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The Effectiveness of Implementing the Teaching-at-the-Right-Level (TaRL) with Number-Board Media Improves Elementary Students' Integer Learning Outcomes

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ABSTRACT

Understanding the concept of Integers remains a significant challenge for many elementary school students, particularly in grasping the concept of place value. This study aims to evaluate the effectiveness of the Teaching at the Right Level (TaRL) approach, assisted by number board media, in improving the learning outcomes of fifth-grade students in Integer material. A quantitative method with a one-group pretest-posttest pre-experimental design was employed, involving 24 students from SDN Bantarkemang 6 selected through purposive sampling. Data were collected using a 10-item multiple-choice test administered before and after the intervention. The results show an increase in the average score from 68.33 (pretest) to 87.08 (posttest). The Wilcoxon Signed-Rank Test revealed a significance value of 0.001 ($p < 0.05$), indicating a statistically significant improvement. The N-Gain score of 0.6604 was classified as moderate, supporting the conclusion that the TaRL approach, combined with number board media, is effective in enhancing students' learning outcomes in Integers concepts.

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1. INTRODUCTION

Mathematics has long been recognized as a cornerstone of educational development, particularly at the primary level, where fundamental numeracy skills lay the groundwork for higher-order reasoning, scientific inquiry, and problem-solving across disciplines. Foundational competencies, such as integer comprehension and place value, are not only essential for understanding more advanced arithmetic but also serve as critical indicators of students' readiness to engage in abstract reasoning [1]. However, the process of internalizing these concepts—especially place value—poses persistent challenges for many learners.

Recent empirical studies conducted in Indonesia indicate that misconceptions about place value remain widespread among elementary students. For example, Unaenah et al. [2]

identified that students often fail to distinguish between the value and the position of digits within multi-digit numbers. Wafiqni and Putri [3] found that this confusion leads to systematic errors in mathematical operations. In local classroom observations at SDN Bantarkemang 6, it was found that Grade V students frequently misread numbers and showed difficulty in decomposing them into base-ten units. The results of observations made at SDN Bantarkemang 6 in class V in Mathematics showed that most students had difficulty understanding the concept of place value in numerical numbers. This difficulty can be seen when students are asked to determine the value of a number based on its position in a number, for example, distinguishing the value of the number 5 in the numbers 5,432 and 35,216. Many students still misunderstand that the position of a number determines its value, so they tend to answer based on the number itself without considering its location in units, tens, hundreds, thousands, or tens of thousands. In addition, some students appear to struggle with relating place value to the writing of the long form of numbers, which suggests a lack of conceptual understanding of number structure. The continued reliance on one-size-fits-all instructional methods, as highlighted by Novianto et al. [4], fails to address this cognitive diversity, leading to widening learning disparities [5], [6].

To overcome these challenges, this study proposes an integrated approach combining the Teaching at the Right Level (TaRL) methodology with number board media. TaRL, which organizes students by learning levels rather than by age or grade, aligns well with Vygotsky's Zone of Proximal Development, enabling tailored instruction within each learner's cognitive readiness [7]. Recent studies have shown the effectiveness of TaRL in enhancing student motivation and performance across various disciplines [8]–[10]. In parallel, number boards have demonstrated effectiveness in supporting concrete learning experiences in mathematics, allowing young learners to visualize numerical patterns and place values through physical interaction [15], [16].

Theoretically, this instructional model is supported by Bruner's stages of representation, which emphasize progression from enactive to iconic and, finally, symbolic understanding [8]. It also integrates principles of differentiated learning and constructivism, ensuring that instruction adapts to students' individual needs and readiness [17], [18]. Despite this theoretical promise, empirical research combining TaRL with concrete visual aids such as number boards in the Indonesian elementary context remains limited—a gap this study seeks to address.

Therefore, this study aims to assess the effectiveness of combining the TaRL approach with number board media in improving the understanding of Integers place value among Grade V students. This research is expected to make both theoretical contributions to integrating adaptive and visual pedagogies and practical implications for improving mathematics instruction in diverse, real-world classrooms.

2. METHOD

This study employed a one-group pretest-posttest design to investigate the effectiveness of the Teaching at the Right Level (TaRL) approach, assisted by number board media, in enhancing students' understanding of Integers place value. The absence of a control group is justified on practical and ethical grounds, given that random assignment of

elementary classes was not feasible due to administrative limitations and the need to maintain instructional continuity. Despite this, precautions were taken to ensure internal validity. The intervention was synchronized with the school's instructional schedule to mitigate history effects, conducted over a short period (three weeks) to minimize maturation, and employed alternate but equivalent forms of the test to reduce threats from test familiarity. [19]. The research was conducted by giving a pretest first before treatment, then giving a posttest after treatment, as Jaya & Laut said [20] that this method uses one group before treatment and after treatment, and if there is a difference before and after, the results will be used to see the effect of treatment. With this design, researchers can compare pretest and posttest scores to determine the significant effect of treatment. The design of this study is following the following table.

Table 1. One-Group Pretest-Posttest Design

Pretest	*Treatment*	*Posttest*
O_1	X	O_2

Description:

O_1 = Initial test score obtained before treatment

X = The treatment applied utilizes the TaRL approach, aided by number board media.

O_2 = Final test score obtained after treatment

The research was conducted in the even semester of the 2024/2025 school year at SDN Bantarkemang 6 Bogor City. The population of this study was all grade V students. The sample consisted of 24 fifth-grade students selected through a purposive sampling technique. The sample was selected using purposive sampling, focusing on a single fifth-grade class at SDN Bantarkemang 6. This class was selected based on its accessibility, teacher readiness, and representative academic profile. The previously used phrase "purposive random sampling" was corrected to clarify that while the selection was purposeful, it was not random. The selection aimed to ensure smooth coordination during the intervention and to reflect the typical instructional environment in public primary schools.

The instrumentation consisted of 15 multiple-choice items developed to measure students' conceptual understanding of Integers and place value. The test was designed following a blueprint that aligned items with national curriculum indicators and Bloom's taxonomy. To ensure validity and reliability, item analysis was conducted, yielding difficulty indices ranging from 0.30 to 0.70 and discrimination indices above 0.30, indicating moderate to high quality. The reliability of the instrument was confirmed using the Kuder-Richardson Formula 20 (KR-20), which yielded a coefficient of 0.81, indicating a high level of internal consistency.

Data analysis in this research was conducted using descriptive and inferential statistics. The first step involved descriptive statistics, which provided a summary of key data characteristics, such as the number of participants, maximum and minimum scores,

mean, and standard deviation. These statistics enabled the researcher to identify trends in students' learning outcomes before and after the treatment [21]. Before moving to inferential analysis, a normality test was conducted on pretest and posttest data using either the Kolmogorov-Smirnov or Shapiro-Wilk methods to determine whether the data followed a normal distribution. If normality was confirmed (significance value > 0.05), a paired sample t-test was applied to evaluate the significance of differences between the pretest and posttest results. If the data were non-normally distributed (significance value ≤ 0.05), the Wilcoxon Signed-Rank Test was used as a non-parametric alternative. All statistical analyses were performed using SPSS Version 30.0. The hypothesis proposed in this study is as follows:

H_a : The implementation of the TaRL approach, with the help of number board media, effectively improves student learning outcomes.

H_0 : The implementation of the TaRL approach, aided by number board media, is not effective in improving student learning outcomes.

Interpretation is carried out by comparing the significance value with the significance level of 0.05. If the significance value is < 0.05, it can be concluded that there is a significant difference between the pretest and posttest scores. Therefore, the alternative hypothesis (Ha) is accepted, and the null hypothesis (H0) is rejected. Conversely, if the significance value is ≥ 0.05, it indicates no significant difference, so H0 is accepted, and Ha is rejected [22].

The level of effectiveness of a treatment can be measured by calculating Normalised Gain (N-Gain). The N-Gain formula used is as follows [23]:

$$N - Gain = \frac{Posttest\ Score - Pretest\ Score}{Max\ Score - Pretest\ Score} \quad (1)$$

The criteria for the N-Gain value that can be used as a basis for making decisions or conclusions are as follows:

Table 2. Classification of N-Gain Values

Nilai N-Gain	Criteria
$g \geq 0{,}70$	High
$0{,}70 > g \geq 0{,}30$	Medium
$g < 0{,}30$	Low

3. RESULTS AND DISCUSSION

3.1. RESULTS

This research employs a pre-experimental design using a one-group pretest-posttest approach (initial test - single group final test) with one class, specifically class VA at SDN Bantarkemang 6, comprising a total of 24 students. This study employed two variables: the independent variable, which consisted of applying the TaRL approach using number board media (X), and the dependent variable, which represented learning outcomes (Y). Learning outcomes were obtained from pretest-posttest scores collected before and after applying the TaRL approach, which utilized the number board media. The pretest-posttest questions given

were 10 multiple-choice questions with four answer choices. The research commenced with the administration of a pretest designed to assess students' prior understanding before implementing the Teaching at the Right Level (TaRL) approach using number board media.

These findings suggest that the TaRL approach is effective in increasing student learning outcomes. A summary of the pretest and posttest results is presented in Table 3.

Table 3. Recapitulation of Pretest and Posttest Results

Tes	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	24	40	90	68.33	15.511
Posttest	24	70	100	87.08	10.417
Valid N (listwise)	24				

The median pretest score was 56, with an interquartile range (IQR) of 48–64, while the posttest median increased to 84 (IQR = 76–88). A Wilcoxon Signed-Rank Test was conducted, yielding a Z-value of -4.829 with a significance level of p = 0.000, indicating a statistically significant improvement in students' learning outcomes.

The effect size, calculated using Cohen's r, was 0.62, which falls into the large effect category. Additionally, the normalized gain (N-Gain) score was 0.66, classified as moderate.

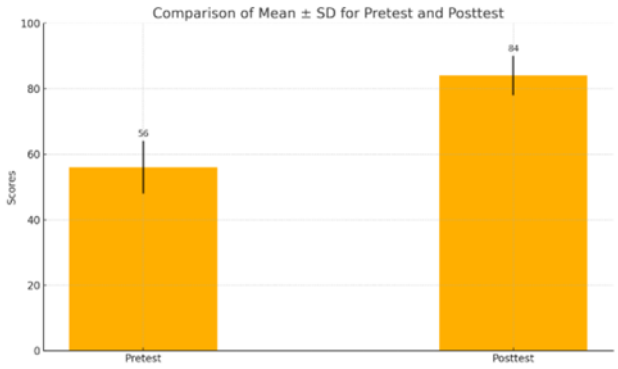

Figure 1. Comparison of mean ± standard deviation (SD) of pretest and posttest scores

Figure 1 illustrates a bar graph comparing the mean ± standard deviation (SD) of pretest and posttest scores, visually emphasizing the magnitude of learning improvement. Table 3 presents a summary of the pretest and posttest scores, clearly illustrating the comparison between students' initial and final abilities following the intervention. The pretest scores ranged from a minimum of 40 to a maximum of 90, whereas the posttest scores increased to a minimum of 70 and a maximum of 100. These findings demonstrate an improvement in learning outcomes after the implementation of the TaRL approach supported by number board media, suggesting that this approach can serve as an effective alternative instructional method.

The pretest and posttest scores were subsequently subjected to a normality test to assess whether the data were normally distributed. Conducting a normality test is a prerequisite step prior to hypothesis testing to ensure the validity of subsequent statistical analyses. In this study, the Shapiro-Wilk test was employed using SPSS version 30.0, as it

is suitable for testing normality in studies with small sample sizes. The results of the normality test for both pretest and posttest data are presented below.

Table 4. Pretest and Posttest Normality Test Results

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.149	24	.180	.931	24	.105
Posttest	.210	24	.008	.866	24	.004

a. Lilliefors Significance Correction

The median pretest score was 56, with an interquartile range (IQR) of 48–64, while the posttest median increased to 84 (IQR = 76–88). A Wilcoxon Signed-Rank Test was conducted, yielding a Z-value of -4.829 with a significance level of p = 0.000, indicating a statistically significant improvement in students' learning outcomes.

Table 4 displays the outcomes of the normality test conducted on the students' pretest and posttest scores. The pretest yielded a significance value of 0.105 (greater than 0.05), indicating that the pretest data followed a normal distribution. Conversely, the posttest produced a significance value below 0.05, suggesting that the posttest data did not meet the assumption of normality. Due to the non-normal distribution of the posttest data, hypothesis testing was performed using the Wilcoxon Signed-Rank Test, a non-parametric alternative to the paired sample t-test, which usually requires distributed data. The results of this Wilcoxon test are summarised in Table 5.

Table 5. Wilcoxon Signed-Rank Test Results

		Rank		
		N	Mean Rank	Sum of Ranks
Posttest - Pretest	Negative Ranks	0[a]	.00	.00
	Positive Ranks	24[b]	12.50	300.00
	Ties	0[c]		
	Total	24		

a. Posttest < pretest
b. Posttest > Pretest
c. Posttest = Pretest

Based on the data in Table 5, there are three categories of comparison results between pretest and posttest scores, namely negative ranks, positive ranks, and ties. Negative ranks totaled 0, indicating that no students experienced a decrease in learning outcomes. Positive ranks totaled 24, indicating that all students experienced an increase in learning outcomes after applying the TaRL approach with the aid of number board media. Meanwhile, ties are also 0, indicating that there are no students who get the same score on the pretest and posttest.

Table 6. Wilcoxon Signed-Rank Test Results

Test Statistics[a]	
	Posttest - Pretest
Z	-4.347[b]
Asymp. Sig. (2-tailed)	,001
a. Wilcoxon Signed Ranks Test	
b. Based on negative ranks.	

As presented in Table 6, the results of the Wilcoxon Signed-Rank Test revealed a significance value of 0.001. Since this value is less than 0.05 ($p < 0.05$), the alternative hypothesis (Ha) is accepted. This indicates a statistically significant difference between students' pretest and posttest scores following the implementation of the TaRL approach supported by number board media. These findings provide evidence that the TaRL approach is statistically effective in enhancing students' learning outcomes. This increase suggests that a learning approach tailored to students' initial abilities, supported by concrete media such as number boards, can create a more meaningful, targeted, and needs-based learning experience.

This study also analyzed the effectiveness of learning through the calculation of N-gain (Normalised Gain). The N-Gain calculation provides a more measurable picture of the effectiveness of the treatment given, in this case, the application of the Teaching at the Right Level (TaRL) approach with the help of number board media. The N-Gain value obtained is then categorized into a level of effectiveness, providing a strong basis for concluding the impact of the applied learning approach.

Table 7. N-Gain Value

	N	Minimum	Maximum	Mean	Std. Deviation
N_Gain	24	.33	1.00	.6604	.24101
Valid N (listwise)	24				

Table 7 presents the result of the N-Gain calculation, which is 0.6604. According to the N-Gain category interpretation outlined in Table 2, this average score falls within the moderate classification. Despite being categorized as moderate, the value indicates a substantial and meaningful improvement in students' learning outcomes. These findings suggest that the TaRL approach is effective not only in aligning instruction with students' initial ability levels but also in delivering a more targeted and impactful learning experience.

The findings of this study demonstrate that the implementation of the TaRL approach, supported by number board media, significantly enhances the learning outcomes of fifth-grade students on the topic of enumerated numbers. The average score increased from 68.33 on the pretest to 87.08 on the posttest. This improvement is further supported by the results of the Wilcoxon Signed-Rank Test, which yielded a significance value of 0.001 ($p < 0.05$), indicating a statistically significant difference between pretest and posttest scores. Additionally, the effectiveness analysis using the N-Gain formula yielded a score of 0.6604,

categorized as moderate, indicating that the TaRL approach is reasonably effective in enhancing student learning performance.

3.2. DISCUSSION

The significant improvement in students' understanding of Integers place value following the TaRL intervention supports the effectiveness of combining leveled instruction with concrete learning media. The use of number boards likely facilitated conceptual change by reducing cognitive load and enhancing the concreteness of abstract numerical concepts. This is consistent with constructivist learning theory, which emphasizes the value of hands-on learning experiences in building mental models.

This study is not without limitations. The sample size was relatively small and drawn from a single public elementary school, which limits the generalizability of findings. The intervention duration was short (three weeks), and the absence of a control group restricts strong causal inferences. Additionally, test-wiseness due to repeated assessments and the Hawthorne effect, where students may perform better simply because they know they are being observed, should be acknowledged as potential sources of bias. For future research, a more robust Randomised Controlled Trial (RCT) design is recommended to strengthen internal validity. Extending the duration of the intervention may allow for more stable learning gains. Moreover, incorporating qualitative methods, such as classroom observations and student interviews, would provide deeper insights into the learning mechanisms that operate during TaRL-based instruction.

The findings of this study reveal a substantial improvement in students' learning outcomes after the application of the Teaching at the Right Level (TaRL) approach supported by number board media. This improvement is indicated by an increase in the mean score from 68.33 on the pretest to 87.08 on the posttest. Statistically, the Wilcoxon Signed-Rank Test yielded a significance value of 0.001 ($p < 0.05$), suggesting that the difference between pretest and posttest scores is not due to chance but rather to the instructional treatment applied. Additionally, the Normalised Gain (N-Gain) score of 0.6604 places the effectiveness in the medium category, indicating that the instructional intervention had a measurable and meaningful impact on students' comprehension of Integers concepts.

These results affirm that the TaRL approach, which groups students according to their actual level of understanding rather than grade level, is effective in addressing the heterogeneity of learners in a classroom setting. By adapting instructional content to the student's zone of proximal development (as conceptualized by Vygotsky), the TaRL model ensures that students engage with material that is appropriately challenging and accessible. The fact that all 24 students demonstrated positive ranks in the Wilcoxon test further validates the universal benefit of this intervention across a diverse group of learners, with no student performing worse or stagnant after the intervention.

The implementation process also integrated number board media, which played a vital role in helping students internalize place value by providing concrete visualizations. The visual and interactive nature of this media supports Bruner's iconic and enactive stages of representation, where learners first understand concepts through tangible means before abstracting them into symbolic mathematical language. According to Ni'mah et al. (2024),

such media is particularly effective for elementary-level learners whose cognitive development still relies heavily on visual and kinesthetic input. In this study, the use of number boards enabled students to actively manipulate number values and engage in pattern recognition, number expansion, and position comparison—key cognitive operations essential for understanding Integers.

The analysis also showed that the standard deviation of the posttest scores (10.417) was lower than that of the pretest (15.511), suggesting a reduction in score variability among students. This implies that the TaRL approach not only improved average performance but also helped narrow the achievement gap between high and low performers, reinforcing its inclusivity. In practical terms, previously underperforming students could catch up with their peers through level-specific learning modules, while higher-achieving students were challenged appropriately.

These outcomes align with previous studies by Khatimah and Kasmiati (2024), who reported significant improvements in learning outcomes after implementing TaRL in elementary schools. Similarly, Ferani and Anwar (2024) confirmed the utility of number board media in improving understanding of place value concepts. However, the novelty of this study lies in the integration of these two components—differentiated instruction and supportive media—into a cohesive instructional model targeting a specific mathematical concept (Integers). This synergy maximizes the strength of each component: TaRL provides personalization, while number board media provides visualization.

The effectiveness of the approach also stems from its ability to foster active learning and student autonomy. During implementation, students were encouraged to collaborate in groups, work through number puzzles using the board, and engage in discussions tailored to their ability level. This aligns with the constructivist paradigm, in which learning is seen as an active, contextualized process of building knowledge rather than passively receiving it. Furthermore, the structured process of diagnosis, grouping, instruction, and assessment under the TaRL framework ensured that students remained within their optimal learning zone. This structure made the learning process predictable and measurable, allowing teachers to monitor progress and adjust instruction accordingly. The process model is replicable and scalable, making it a valuable pedagogical framework for other classrooms facing similar challenges in mathematics education.

The findings of this study are consistent with those of Harahap et al. [24], who suggest that the TaRL approach enhances student learning outcomes by aligning instruction with students' characteristics and initial abilities. This approach fosters independent learning and reduces pressure during the learning process. By grouping students based on their actual ability levels, the TaRL approach ensures that the material delivered is more accessible and relevant to learners. This fosters an inclusive learning environment where every student is allowed to develop without feeling left behind by their peers. Additionally, the TaRL approach encourages students to be more active in the learning process, as activities are tailored to their individual needs and abilities. This is in line with the opinion of 'Adawiyyah et al. [25] that the application of this TaRL approach in learning will make students active because they feel they get ample opportunities to explore their understanding in every

learning activity. This activeness not only increases student participation in class but also has a direct impact on concept understanding and overall learning outcomes.

The role of learning media is also an important aspect in supporting the successful implementation of the TaRL approach. This media helps to concretize abstract concepts, making it easier for elementary school students to understand. In this study, the medium of the counting number board was proven to help students understand the material in a more concrete and structured manner. The same results were also obtained by research conducted by Ferani and Anwar, which showed that the use of the Numbers Board media can improve student learning outcomes in class VB SD Negeri 244 Palembang [26]. This medium is very helpful for students to develop the concept of place value of numerical numbers [15]. Visualization of numbers through the number board allows students to more easily identify place value and number patterns, thereby accelerating the understanding process according to their ability level. This finding suggests that collaboration between an approach tailored to students' abilities and the use of suitable media can lead to more effective and meaningful learning.

The findings of this study imply that teachers should consider implementing differentiated instructional approaches, such as TaRL, particularly when teaching in heterogeneous classrooms. Additionally, the use of concrete media, such as number boards, is also highly recommended, especially when teaching abstract material. This approach can be an alternative learning strategy that is not only effective but also inclusive, as it accommodates the diverse learning needs of students.

In conclusion, this discussion highlights that integrating TaRL with number board media yields a statistically significant and pedagogically sound impact on students' understanding of Integers concepts. It enhances not only cognitive achievement but also motivation, confidence, and participation—elements that are often overlooked in conventional mathematics instruction. This instructional model is particularly relevant in diverse learning environments where student needs vary widely, and it provides a research-informed, practical solution to one of the foundational challenges in early mathematics education.

4. CONCLUSION

The integration of the Teaching at the Right Level (TaRL) approach with number board media in this study presents a promising instructional strategy for addressing learning diversity in elementary mathematics. This model supports differentiated instruction by tailoring content to students' actual proficiency levels, while the use of visual media helps bridge abstract mathematical concepts with concrete understanding. The implications of these findings are significant for classroom practice: teachers should consider flexible grouping based on diagnostic assessments and utilize interactive, low-cost learning aids, such as number boards, to enhance engagement and conceptual mastery.

Despite its promising outcomes, this study has several limitations. The research was conducted in a single school with a small sample size and focused solely on the topic of Integers, limiting its generalizability. Future research should examine the application of this integrated model in broader mathematical content areas and across diverse school contexts.

Moreover, studies on long-term impacts, including the development of student confidence and metacognitive skills, are needed. In practical terms, this study contributes a replicable framework that promotes equity and accessibility in mathematics education, offering tangible value to teachers, school leaders, and the wider educational community.

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