognitive learning outcomes in integer addition and subtraction compared to traditional number line media. The experimental group, which used Mathigon, showed greater improvement in learning outcomes than the control group, demonstrating the effectiveness of interactive digital media in enhancing mathematical understanding.

Based on these findings, it is recommended that schools and mathematics educators incorporate interactive and digital learning tools, such as Mathigon, into their teaching methods to improve student engagement and learning outcomes. Teachers should consider using innovative learning media and creating an engaging learning environment to stimulate students' motivation and enthusiasm for mathematics. For future research, it is suggested to explore the long-term effects of Mathigon media on other mathematical topics and to assess its effectiveness in different educational settings. Further studies could also investigate the impact of Mathigon combined with other teaching methods to identify the most effective instructional strategies for enhancing student learning outcomes.

### **Reference**

Amna, A., Hardiansyah, F., & Armadi, A. (2024). Pengaruh Media Pembelajaran Domat (Domino Matematika) Dalam Meningkatkan Pemahaman Simbol

- Matematika Siswa Kelas 2 di Sekolah Dasar. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, 9(4), 580–590. <https://doi.org/10.23969/jp.v9i04.19985>
- Anggoro, B. S., & Putra, R. W. Y. (2021). *Operasi Hitung Bilangan Bulat Untuk Jenjang SMP/MTs Kelas VII*. Retrieved from <https://repository.radenintan.ac.id/21307/1/PERPUS.pdf>
- Astriani, N., Rochaminah, S., & Sugita, G. (2021). Penerapan Model Pembelajaran Kooperatif Tipe Think Pair Share Untuk Meningkatkan Hasil Belajarsiswa Kelas VII B Smp Bala Keselamatan Maranatha Pada Materi Operasi Penjumlahan Dan Pengurangan Bilangan Bulat. *Jurnal Elektronik Pendidikan Matematika Tadulako*, 8(3), 219–227. Retrieved from <https://jurnal.fkipuntad.com/index.php/jpmt/article/view/864>
- Gemnafle, M., & Batlolona, J. R. (2021). Manajemen Pembelajaran. *Jurnal Pendidikan Profesi Guru Indonesia (Jppgi)*, 1(1), 28–42. <https://doi.org/10.30598/jppgivol1issue1page28-42>
- Gusteti, M. U., & Neviyarni. (2022). Pembelajaran Berdiferensiasi Pada Pembelajaran Matematika Di Kurikulum Merdeka. *Jurnal Lebesgue: Jurnal Ilmiah Pendidikan Matematika, Matematika Dan Statistika Meria*, 3(3), 170–184. <https://doi.org/10.4324/9781003175735-15>
- Hasan, M., Milawati, Darodjat, Khairani, H., & Tahrim, T. (2021). Media Pembelajaran. In *Tahta Media Group*. Retrieved from [https://eprints.unm.ac.id/20720/1/Media\\_Pembelajaran\\_2.pdf](https://eprints.unm.ac.id/20720/1/Media_Pembelajaran_2.pdf)
- Hidayana, A. F. (2021). Pengaruh Kelengkapan Fasilitas Belajar Terhadap Hasil Belajar Matematika Siswa Kelas V Mi Nurul Ulum Madiun. *Jurnal Paradigma*, 11(1), 187–201. <https://doi.org/10.53961/paradigma.v13i1.83>
- Kurnia, N., & Mizan, S. (2023). Pengembangan Jalur Pintar Materi Garis Bilangan Untuk Meningkatkan Hasil Belajar Siswa Kelas III SDN Sugihwaras I. *Prosiding Seminar Nasional Penelitian Dan Pengabdian Masyarakat*, 8(2). Retrieved from <http://prosiding.unirow.ac.id/index.php/new-snasppm%0AProses>
- Malay, M. N. (2022). Belajar Mudah & Praktis (Analisis Data dengan SPSS dan JAPS). In *CV. Madani Jaya*. Retrieved from [https://repository.radenintan.ac.id/25436/1/Buku\\_ISBN\\_Belajar\\_Mudah\\_Praktis\\_SPSS-JASP.pdf](https://repository.radenintan.ac.id/25436/1/Buku_ISBN_Belajar_Mudah_Praktis_SPSS-JASP.pdf)
- Mathigon. (2024). Mathigon: Interactive mathematics. Retrieved from 2024 website: <https://mathigon.org/>
- Montolalu, C. E. J. C., & Langi, Y. A. R. (2018). Pengaruh Pelatihan Dasar Komputer dan Teknologi Informasi bagi Guru-Guru dengan Uji-T Berpasangan (Paired Sample T-Test). *Jurnal Matematika Dan Aplikasi DeCartesiaN*, 7, 44–46. <https://doi.org/10.35799/dc.7.1.2018.20113>
- Nahdi, D. S., & Alfiani, N. A. (2020). Penggunaan media garis bilangan dalam meningkatkan pemahaman matematis siswa sekolah dasar. *Jurnal Didactical Mathematics*, 2(3), 54–61. Retrieved from [http://jurnal.unma.ac.id/index.php/dm/article/view/2455%0Afile:///C:/Users/User/Downloads/2455-6663-1-PB\(1\).pdf](http://jurnal.unma.ac.id/index.php/dm/article/view/2455%0Afile:///C:/Users/User/Downloads/2455-6663-1-PB(1).pdf)
- Novianti, C., Sadipun, B., & Balan, J. M. (2020). Pengaruh Motivasi Belajar Terhadap Hasil Belajar Matematika Peserta Didik. *Science, and Physics Education Journal (SPEJ)*, 3(2), 57–75. <https://doi.org/10.31539/spej.v3i2.992>
- Putri, L. M., Linuhung, N., & Vahlia, I. (2026). Development Of Discovery Learning-

- Based Mathematics Learning Media Accompanied By Crossword Puzzles Of Integer Material. *Prima Magistra: Jurnal Ilmiah Kependidikan*, 7(2), 280-288. <https://e-journal.uniflor.ac.id/index.php/jpm/article/view/5674>
- Saila, N., Alam, M., Inayati, T., Bella, S., & Faizah, S. (2023). *Pelatihan Penggunaan Media Kartu Dalam Pembelajaran Penjumlahan Dan Pengurangan Bilangan Bulat Bagi Siswa Kelas Iv Di Kabupaten Probolinggo*. 1(3), 187-197. <https://doi.org/https://doi.org/10.56855/jcos.v1i3.515>
- Salmina, M., & Fadlillah, A. (2017). Analisis Kualitas Soal Ujian Matematika Semester Genap Kelas XI SMA Inshafuddin Kota Banda Aceh. *Jakarta : Gema Insanipres*, 4(1), 37-47. <https://doi.org/https://doi.org/10.46244/numeracy.v4i1.250>
- Salsabila, S. S., Rohmadani, A. I., Mahmudah, S. R., Fauziyah, N., & Sholihatien, R. A. N. (2022). Tantangan Pendidikan Multikultural Di Indonesia Di Zaman Serba Digital Sonia. *Anwarul*, 2(1), 99-110. Retrieved from <https://ejournal.yasin-alsys.org/index.php/anwarul>
- Silva, A. D. C. ., Garak, S. S., & Udil, P. A. (2023). Analisis Hasil Belajar Siswa Pada Materi Perbandingan Berdasarkan Ranah Kognitif Revisi Taksonomi Bloom. *Fraktal: Jurnal Matematika Dan Pendidikan Matematika*, 8(2:), 81-88. [https://doi.org/10.36456/buana\\_matematika.8.2:1732.81-88](https://doi.org/10.36456/buana_matematika.8.2:1732.81-88)
- Srintin, A. S., Setyadi, D., & Mampouw, H. L. (2019). Development of Umino card game media in learning whole number operations math. *Cendekia Journal: Journal of Mathematics Education*, 3(1), 126-138. <https://doi.org/https://doi.org/10.31004/cendekia.v3i1.82>
- Suhartini. (2018). *Pengaruh Penggunaan Media Alat Peraga (Garis Bilangan) Terhadap Hasil Belajar Siswa Pada Mata Pelajaran Matematika Kelas Iv Di Mi Nurul Qomar Palembang*. <https://doi.org/http://repository.radenfatah.ac.id/3423/1/SUHARTINI.pdf>
- Suprihatin, S., Sholiha, S., & Vahlia, I. (2025). Development of Android-Based Project-Based Learning Media to Enhance Students Enterpreneurial Skills. *AL-ISHLAH: Jurnal Pendidikan*, 17(3), 5268-5284. <https://doi.org/10.35445/alishlah.v17i3.7622>
- Suratman, A., Afyaman, D., & Rakhmasari, R. (2019). Pembelajaran Berbasis TIK Terhadap Hasil Belajar Matematika Dan Motivasi Belajar Matematika Siswa. *Jurnal Analisa*, 5(1), 41-50. <https://doi.org/10.15575/ja.v5i1.4828>
- Syamil, M. F., Vahlia, I., & Sudarman, S. W. (2024). Pengembangan Media Pembelajaran Berbantu Aplikasi Powtoon Disertai Nilai-Nilai Islam Pada Materi Segiempat Dan Segitiga. *EMTEKA: Jurnal Pendidikan Matematika*, 5(1), 95-108.
- Telaumbanua, A., Gulo, D., Lahagu, L. A., Gulo, C. K., & Gulo, E. K. K. (2022). Pengaruh Penerapan Teori Belajar Siberetik Terhadap Kemampuan Mahasiswa Mengelola Pembelajaran Berbasis Digital. *Jurnal Teologi Dan Pendidikan Kristen*, 1(2), 60-69. <https://doi.org/10.56854/pak.v1i2.105>
- Tuntunan, G. S., & Sugiman, S. (2024). The Effectiveness of Guided Inquiry Learning with Mathigon on Problem Solving, Mathematical Connection, and Self-Efficacy. *International Journal of Multicultural and Multireligious Understanding*, 11(8), 743. Retrieved from <https://ijmmu.com/index.php/ijmmu/article/view/6121>
- Usmadi. (2020). Pengujian Persyaratan Analisis (Uji Homogenitas Dan Uji Normalitas). *Inovasi Pendidikan*, 7(1), 50-62.

<https://doi.org/10.31869/ip.v7i1.2281>

Wahab, A., Junaedi, & Azhar, M. (2021). Efektivitas Pembelajaran Statistika Pendidikan Menggunakan Uji Peningkatan N-Gain di PGMI. *Jurnal Basicedu*, 5(2), 1039–1045. <https://doi.org/10.31004/basicedu.v5i2.845>

Widiani, Y. (2019). Matematika dan lingkungan. *Jurnal Equation: Teori Dan Penelitian Pendidikan Matematika*, 2(1), 39. <https://doi.org/10.29300/equation.v2i1.2309>