

Enhancing Learning Outcomes in KPK and FPB through Teaching at the Right Level (TaRL) Using the 'Musi Board' in Grade IV Elementary Education

Nilam Permata Sari¹, Yuli Witanto²

¹ Universitas Negeri Semarang, Indonesia; Permatasarinilam@students.unnes.ac.id

² Universitas Negeri Semarang, Indonesia; yuliw64@mail.unnes.ac.id

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ABSTRACT

This study explores the impact of the Teaching at the Right Level (TaRL) approach, combined with Musi Board media, on enhancing mathematics learning outcomes and student motivation, particularly in the topics of KPK (Least Common Multiple) and FPB (Greatest Common Divisor), among fourth-grade students at SDN Gisikdrono 03, Semarang. A quasi-experimental design with a non-equivalent control group was employed, involving 46 students divided into an experimental group and a control group. Both groups completed pretests and posttests to assess learning gains and motivational changes. The experimental group, which received instruction through the TaRL approach integrated with Musi Board media, demonstrated significantly greater improvements in both learning outcomes and motivation than the control group. Statistical analysis confirmed the effectiveness of the intervention. The findings suggest that applying level-appropriate, interactive, and contextual teaching methods—such as the TaRL approach supported by visual media—can substantially improve student engagement and achievement in elementary mathematics.

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Corresponding Author:

Nilam Permata Sari

Universitas Negeri Semarang, Indonesia; Permatasarinilam@students.unnes.ac.id

1. INTRODUCTION

Education plays a crucial role in shaping individuals throughout all stages of life, serving as the foundation for intellectual, emotional, and social development. In Indonesia, recent curriculum reforms—particularly the implementation of Kurikulum Merdeka (Independent Curriculum)—aim to modernize educational practices by promoting autonomy, flexibility, and student-centered learning (Gumilar, Rosid, Sumardjoko, & Ghufro, 2023). This curriculum emphasizes the need for personalized instruction that addresses each student's unique characteristics, interests, and learning pace.

Among the core subjects in the national curriculum, mathematics remains a fundamental discipline. It equips students with essential analytical and problem-solving skills necessary for navigating technological and scientific advancements (Sutama & Novitasari, 2019). However, in practice, elementary school students often view mathematics as a difficult subject. Topics such as Kelipatan Persekutuan Terkecil (KPK or Least Common Multiple) and Faktor Persekutuan Terbesar (FPB or Greatest Common Divisor) are particularly challenging due to their abstract nature and the lack of concrete instructional

tools. As Kamarullah (2017) emphasizes, mathematical understanding is foundational and must be nurtured from early education levels through to higher education.

Classroom observations at SDN Gisikdrono 03, Semarang, revealed persistent issues in student engagement and achievement in mathematics. In fourth-grade classes, students demonstrated low retention of previously taught material, limited motivation, and suboptimal test scores. The average scores in the chapters on numbers and calculation, as well as area, were 68 and 70 respectively—both below the Minimum Mastery Criterion (KKM) of 75. Interviews with teachers indicated that while the Independent Curriculum was being implemented, its effectiveness was undermined by the lack of interactive media and innovative teaching strategies. Teachers continued to rely heavily on traditional methods, often neglecting more dynamic, student-centered learning models.

To address these issues, this study investigates the application of the Teaching at the Right Level (TaRL) approach in combination with the Musi Board media. The TaRL method is designed to adapt instruction to students' current learning levels rather than their grade level, thereby minimizing learning gaps and promoting skill mastery (Siswaningsih et al., 2023). The approach is grounded in the principle that learning is most effective when instruction is aligned with the learner's actual capabilities. This framework enables educators to identify and support students who are falling behind, while simultaneously challenging those who are more advanced.

Learning media play an essential role in this process. According to Nurrita (2018), well-designed educational media not only stimulate student interest but also enhance comprehension and retention. When properly integrated, media can serve as a bridge between abstract concepts and tangible understanding. The Musi Board—an interactive, visual learning tool—has been used in several elementary school classrooms to teach mathematics topics like FPB and KPK (Yonanda, Kurino, & Ramayanti, 2021). The board presents a grid of numbers (typically 1–50), allowing students to manipulate and visualize number relationships in response to teacher prompts. Its hands-on format encourages participation, supports differentiated instruction, and provides immediate feedback through guided interaction.

Previous research supports the integration of interactive media with learner-centered strategies. Studies by Listyaningsih, Nugraheni, and Yuliasih (2023), as well as Mangesthi, Setyawati, and Miyono (2023), found that combining TaRL with media such as the Musi Board significantly improved students' mathematical understanding and motivation. Similar findings were reported by Muzkiati, Ahadin, and Victoria (2024), who demonstrated that the synergy between appropriate learning tools and instructional strategies leads to measurable gains in student achievement. These studies collectively highlight the effectiveness of merging structured pedagogy with adaptable media to enhance learning outcomes.

Despite this growing body of evidence, there remains limited research on the use of Musi Board media within the framework of the Independent Curriculum, particularly when paired with the TaRL method. This gap presents an opportunity to contribute novel insights and practical applications for elementary education in Indonesia. The current study was thus designed to explore how these two components—TaRL and Musi Board—can be utilized together to improve the teaching of KPK and FPB in fourth-grade classrooms.

To test the effectiveness of this approach, researchers adopted a quasi-experimental design involving control and experimental groups. Pretests were administered to ensure the equivalency and homogeneity of the groups. Following the intervention, which consisted of mathematics instruction using the TaRL model supported by Musi Board media, posttests were conducted to measure changes in learning outcomes and student motivation. These quantitative results were further enriched by qualitative data obtained from teacher interviews and classroom observations.

In line with the goals of Kurikulum Merdeka, this study aims not only to assess learning outcomes but also to demonstrate the value of adaptable, student-centered instruction. The TaRL method provides a structure that aligns with the curriculum's emphasis on differentiation and autonomy, while the Musi Board offers a tangible, engaging way for students to explore and internalize mathematical concepts. By

integrating these tools, this research contributes to a growing body of literature advocating for innovation in instructional design to improve student performance in mathematics.

Ultimately, this study seeks to respond to observed challenges in elementary mathematics instruction, particularly in the teaching of KPK and FPB, by offering an empirically supported, context-sensitive pedagogical intervention. The findings are expected to inform both practice and policy, with the potential to enhance the delivery of mathematics education in Indonesian elementary schools.

2. METHODS

The study was conducted at SDN Gisikdrono 03, located in the West Semarang District of Semarang City. It employed a quasi-experimental research design using a non-equivalent control group approach (Arib, Rahayu, Sidorj, & Afgani, 2024). Two fourth-grade classes participated in the study, with one serving as the experimental group and the other as the control group. In this design, both groups received a pretest prior to the intervention and a posttest afterwards, enabling the researchers to assess the effectiveness of the treatment (Zyra, Alamsyah, & Yuliana, 2022).

Experimental Class	O1	X	O2
Control Class	O3		O4

Figure 1. Research Design

(Sugiyono 2012: 116)

Description :

O1 : Experimental class pretest

O2: Experimental class posttest

O3 : Control class pretest

O4 : Posttest of control class

X: Treatment applied using the *Teaching at the Right Level* (TARL) approach assisted by Musi Board media in mathematics learning.

This study's research population was fourth-grade students in the 2024/2025 school year at Gisikdrono 03 Elementary School. While the sample used was a saturated sample, meaning that all members of the population were sampled by the researcher. This study's data was analysed using the t-test, gain test, homogeneity test, and normalcy test. This study's data came from lift and student learning test scores. This is the survey that was used to find out how enthusiastic students were about studying maths. A motivational questionnaire and a test of learning outcomes were used as data collecting instruments in this research. The experimental and control groups of students were each given a 20-question learning motivation questionnaire to complete before and after the therapy. Parallel to this, students in both the experimental and control groups were given learning outcomes exams both before and after the evaluations.

3. FINDINGS AND DISCUSSION

3.1 Findings

3.1.1 Pre-test and Post-test Results

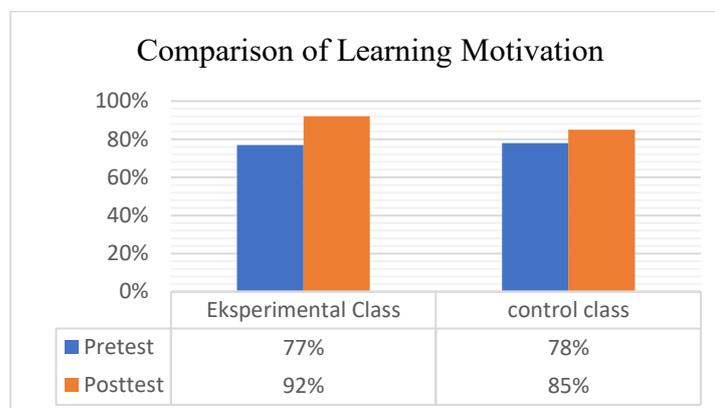


Figure 2. Comparison of pretest and posttest findings of learning motivation

The diagram above presents a comparison of learning motivation between the experimental and control classes based on pretest and posttest results. In the experimental class, the average pretest score was 77%, which increased to 92% in the posttest. Meanwhile, the control class scored an average of 78% on the pretest and 85% on the posttest. These results indicate a 15% improvement in the experimental class, suggesting that the use of the *Teaching at the Right Level* (TaRL) approach supported by Musi Board media effectively enhanced student motivation compared to traditional instruction in the control group.

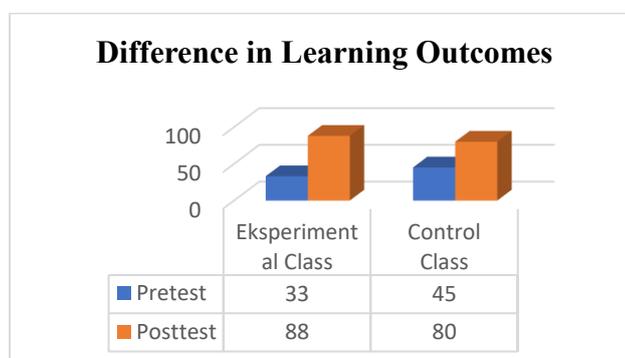


Figure 3. Comparison of Experimental and Control Class Learning Outcomes

Based on the diagram, the control class achieved an average pretest score of 45 and a posttest score of 80. In comparison, the experimental class scored an average of 33 on the pretest and 88 on the posttest. This reflects a 55-point improvement in the experimental group's average score. These findings indicate that the use of the *Teaching at the Right Level* (TaRL) approach, supported by Musi Board media, significantly enhanced students' learning outcomes in the experimental class.

3.1.2 Normality Test Results

A normalcy test was carried out by the researchers to see whether the data collected follows a normal distribution. The Kolmogorov-Smirnov test (K-S Test) is used in this normalcy test. The Asymp value displays the results of the normalcy test. Statistical significance (two-tailed) for both the experimental and control groups on both the pretest and posttest. Data on learning motivation may be

"normally" or "abnormally" tested using a normalcy test. Data is declared normal if it obtains sig. value > 0.05 and declared not normally distributed if it obtains sig. value < 0.05. In this study, researchers used the *one-sample kolmogorov smirnov* technique and then *analyze-descriptive statistic-explore* assisted by SPSS 25. The findings of the normalcy test for the student learning motivation pretest are as follows:

Table 1. Tests of Normality

	Koimogorov-Smirnov ^a			Shapiro-Wik		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest kelas expert	.184	23	.042	.924	23	.082
from post to reel control	.154	23	.170	.947	23	.250

a. Lilliefors Significance Correction

In table 3. displays the abnormality test results of experimental class and the control class learning motivation pretest data. The study's sample size was under 50 participants, which yielded a significant value. The Shapiro-Wilk column displays the value gained from the collection of student outcomes. The experimental data used for the pretest have a regularly distributed sig value of 0.082. The data from the control class's pretest shows a regularly distributed sig. value of 0.25. It is possible to state that the data follows a normal distribution, and the relevant hypothesis findings are Ho accepted and Ho rejected. Additionally, posttest data on learning motivation for both the experimental and control groups were subjected to a normality test by the researchers. Here are the findings of the posttest on student learning motivation based on the normalcy test.

Table 2. The results of the normality test of student learning motivation posttest

	Koimogorov-Smirnov ^a			Shapiro-Wik		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest kelas expert	.190	23	.030	.922	23	.075
from post to reel control	.180	23	.052	.922	23	.074

a. Lilliefors Significance Correction

Data on post-test desire to learn for both the experimental and control groups are included in table 4, which shows the results of a normality test. The sig. value is visible in the shapiro-wilk column because the sample size is smaller than 50 responders. The experimental class sig. value of 0.75 indicates a normal distribution for the outcomes. A result of 0.074, which also indicates normal distribution, is obtained in the control class sig. Then, the applicable hypothesis is "Ho accepted and Ha rejected, namely the data can be declared normally distributed".

3.1.3 Learning motivation homogeneity test results

The following table displays the results of the homogeneity test conducted on the final data.

Table 3. Student learning motivation pretest homogeneity test results
Test of Homogeneity of Variances

		Levene	df1	df2	Sig.
		Statistic			
learning motivation pretest	Based of Mean	1.788	1	29	.179
	Based on Median	1.900	1	29	.179
	Based on Median and with adjusted	1.900	1	28.737	.179
	df				
	Based on trimmed mean	1.765	1	29	.194

Results from a homogeneity test of pretest data on experimental and control groups' learning motivation are shown in table 5. According to the table, the data is considered homogenous since the sig. value of 0.192 is more than 0.05. "Pretest data on experimental and control groups' learning motivation was homogenous, meaning that the null hypothesis (Ho) is accepted and the alternative

hypothesis (Ha) is rejected. In addition, post-test data on learning motivation for both the experimental and control groups were subjected to a normality test". The following are the homogeneity test results of the posttest of student learning motivation:

Table 4. Results of the homogeneity test of student motivation posttest
Test of Homogeneity of Variances

		Levene	df1	df2	Sig.
		Statistic			
learning motivation posttest	Based on Mean	178	1	44	.675
	Based on Median	.091	1	44	.764
	Based on Median and with adjusted df	.091	1	39.104	.764
	Based on trimmed mean	163	1	44	.688

This finding indicates that the posttest scores for learning motivation in both the experimental and control groups were statistically homogeneous. As shown in the table, the homogeneity test yielded a significance value of 0.675, which meets the criteria for homogeneity. Therefore, it can be concluded that the null hypothesis (Ho) is accepted and the alternative hypothesis (Ha) is rejected, meaning the posttest data on learning motivation for both groups is considered homogeneous.

3.1.4 Homogeneity test results of learning outcomes

Researchers conducted a homosimilarity test on each of the pretest and posttest data in the experiment class and control class data. The homogeneity test on learning outcomes data aims to determine that the data has the same variance. Once the data is determined to be regularly distributed, this test is carried out. Data is declared homogeneous if it obtains a sig score. > 0.05 and declared inhomogeneous if it obtained a sig value. $< 0,05$. In this study, researchers used the SPSS 25.00 program. The following are the pretest homogeneity testing results of students' learning outcomes:

Table 5. Homogeneity Test Results of Student Learning Outcomes Pretest
Test of Homogeneity of Variances

		Levene	df1	df2	Sig.
		Statistic			
learning motivation pretest	Based on Mean	1.803	1	44	.186
	Based on Median	.786	1	44	.380
	Based on Median and with adjusted df	.786	1	38.632	.381
	Based on trimmed mean	1.610	1	44	.211

Table 5 displays the findings of the pretest data homogeneity test for the learning outcomes of the experimental and control groups. According to the table, the data is considered homogenous since the significance level (sig. by 0.186) is more than 0.05. The findings of the homogeneity test of the pretest data on the learning outcomes of the experimental and control classes indicate that "the data is homogenous, suggesting that the appropriate hypothesis is Ho accepted and Ha rejected". Also, after the test, researchers checked whether the Experimental and Control groups' posttest results were similar in terms of their learning outcomes. Here are the findings from the posttest homogeneity test of student learning outcomes:

Table 6. The results of the homogeneity test of the posttest of student learning outcomes

		Test of Homogeneity of Variances			
		Levene Statistic	df1	df2	Sig.
results	Based on Mean	2.444	1	44	.125
	Based on Median	2.568	1	44	.116
	Based on Median and with adjusted df	2.568	1	43.140	.116
	Based on trimmed mean	2.387	1	44	.130

The results of the homogeneity test of the posttest data on the learning outcomes of the Experimental and Control classes. In the table it is stated that the sig. value of 0.125 means > 0.05 so that the data is declared homogeneous. The findings of the Homogeneity test indicate that "the data is homogenous, meaning that the appropriate hypothesis is H_0 accepted and H_a rejected, based on the posttest data on learning outcomes of the experimental and control classes".

3.1.5 Independent sample t-test results

An independent samples t-test is used to answer the hypothesis that has been determined by the researcher. Previously, the authors had tested normality and homogeneity with normal and homogeneous results as a condition for using this hypothesis test. Researcher performs an independent samples t-test test on learning motivation data and learning outcomes of each the experimental class and control class. Researchers used SPSS 25 with a significance level of sig. (2-tailed) 0.05. Data from both the experimental and control classes' posttests are used in this analysis. Findings from a paired sample t-test on students' achievement are as follows:

Table 7. Results of independent sample t-test of student motivation to learn

		Independent Samples Test								
		Leave's Test for equality of variances		t-test for Equality of Means			95% confidences Interval of the Differences			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Differences	Std. Error Differences	Lower	Upper
learning motivation pretest	Equal variances assumed	.178	.675	3.752	44	.001	7.435	1.982	3.441	11.429
	Equal variances not assumed			3.752	43.123	.002	7.435	1.982	3.439	11.431

Table 7 presents the results of the dependent sample t-test on student motivation data. The analysis produced a significance value of 0.001, which is less than the threshold of 0.05. This indicates a statistically significant difference in average learning motivation between the experimental class (which received treatment) and the control class (which did not). Therefore, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted, confirming the effect of the treatment on student motivation. Furthermore, student learning outcomes were analyzed using an independent sample t-test, and the results are presented as follows:

Table 8. Independent sample t-test results of student learning outcomes

		Independent Samples Test					t-test for Equality of Means		95% Confidence interval of the Difference	
		Levene's Test for Equality of Variances		t	df	Sig. (2-tailed)	Mean Differences	Std. Error Differences	Lower	Upper
		F	Sig.							
Result	Equal variances assumed	2.444	.125	4.772	44	.000	8.174	1.713	4.722	11.626
	Equal variances not assumed			4.772	40.993	.000	8.174	1.713	4.715	11.633

Table 8 presents the results of the independent sample t-test conducted on student learning outcomes data. The analysis yielded a significance value of 0.000, which is less than the standard threshold of 0.05. This indicates a statistically significant difference in the average learning outcomes between the experimental class (which received treatment) and the control class (which did not). Therefore, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted, confirming the effectiveness of the treatment in improving student learning outcomes.

Discussion

The results of this study provide strong empirical evidence that the Teaching at the Right Level (TaRL) approach, when combined with Musi Board media, significantly enhances both student learning motivation and academic achievement in the mathematics topics of KPK (Least Common Multiple) and FPB (Greatest Common Divisor). These findings align with previous studies that support differentiated instruction and the use of interactive learning media to improve outcomes in primary education (Jauhari, Yuliasih, & Nurul, 2023; Mangesthi, Setyawati, & Miyono, 2023).

To measure the effectiveness of the intervention, researchers used two main instruments: a learning motivation questionnaire and a test of student learning outcomes. Both instruments underwent rigorous validation procedures prior to their application. The instruments were first piloted with 27 fourth-grade students at SD Sukorejo, who shared similar characteristics with students in both the control and experimental groups. This step was essential to ensure that the instruments would yield valid and reliable data.

The learning motivation questionnaire consisted of 20 items, all of which were confirmed to be valid and reliable following comprehensive validity and reliability testing. This aligns with the findings of Slamet and Wahyuningsih (2022), who stress the importance of instrument feasibility and consistency to ensure research credibility. For the student learning outcomes test, 40 items were developed and assessed for validity, reliability, difficulty level, and discriminating power. Out of these, 25 items were validated based on a threshold value below 3.71, and the test achieved a high reliability coefficient of 0.90, indicating strong internal consistency. In terms of difficulty, the test comprised 9 easy questions, 22 moderate ones, and 9 classified as difficult. Regarding discriminating power, the test included 4 items rated as very good, 16 as good, 8 as sufficient, 5 as weak, and 7 with no discriminating power. This thorough validation process ensured that both the motivation questionnaire and the learning outcomes test were effective in accurately measuring student motivation and academic performance before and after the intervention.

The research spanned six classroom meetings: one for the pretest, four for intervention sessions, and one for the posttest. The experimental group received treatment using the TaRL approach and Musi Board media, while the control group was taught using conventional methods without any additional intervention.

Results showed a 14% improvement in student motivation scores in the experimental group, compared to a 7% improvement in the control group. This clearly indicates that the treatment had a more pronounced effect on enhancing students' interest and engagement in learning.

During the four treatment sessions, students in the experimental group initially showed some hesitation as they adjusted to the new instructional method. However, by the second and third sessions, a noticeable increase in engagement was observed. Students became more active and participative, expressing that the use of Musi Board media helped them better grasp and solve problems related to KPK and FPB. These findings are supported by previous research, such as the study by Yonanda, Kurino, and Ramayanti (2021), which highlights the role of Musi Board media in enhancing student motivation and aiding conceptual understanding.

Quantitative analysis of learning outcomes further revealed significant differences between the experimental and control groups. The experimental group showed an average pretest score of 37 and a posttest average of 88, resulting in a gain of 51 points. In comparison, the control group improved from a pretest average of 47 to a posttest average of 80, showing a gain of 33 points. This 18-point gap in score improvement suggests that the students exposed to the TaRL method, supported by Musi Board media, experienced a more substantial improvement in learning outcomes. These findings reinforce the effectiveness of personalized, level-appropriate instruction, as evidenced in studies by Muzkiati, Ahadin, and Victoria (2024), Nurlaila and Mahmudah (2023), and Muhammad (2022).

To ensure the accuracy of the statistical comparisons, normality and homogeneity tests were performed using SPSS version 25. The normality test results for both learning motivation and learning outcomes indicated that all significance (sig.) values exceeded 0.05, confirming that the data followed a normal distribution. For example, the posttest motivation scores for the experimental and control groups yielded sig. values of 0.075 and 0.074, respectively. The pretest scores for learning outcomes showed sig. values of 0.115 for the experimental group and 0.071 for the control group, both above the 0.05 threshold. Similarly, homogeneity tests indicated that the pretest and posttest scores for both learning motivation and learning outcomes were homogeneous, meaning there were no significant differences in data variance between the groups prior to the intervention. These results validated the comparability of the groups and confirmed that any differences observed after the treatment could be attributed to the intervention itself.

To determine the significance of the treatment's effect, researchers conducted both dependent sample t-tests (for within-group comparisons) and independent sample t-tests (for between-group comparisons). The independent sample t-test for learning motivation yielded a significance (2-tailed) value of 0.001, which is below the standard alpha level of 0.05. This indicates a statistically significant difference in motivation levels between the experimental and control groups. Consequently, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_a) was accepted, confirming that the intervention had a meaningful effect on student motivation.

Similarly, the independent sample t-test for learning outcomes produced a significance value of 0.000, which is also below the 0.05 threshold. This result confirms that the experimental group achieved significantly higher academic performance than the control group. Taken together, these statistical findings provide strong evidence that the TaRL approach, when implemented with the support of interactive tools like the Musi Board, has a substantial and positive impact on both student motivation and learning achievement in mathematics.

This research supports the growing body of literature advocating for differentiated and interactive teaching approaches in primary education. The Teaching at the Right Level approach focuses on adjusting instruction to students' current competencies rather than their grade level, thereby helping to close learning gaps and ensure that all students progress at their own pace (Siswaningsih et al., 2023). When paired with interactive tools like the Musi Board, this approach not only reinforces conceptual understanding but also cultivates a more engaging and inclusive classroom environment.

The improved outcomes observed in this study suggest that educators and policymakers should consider integrating TaRL-based models and interactive media into the national curriculum, especially in foundational subjects like mathematics.

In conclusion, the study found that the Teaching at the Right Level (TaRL) approach, when implemented alongside Musi Board media, significantly improves both learning motivation and mathematics achievement among fourth-grade students in the topics of KPK and FPB. The rigorous testing of research instruments, effective implementation of the intervention, and statistically significant results all point to the effectiveness of this pedagogical model. These findings underscore the importance of using student-centered, level-appropriate instruction supported by interactive learning media to enhance the quality of primary education in Indonesia.

4. CONCLUSION

This study concludes that the implementation of the *Teaching at the Right Level* (TaRL) approach, when supported by Musi Board media, significantly improves student motivation and learning outcomes in the mathematics topics of KPK and FPB among fourth-grade students. The experimental group, which received this treatment, demonstrated higher levels of engagement and achieved better test scores compared to the control group taught through conventional methods. These findings highlight the value of integrating differentiated instruction with interactive media, aligning effectively with the *Kurikulum Merdeka* framework that promotes contextual, flexible, and student-centered learning. The results suggest practical implications, including the broader use of Musi Board media across other subjects and grade levels, and the need to prioritize teacher training in level-based instruction strategies like TaRL. However, the study has limitations, particularly its focus on a single school and the relatively short duration of the intervention. These constraints limit the generalizability of the findings. For future research, it is recommended to explore the long-term impacts of TaRL and Musi Board implementation, conduct comparative studies across diverse educational settings, and consider the development of digital or hybrid versions of Musi Board media to support blended and remote learning environments.

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