# The Impact of Integrating the Wordwall Website in Student-Centered Learning on Numeracy Problem-Solving Skills in Elementary Schools

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***Abstract*—The low numeracy problem-solving ability among elementary school students has become a major concern in Indonesia's education system. This ability includes skills in analyzing, formulating, and finding solutions to problems related to fundamental mathematical concepts. This study aims to examine the impact of integrating the WordWall website into the Student-Centered Learning approach on numeracy problem-solving skills in elementary schools. The research context stems from the need to actively and collaboratively enhance students' numerical skills, considering the high demands for mathematical literacy in the 21st century. This study employs a quasi-experimental design involving 60 fifth-grade students, divided into control and experimental groups. The experimental group was subjected to learning with WordWall integration, while the control group used conventional methods. Data collection was conducted through pre-tests and post-tests to assess numeracy problem-solving abilities. The analysis results indicate a significant increase in average scores in the experimental group compared to the control group ($p < 0.05$), with a percentage increase of 30% from pre-test to post-test. Additionally, the achievement of learning objectives is reflected in the high level of student participation during the learning process, as evidenced by positive feedback and increased learning motivation. The uniqueness of this study lies in the utilization of WordWall as an interactive web-based media specifically designed to support student-centered learning, differing from most previous studies that examine the use of digital tools in general. Thus, the findings of this study conclude that integrating WordWall into the Student-Centered Learning approach effectively enhances numeracy problem-solving skills, while also strengthening learning motivation and the achievement of learning objectives in elementary schools.**

***Keyword*—WordWall website, student-centered learning, numeracy problem-solving, elementary school, interactive learning**

## I. Introduction

The low numeracy problem-solving skills among elementary school students have become a major concern in the Indonesian education sector [1–3]. This competency encompasses the skills of analyzing, formulating, and seeking solutions to problems related to fundamental mathematical concepts. Several national assessment results indicate that many students struggle to apply conceptual understanding when confronted with problemss that require higher-order reasoning.

Data from the Programme for International Student Assessment (PISA) 2022 indicates that Indonesia still ranks relatively low in mathematical literacy [4, 5]. Indonesian students are generally capable of solving routine problems but lack sufficient resilience when faced with tasks that require more complex problem-solving. This finding is further supported by the National Numeracy Survey, which discovered that more than 60% of elementary school students have not yet achieved the basic competencies in mathematical reasoning [6–9], thereby leading to difficulties in understanding important concepts, such as numbers and arithmetic operations.

Based on observations in several schools, field issues become apparent when the teaching and learning process remains predominantly teacher-centered. This model inadequately facilitates students' active engagement and expression of their thoughts in problem-solving. Consequently, students' motivation and participation in mathematics learning tend to be low, thereby impacting the achievement of numeracy problem-solving competencies. This condition demands improvements in educational quality that emphasize active and interactive learning, particularly in the field of numeracy. If this situation is not adequately addressed, weaknesses in basic competencies at the elementary school level will affect learning outcomes in subsequent levels. Therefore, innovative strategies are required to encourage student involvement, facilitate conceptual understanding, and foster critical and creative thinking skills.

This study is grounded in constructivist theory, which emphasizes that students should construct knowledge through processes of exploration and social interaction. Vygotsky highlights the importance of scaffolding and collaboration in facilitating students' cognitive development [10–12], while Piaget emphasizes that learning should be tailored to the cognitive developmental stages of children [13–15]. he Student-Centered Learning approach emerges from the notion that students need to be the primary subjects in the learning process. The interactive WordWall website can further optimize students' roles in exploring various digital activities to enhance numeracy skills.

Several previous studies have demonstrated that the utilization of technology in mathematics education can have positive effects on learning outcomes and student engagement. Some researchers have found that the use of interactive digital media can increase understanding of mathematical concepts by up to 25% [16–18]. Student participation levels increase when teachers apply the Student-Centered Learning approach based on group

activities [19–23]. However, research that specifically integrates the WordWall platform with Student-Centered Learning strategies to improve numeracy problem-solving skills among elementary school students remains limited, thereby necessitating further studies to strengthen empirical evidence in this field.

Initial data obtained from an elementary school in Bima Regency, West Nusa Tenggara Province in 2023 (Table 1) indicate that the average numeracy problem-solving scores of students in classes VA, VB, and VC are in the range of 58–62, below the established Minimum Mastery Criteria of 70. These findings highlight a gap between curriculum expectations and the actual numeracy achievement in the field.

Table 1. Average numeracy problem-solving scores of elementary school students

| Class | Number of Students | Average Score |
|---|---|---|
| VA | 28 | 62 |
| VB | 30 | 58 |
| VC | 27 | 60 |
| Overall Averag | 85 | 60 |

In this context, the Student-Centered Learning approach becomes relevant. Through Student-Centered Learning, students are given the opportunity to think critically, design problem-solving strategies, and collaborate with their classmates. The integration of the WordWall website adds an interactive dimension and can enhance learning motivation, as activities on this platform are varied and engage students' interest. Consequently, students not only receive knowledge passively but also actively participate in the learning process.

This study aims to: (1) Analyze the impact of integrating the WordWall website into Student-Centered Learning on numeracy problem-solving skills in elementary schools; (2) Explain the differences in numerical competency achievements between groups of students using Student-Centered Learning assisted by WordWall and those using conventional methods; (3) Identify the supporting and hindering factors in the implementation of WordWall in facilitating interactive numeracy learning

Based on these objectives, the research problems can be formulated as follows: (1) To what extent does the integration of the WordWall website into the Student-Centered Learning approach enhance numeracy problem-solving skills among elementary school students?; (2) Is there a significant difference in numeracy score achievements between the experimental group and the control group?; (3) What factors influence the successful implementation of WordWall in the classroom?

Overall, this study is expected to contribute to the enhancement of educational quality, particularly in Mathematics subjects at the elementary school level. The findings obtained will serve as a reference for teachers, schools, and policymakers to develop innovative technology-based learning strategies. By integrating the Student-Centered Learning approach with the WordWall platform, students are anticipated to become more motivated, active, and creative in solving numeracy problems, thereby significantly elevating the quality of mathematics education in Indonesia.

## II. Methodology

### A. Research Design

This study employs a quantitative design with a quasi-experimental approach [24–27]. This design was chosen because the researcher aims to determine the effect of implementing a specific teaching method—in this case, the integration of the WordWall website into Student-Centered Learning—on the improvement of numeracy problem-solving skills. Two class groups, namely the experimental group and the control group, were established to compare their learning outcomes before and after the treatment.

### B. Subjects/Participants of the Study

The subjects of this study are fifth-grade students at an elementary school (SD) in Bima Regency, West Nusa Tenggara Province, Indonesia. A total of 60 students participated, divided into two parallel classes, each consisting of 30 students. The criteria for selecting participants were (1) students had previously received basic Mathematics instruction, (2) relatively homogeneous age (10–11 years), and (3) no significant differences in initial academic ability characteristics based on report card scores. The experimental class received instruction integrating the WordWall website within the Student-Centered Learning approach, while the control class received instruction using conventional methods.

### C. Research Instruments

The primary instruments in this study consist of the Numeracy Problem-Solving Ability Questionnaire and the Learning Activity Observation Sheet. The questionnaire is designed to measure the extent to which students are capable of understanding and solving numeracy problems that require high-level reasoning. The observation sheet is used to record students' behaviors and the implementation of learning activities using the Student-Centered Learning approach integrated with the WordWall website. The numeracy problem solving ability instrument can be seen in Table 2 as follows:

Table 2. Numeracy problem-solving ability instrument

| Aspect/Indicator | Question No. | Number of Items | Cognitive Level (Bloom) | Score Weight per Item |
|---|---|---|---|---|
| Understanding Basic Concepts | 1–3 | 3 | C1/C2 | 1 |
| Using Selected Strategies in Numeracy | 4–7 | 4 | C3/C4 | 2 |
| Interpreting Data/Information | 8–10 | 3 | C4 | 2 |
| Developing Mathematical Models | 11–13 | 3 | C4/C5 | 3 |
| Drawing Conclusions & Evaluating Strategies | 14–15 | 2 | C5/C6 | 3 |
| **Total** | **1–15** | **15** | — | — |

The determination of aspects/indicators in the table above refers to Bloom's taxonomy, which has been adapted for Mathematics learning at the elementary school level. Each

aspect is designed to explore students' abilities at different stages, ranging from understanding basic concepts to drawing conclusions from the numeracy problem-solving process. Additionally, the questionnaire is supported by (1) content validity tested by Mathematics Education experts, and (2) reliability assessed using Cronbach's alpha. The initial trial results indicate that the instrument has a reliability coefficient of 0.78, which is categorized as sufficiently high for educational research.

### D. Research Procedure

#### 1) Class arrangement

- Experimental Class: Implemented instruction by integrating the WordWall website into the Student-Centered Learning approach. The teacher acted as a facilitator, guiding and providing directions during the initial stages, after which students collaborated, discussed, and conducted independent explorations through various activities on the WordWall platfor.
- Control Class: Implemented conventional instruction using lecture methods and textbook exercises without the integration of interactive media.

#### 2) Stages of integrating the WordWall website into student-centered learning

- Preparation Stage: The teacher selects numeracy material relevant to the fifth-grade curriculum, sets up a WordWall account, and prepares content (quizzes, puzzles, and other interactive activities).
- Problem Presentation Stage: The teacher begins the class with a contextual scenario or problem related to the numerical topic. Students are encouraged to identify the issues and consider possible problem-solving strategies.
- Collaborative Exploration Stage: Students are divided into small groups and access WordWall to engage in various prepared activities. They discuss, ask questions, and help each other. At this stage, the teacher provides minimal guidance (scaffolding) when students encounter difficulties.
- Presentation and Discussion Stage: Student groups present their findings and the strategies they used. The class discussion focuses on the thought processes and alternative solutions to numerical problem.
- Reflection and Evaluation Stage: Teachers and students collaboratively reflect on the learning that has taken place, including discussing the challenges faced, lessons learned, and the connection between activities on WordWall and the mastery of numeracy material.

#### 3) Data collection

- Pre-test: The Numeracy Problem-Solving Ability Questionnaire was administered at the beginning of the session to assess students' initial abilities.
- Treatment: The experimental group received instruction integrating the WordWall website within the Student-Centered Learning approach, while the control group continued using conventional teaching methods.
- Post-test: The questionnaire was administered again at the end of the learning session to measure the extent of improvement in numeracy problem-solving skills.
- Observation: The researcher and an observer recorded the levels of engagement, collaboration, and the dynamics of student discussions during the learning process (only in the experimental class).

### E. Data Analysis

#### 1) Descriptive statistical tests

The results of the pre-test and post-test were analyzed descriptively to examine the mean values, standard deviations, and data distributions in both groups. Additionally, the percentage increase in scores was calculated to determine the effectiveness of the treatment.

#### 2) Prerequisite tests

- Normality Test: Utilizing the Kolmogorov–Smirnov or Shapiro–Wilk test to ensure that the data is normally distributed.
- Homogeneity Test: Utilizing Levene's Test to assess the equality of variances between both groups.

#### 3) Hypothesis testing (t-test)

- Independent t-test: If the data is normally distributed and variances are homogeneous, an independent t-test is conducted on the gain scores (the difference between pre-test and post-test scores) to determine whether there is a significant difference between the experimental and control groups.
- Significance Level: The significance level is set at $\alpha = 0.05$. If $p < 0.05$, it is concluded that there is a statistically significant difference between the two groups.

#### 4) Qualitative analysis (observation and observation sheets)

Descriptive–Qualitative Analysis: Observational data on student engagement and the implementation of learning activities were analyzed descriptively and qualitatively to complement the quantitative findings. The results of the observations provide information on how the Student-Centered Learning process supported by WordWall influences student motivation, cooperation, and understanding of the material.

## III. Results and Discussion

### A. Results

#### 1) Quantitative test results (pre-test and post-test)

This study focuses on the enhancement of numeracy problem-solving skills among elementary school students through the integration of the WordWall website within the Student-Centered Learning approach. Presented below are the pre-test and post-test results for both groups, namely the experimental group (which received the treatment) and the control group (which did not use WordWall). The pretest and posttest results can be seen in Table 3 as follows:

Based on Table 3, there was a notable increase in the average scores of the experimental group, from 60.20 (pre-test) to 78.80 (post-test). In contrast, the control group improved from 59.80 to 70.10. The t-test on the gain scores revealed a significance value ($p$) = 0.000 (< 0.05), thereby concluding that there is a significant difference between the group using WordWall with the Student-Centered Learning approach and the conventional method.

In Fig. 1 above, it is clear that the increase in scores for the experimental group (using WordWall) is more substantial

compared to the control group. The average numbers above each bar can be added for clarity (e.g., 60.2 for the experimental pre-test, 78.8 for the experimental post-test, 59.8 for the control pre-test, and 70.1 for the control post-test). These results indicate that the intervention given to the experimental group has a positive impact on students' numerical problem-solving skills.

Table 3. Pre-test and post-test results of numeracy problem-solving ability

| Group | Number of Students | Pre-test Average Score | Pre-test SD | Post-test Average Score | Post-test SD | Sig. Value (p) |
|---|---|---|---|---|---|---|
| Experimental (WordWall) | 30 | 60.2 | 5.45 | 78.8 | 6.12 | 0 |
| Control (Conventional) | 30 | 59.8 | 5.37 | 70.1 | 5.83 | — |

Notes:
*SD* = Standard Deviation
t-test was conducted on the difference (gain score) between the Pre-test and Post-test.
$p < 0.05$ indicates a statistically significant difference.

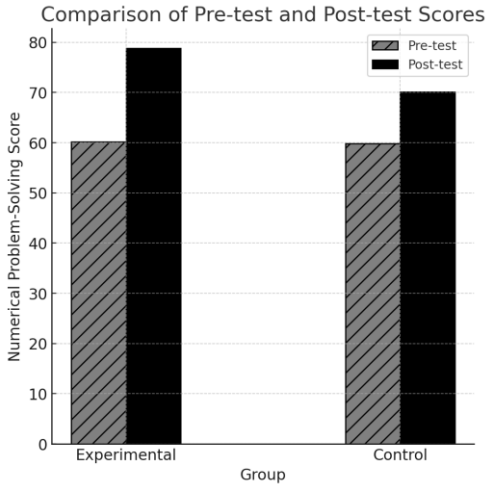


Fig. 1. Comparison of mean scores of pre-test and post-test.

*2) Qualitative analysis of observations and interviews*

In addition to quantitative data, the researcher also conducted observations during the learning process and interviewed several students and teachers to obtain a more comprehensive understanding.

*a) Observation of the learning process in the experimental class*

- During the WordWall integration sessions, most students appeared enthusiastic and actively engaged in discussions with their group members. They frequently attempted various alternative strategies when facing numeracy challenges. The teacher provided scaffolding only when the groups genuinely encountered obstacles.

*b) Student interview quotes*

- "I became more enthusiastic about studying Mathematics because I could play quizzes on WordWall. It's fun, and we can immediately see our scores." (Interview with Student A, Experimental Class).
- "When there is a difficult question, we immediately discuss it with our group, then try similar questions on WordWall." (Interview with Student B, Experimental Class)

*c) Teacher interview quotes*

- "Previously, the children tended to be passive. After WordWall was introduced, they became more motivated because its format is like a game. As a result, they became more diligent and no longer fear mathematics problems." *(Interview with Fifth Grade Teacher)*

From the aforementioned quotes, it can be concluded that the use of WordWall facilitates students in learning collaboratively and interactively, in alignment with the principles of Student-Centered Learning. Students not only listen to the teacher's explanations but also actively engage in solving numerical problems through various educational games on the platform.

*3) Supporting and hindering factors*

Supporting Factors: (1) Adequate internet access and devices, (2) Support from teachers skilled in utilizing technology, (3) High student interest in interactive media, and (4) Mathematics material that can be easily accommodated in the WordWall format.

PenghambaHindering Factors: (1) The time required for teachers to prepare WordWall activities is quite long, (2) The need for training for teachers who are still unfamiliar with digital platforms, and, (3) Potential technical disruptions (e.g., unstable internet connections).

*4) Implications and summary of findings*

The quantitative test results confirm that the integration of WordWall into Student-Centered Learning has a significant impact on improving numeracy problem-solving skills. Qualitative analysis through observations and interviews further reinforces these findings, where students exhibit higher learning motivation, a more dynamic discussion atmosphere, and enhanced critical thinking abilities. Thus, it can be concluded that the intervention of using WordWall within the student-centered learning model not only improves numeracy learning outcomes but also strengthens a collaborative and interactive learning culture in the classroom. These findings serve as a foundation for developing similar learning innovations in the future, both in Mathematics and other fields of study.

*B. Discussion*

The results of this study confirm that the integration of the WordWall website into the Student-Centered Learning approach significantly enhances elementary school students' numeracy problem-solving skills. These findings align with constructivist theory, which emphasizes the active role of students in constructing knowledge through exploration and social interaction [28–31]. By utilizing WordWall, students not only practice solving numeracy problems but also engage in collaborative discussions and receive immediate feedback from the digital platform. These results support the notion that technology can have a positive effect when integrated with learning strategies that position students as the primary subjects of the learning process.

Specifically, the implementation of Student-Centered Learning is supported by the principle of scaffolding, where the teacher acts as a facilitator providing minimal yet focused

guidance. This encourages students to actively construct understanding and independently find solutions. Previous studies have reported that also highlight that student-centered approaches have the potential to develop critical thinking skills and learning motivation [32–34]. In the context of this study, the integration of WordWall adds an interactive dimension that promotes participation and fosters meaningful discussions among students. The relationship between the obtained results and the underlying theory, as well as previous studies, indicates that the use of digital media in education is effective when designed to empower students, rather than merely presenting material passively.

Other research results also concluded that the use of educational games and interactive quizzes can increase student engagement and academic achievement [35, 36]. However, the studies by Amaliyah & Rahayu; Fitria stated that the success of utilizing technology is not solely determined by the presence of digital platforms but rather by how the learning approach is designed [37, 38]. This study demonstrates that combining WordWall with Student-Centered Learning successfully engages students in more intensive exploration and discussion processes. Thus, the findings confirm that technology has an optimal impact when facilitated by skilled teachers who integrate digital activities with student-centered learning strategies.

In educational practice, these findings have several important implications. First, teachers can utilize WordWall or similar media to enrich the mathematics learning process, particularly in developing numeracy problem-solving skills. Second, educational institutions need to provide adequate training for teachers so they can design creative and contextual learning activities through technology. Third, infrastructure support, such as internet access and supporting devices, plays a crucial role in implementing digital platforms. If these factors are fulfilled, the Student-Centered Learning approach assisted by WordWall has been proven to enhance student motivation, classroom participation, and understanding of numerical concepts.

Nevertheless, this study has several limitations. The data collection process was conducted over a relatively short period, thus not reflecting the long-term sustainability of using WordWall. Additionally, the sample size was limited to one school in a specific region, so generalizing the findings to broader educational contexts requires further investigation. This study also focused solely on one topic, namely numeracy problem-solving; further exploration could include a variety of other learning materials to examine whether similar positive effects also emerge in other subjects.

Overall, the results of this study confirm that the implementation of digital media based on educational games, such as WordWall, when grounded in the Student-Centered Learning approach, encourages students to become more active, creative, and critical. Students not only practice solving routine problems but also develop conceptual understanding and more complex problem-solving strategies. Thus, these findings are expected to serve as a reference for educators, researchers, and policymakers in efforts to improve the quality of mathematics learning in elementary schools while preparing a skilled younger generation to face future challenges.

## IV. Conclusion

This study successfully demonstrated that the integration of the WordWall website into the Student-Centered Learning approach significantly enhances elementary school students' numeracy problem-solving skills. The pre-test and post-test results obtained from the experimental group using WordWall showed a higher score improvement compared to the control group applying conventional methods. These findings support constructivist theory, which emphasizes the active role of students in the learning process, and illustrate that interactive digital media can be an effective tool in facilitating more dynamic and participatory learning.

The success of this method is not limited to improving numeracy learning outcomes but also includes enhancing students' motivation and engagement in the learning process. Students involved in WordWall-based learning demonstrated higher enthusiasm, better collaboration, and more developed critical and creative thinking skills. This indicates that integrating technology with the Student-Centered Learning approach can create a more conducive learning environment for the development of deeper numeracy skills.

Based on these findings, it is recommended that teachers adopt the use of WordWall or other interactive digital media in the mathematics learning process. Specialized training on how to effectively utilize this technology and integrate it with the Student-Centered Learning strategy is highly encouraged to maximize the potential of this tool in improving student learning outcomes. Additionally, schools need to provide adequate technological infrastructure, including stable internet access and supporting devices such as computers or tablets for students. Administrative support in the form of allocated time and resources for teacher training is also crucial to ensure successful implementation.

For future researchers, this study opens opportunities to explore the effectiveness of integrating WordWall in other educational levels, such as Junior High School or Senior High School, as well as in various subjects beyond mathematics. Further research could also consider employing a mixed-methods approach to gain a deeper understanding of the impact of technology in learning.

Overall, this study provides a significant contribution to efforts in improving numeracy problem-solving skills at the elementary school level by introducing an innovative and technology-based learning method. By combining the Student-Centered Learning approach with interactive digital media such as WordWall, it is expected that the quality of mathematics learning can be significantly enhanced, preparing students to face increasingly complex academic and everyday challenges. These findings are expected to serve as a reference for educators, curriculum developers, and policymakers in efforts to improve the quality of education in the digital era.

## Conflict of Interest

The authors declare no conflict of interest

## Author Contributions

Adi Apriadi Adiansha was the main contributor in this study, responsible for designing the research framework, developing research instruments, and drafting the manuscript.

Syarifuddin contributed to the formulation of the research methodology and assisted in data analysis. Syarifudin focused on conducting the literature review and validating the research instruments. Nanang Diana supported the implementation of the study in the field and helped collect the data. Asriyadin contributed to data processing and played a key role in revising and editing the final manuscript. All authors had approved the final version.

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