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The Effect of the Pair Check Cooperative Learning Model Assisted by Wordwall on the Mathematics Learning Outcomes

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ABSTRACT

Mathematics is a fundamental subject in elementary education because it develops students' logical reasoning, problem-solving skills, and conceptual understanding. However, many elementary students continue to experience difficulties in learning mathematics due to teacher-centered instructional practices, limited student interaction, and insufficient use of innovative learning media. These conditions often result in low learning outcomes, particularly in understanding the concepts of the area and perimeter of plane figures. Therefore, effective instructional strategies that promote active learning and meaningful student engagement are needed. This study aimed to examine the effect of the Pair Check Cooperative Learning Model assisted by Wordwall media on the mathematics learning outcomes of Grade V students at UPT SD Negeri 018 Aeklung, Humbang Hasundutan Regency, during the 2025/2026 academic year. This research employed a quantitative approach using a pre-experimental one-group pre-test–post-test design. The participants consisted of 27 Grade V students selected through total sampling. Data were collected using mathematics achievement tests and a student response questionnaire. The collected data were analyzed using descriptive statistics, normality testing, Pearson Product–Moment correlation, coefficient of determination, and t-test analysis. The findings revealed that students' mean score increased from 61.30 on the pre-test to 73.63 on the post-test, indicating improved mathematics achievement after the intervention. Statistical analyses also demonstrated a significant positive effect of the Pair Check Cooperative Learning Model assisted by Wordwall media on students' mathematics learning outcomes. The study concludes that integrating cooperative learning with interactive digital media creates an engaging learning environment that enhances conceptual understanding, active participation, collaboration, and mathematics achievement among elementary school students.

Introduction

Education is a deliberate and systematic process designed to facilitate learning experiences that enable students to develop their cognitive, affective, and psychomotor competencies. Through education, learners are expected to build responsible character, acquire essential life skills, and contribute positively to society. Consequently, education

plays a fundamental role in improving the quality of human resources and supporting sustainable national development. In Indonesia, Law Number 20 of 2003 concerning the National Education System emphasizes that education aims to develop learners' potential so that they become individuals who are faithful, knowledgeable, creative, independent, democratic, and responsible citizens. Therefore, elementary education serves as the foundation for students' academic, social, and personal development, making it a critical stage for cultivating essential knowledge, attitudes, and lifelong learning habits (Aminulloh & Abidatillah, 2024; Sunedi et al., 2023).

Mathematics is one of the core subjects in elementary education because it develops logical reasoning, problem-solving ability, critical thinking, and decision-making skills that are required in both academic and everyday contexts. Mathematics is concerned with numbers, patterns, structures, relationships, and quantitative reasoning, enabling learners to understand abstract concepts and apply them in real-life situations. According to Sunedi et al. (2023), mathematics is a scientific discipline that focuses on numerical reasoning, patterns, structures, and logical thinking while serving as the foundation for various scientific and technological developments. Consequently, mathematics learning should not only emphasize procedural knowledge but also promote conceptual understanding and higher-order thinking skills.

Students in upper elementary grades possess developmental characteristics that make collaborative learning particularly appropriate. Havighurst (as cited in Hayati et al., 2021) explains that learners at this stage demonstrate greater independence, responsibility, and social maturity. They are capable of organizing their learning activities, completing assigned tasks responsibly, and interacting constructively with peers through cooperative activities. These characteristics indicate that instructional approaches emphasizing collaboration, communication, and shared responsibility are likely to improve students' engagement and learning outcomes.

Despite the importance of mathematics, many elementary school students continue to perceive the subject as difficult because of its abstract nature and the predominance of teacher-centered instructional practices. Previous studies have reported that students often memorize formulas without fully understanding the underlying mathematical concepts, resulting in difficulties when solving problems that require conceptual reasoning or the application of knowledge in different contexts (Aminulloh & Abidatillah, 2024; Sunedi et al., 2023). Furthermore, mathematics instruction frequently relies on individual assignments with limited opportunities for discussion, peer interaction, or collaborative problem-solving. Such learning environments reduce student participation, limit meaningful classroom interaction, and ultimately contribute to unsatisfactory learning outcomes. These findings indicate the necessity of implementing instructional models that actively engage students in constructing mathematical understanding through collaboration and meaningful learning experiences.

Preliminary classroom observations conducted by the researcher in collaboration with the Grade V classroom teacher at UPT SD Negeri 018 Aeklung, Humbang Hasundutan Regency, revealed several instructional problems in mathematics learning. Classroom instruction was predominantly teacher-centered, where students listened to explanations,

completed individual exercises, and relied almost exclusively on textbooks without participating in collaborative discussions or interactive learning activities. As a result, many students demonstrated limited conceptual understanding, low enthusiasm, and reduced motivation during mathematics lessons. These instructional conditions were reflected in students' academic achievement, which remained below the Minimum Learning Achievement Criteria (KKTP).

The results of the daily mathematics assessment further confirmed these conditions. Among the 27 Grade V students, only two students (7.4%) achieved scores between 81 and 100, categorized as "Highly Developed," while three students (11.1%) scored between 61 and 80 ("Developed"). Eight students (29.6%) obtained scores ranging from 41 to 60 ("Fairly Developed"), twelve students (44.4%) scored between 21 and 40 ("Less Developed"), and two students (7.4%) obtained scores between 0 and 20, indicating that they required substantial remediation. Overall, more than half of the students failed to achieve satisfactory learning outcomes, demonstrating that improvements in instructional strategies are urgently needed to enhance students' mathematical understanding and academic performance.

One instructional approach that has the potential to address these challenges is the Cooperative Learning Model of the Pair Check type. Pair Check is a cooperative learning strategy in which students work in pairs to solve problems, exchange ideas, verify each other's answers, and provide constructive feedback throughout the learning process. According to Indrawan et al. (2024), Pair Check encourages active student participation by emphasizing collaborative problem-solving, peer assessment, and shared responsibility for learning outcomes. Through mutual checking and discussion, students develop deeper conceptual understanding, improve communication skills, strengthen teamwork, and enhance critical thinking abilities. These characteristics make Pair Check particularly suitable for mathematics learning, where conceptual reasoning and collaborative problem-solving are essential.

In addition to selecting an appropriate instructional model, integrating effective learning media is equally important to facilitate students' conceptual understanding and classroom engagement. One increasingly popular digital learning platform is Wordwall, an interactive educational application that enables teachers to design quizzes, matching activities, games, and formative assessments. Wordwall presents mathematical concepts through attractive visual and interactive formats that encourage active student participation and provide immediate feedback during learning activities. Fitri & Ninawati, (2021) reported that Wordwall effectively supports classroom assessment while simultaneously increasing students' motivation, participation, and learning interest. Consequently, integrating Wordwall with cooperative learning activities may create a more engaging and meaningful mathematics learning environment.

Several empirical studies have demonstrated the effectiveness of Pair Check and Wordwall in improving mathematics achievement. Desi (2025) found that the Cooperative Learning Model of the Pair Check type assisted by Wordwall significantly improved fourth-grade students' mathematics achievement on the topic of area and perimeter at UPTD SD Negeri 62 Parepare. Similarly, Hikmah (2025) reported that the Pair Check learning model

significantly enhanced mathematics learning outcomes among fourth-grade students at SD Inpres 6/75 Manurunge, Bone Regency. These studies consistently indicate that collaborative learning combined with interactive digital media can positively influence students' mathematical achievement. Nevertheless, most previous studies were conducted with fourth-grade students, involved different school contexts, and rarely investigated the effectiveness of Pair Check integrated with Wordwall for Grade V students in rural elementary schools. Consequently, empirical evidence regarding the effectiveness of this instructional combination in the context of UPT SD Negeri 018 Aeklung remains limited.

Based on the foregoing review, the present study addresses this research gap by investigating the effect of the Cooperative Learning Model of the Pair Check type assisted by Wordwall media on Grade V students' mathematics learning outcomes. The novelty of this study lies in integrating a collaborative learning strategy with interactive digital media within the implementation of Indonesia's elementary mathematics curriculum in a rural public elementary school. This combination is expected to foster greater student engagement, improve conceptual understanding, strengthen collaborative learning skills, and ultimately enhance mathematics achievement.

Accordingly, the research problem addressed in this study is: Does the Cooperative Learning Model of the Pair Check type assisted by Wordwall media significantly affect the mathematics learning outcomes of Grade V students at UPT SD Negeri 018 Aeklung, Humbang Hasundutan Regency, in the 2025/2026 academic year? The objective of this research is to determine the effect of implementing the Cooperative Learning Model of the Pair Check type assisted by Wordwall media on students' mathematics learning outcomes. The research hypothesis is that students who learn through the Pair Check cooperative learning model assisted by Wordwall media will demonstrate significantly higher mathematics learning outcomes than before the implementation of the intervention.

The findings of this study are expected to contribute theoretically by enriching the body of knowledge concerning cooperative learning and technology-assisted mathematics instruction in elementary education. Practically, the study is expected to provide teachers with an effective instructional alternative for improving mathematics learning outcomes, offer schools evidence-based recommendations for enhancing instructional quality, and serve as a valuable reference for future researchers investigating innovative mathematics learning models. Therefore, this research is significant because it addresses an important instructional issue while providing empirical evidence regarding the effectiveness of integrating the Pair Check cooperative learning model with Wordwall media to improve elementary students' mathematics learning outcomes.

Research Methods

Research Design

This study employed a quantitative research approach using a pre-experimental method with a One-Group Pretest–Posttest Design. The purpose of this design was to examine the effect of the Pair Check Cooperative Learning Model assisted by Wordwall media on students' mathematics learning outcomes. In this design, participants completed a pretest before receiving the instructional treatment and a posttest after the intervention.

The difference between the pretest and posttest scores was used to determine the effectiveness of the instructional model.

The research design can be illustrated as follows:

$O_1 - X - O_2$

Where:

O_1 = Pretest

X = Treatment using the Pair Check Cooperative Learning Model assisted by Wordwall media

O_2 = Posttest

This design enables researchers to measure students' learning achievement before and after the intervention and evaluate the instructional effect of the treatment.

Research Setting

The research was conducted at UPT SD Negeri 018 Aeklung, Humbang Hasundutan Regency, North Sumatra, Indonesia, during the second semester of the 2025/2026 academic year (January–July 2026).

The school was selected because it provided an appropriate setting for investigating mathematics learning outcomes. Preliminary classroom observations indicated that mathematics instruction remained predominantly teacher-centered, students demonstrated low engagement during classroom activities, and many students had not achieved the Minimum Learning Achievement Criteria (KKTP). These conditions made the school suitable for implementing and evaluating an innovative instructional model.

Research Participants

Population

The population consisted of all Grade V students enrolled at UPT SD Negeri 018 Aeklung during the 2025/2026 academic year. The population included 27 students, consisting of 16 female students and 11 male students, aged approximately 10–11 years.

Sample and Sampling Technique

Since the population consisted of only one class with fewer than 100 students, this study employed a total sampling technique, in which every member of the population was selected as the research sample. Therefore, the sample comprised all 27 Grade V students. Using total sampling ensured that the collected data accurately represented the entire target population while eliminating sampling bias.

Research Variables

The study investigated two research variables: Independent Variable (X): Pair Check Cooperative Learning Model assisted by Wordwall media. Dependent Variable (Y): Students' mathematics learning outcomes on the topic of plane geometry (perimeter and area).

Data Collection Techniques

Three techniques were employed to collect research data.

Achievement Test

Students' mathematics achievement was measured using a multiple-choice achievement test consisting of 25 valid items covering the topics of identifying plane figures and calculating the perimeter and area of plane geometry. The same test was administered twice: Pretest, before the implementation of the instructional treatment, to determine

students' initial mathematical ability. Posttest, after the treatment, to measure improvements in students' learning outcomes.

Questionnaire

A structured questionnaire was administered to collect information regarding students' responses to the implementation of the Pair Check Cooperative Learning Model. The questionnaire used a four-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (4). After instrument validation, 24 questionnaire items were retained for the final study.

Documentation

Documentation techniques were used to obtain supporting research data, including students' attendance records, class lists, photographs of classroom activities, and other school documents related to the implementation of the research.

Research Instrument Validation

Prior to data collection, all research instruments were subjected to validity and reliability testing.

Validity Testing

Instrument validity was examined using the Pearson Product-Moment Correlation with the assistance of IBM SPSS Statistics Version 25. The mathematics achievement test initially consisted of 40 items, of which 25 items met the validity criteria and were retained for data collection, while 15 items were discarded. Similarly, the questionnaire initially contained 35 statements, and 24 items were declared valid and subsequently used in the research. Items were considered valid when r-count ≥ r-table at the 5% significance level.

Reliability Testing

Instrument reliability was evaluated using Cronbach's Alpha. The achievement test obtained a Cronbach's Alpha coefficient of 0.872, while the questionnaire obtained 0.971. According to commonly accepted reliability criteria, both coefficients indicate excellent internal consistency, demonstrating that the research instruments were highly reliable for data collection.

Data Analysis Techniques

Several statistical analyses were conducted to answer the research problem.

Normality Test

Prior to hypothesis testing, the distribution of the data was examined using the Liliefors normality test to determine whether the pretest and posttest scores followed a normal distribution. The data were considered normally distributed when Lcount ≤ Ltable at the 0.05 significance level.

Correlation Analysis

The relationship between the implementation of the Pair Check Cooperative Learning Model and students' mathematics learning outcomes was analyzed using the Pearson Product-Moment Correlation Coefficient. This analysis determined both the strength and direction of the relationship between the independent and dependent variables.

Coefficient of Determination

The coefficient of determination (R^2) was calculated to identify the percentage contribution of the Pair Check Cooperative Learning Model assisted by Wordwall media to

students' mathematics learning outcomes. The coefficient of determination was computed using: $R^2 = r^2 \times 100\%$ where r represents the Pearson correlation coefficient.

Hypothesis Testing

The research hypothesis was tested using a paired-samples t-test at a 5% significance level ($\alpha = 0.05$) with the assistance of IBM SPSS Statistics Version 25. The hypotheses were formulated as follows: H_0: The Pair Check Cooperative Learning Model assisted by Wordwall media has no significant effect on students' mathematics learning outcomes. H_1: The Pair Check Cooperative Learning Model assisted by Wordwall media has a significant effect on students' mathematics learning outcomes.

The decision criteria were: If Sig. < 0.05, H_0 was rejected and H_1 was accepted, If Sig. ≥ 0.05, H_0 was accepted. The results of the statistical analyses were used to determine whether the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media significantly improved Grade V students' mathematics learning outcomes.

Findings

Grade V Pre-Test Results

The study was conducted in Grade V at UPT SD Negeri 018 Aeklung and involved 27 students as the research participants. Before the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media, a pre-test was administered to determine the students' initial mathematical ability on the topic of Perimeter and Area of Plane Figures. The results of the pre-test are presented in Table 1.

Table 1. Frequency Distribution of Grade V Pre-Test Scores

Score (X)	Frequency (F)	FX	X – Mean	$(X - Mean)^2$	$F(X - Mean)^2$
35	1	35	-26.30	691.69	691.69
42	1	42	-19.30	372.49	372.49
45	2	90	-16.30	265.69	531.38
48	1	48	-13.30	176.89	176.89
50	1	50	-11.30	127.69	127.69
52	1	52	-9.30	86.49	86.49
54	1	54	-7.30	53.29	53.29
55	4	220	-6.30	39.69	158.76
60	2	120	-1.30	1.69	3.38
62	1	62	0.70	0.49	0.49
65	2	130	3.70	13.69	27.38
68	1	68	6.70	44.89	44.89
70	3	210	8.70	75.69	227.07
72	1	72	10.70	114.49	114.49
75	1	75	13.70	187.69	187.69
80	2	160	18.70	349.69	699.38

Score (X)	Frequency (F)	FX	X – Mean	$(X - Mean)^2$	$F(X - Mean)^2$
82	1	82	20.70	428.49	428.49
85	1	85	23.70	561.69	561.69
Total	27	1,655			4,493.10

Based on Table 1, descriptive statistical measures, including the mean, standard deviation, and standard error, were calculated to describe the distribution of the students' initial mathematics achievement. The mean pre-test score was 61.30, indicating that the average mathematics achievement of the students before receiving the instructional treatment was relatively low. The standard deviation of 13.14 indicates a moderate dispersion of students' scores around the mean, suggesting that students demonstrated varying levels of prior mathematical knowledge. The standard error of 2.485 indicates that the sample mean provides a reasonably accurate estimate of the population mean.

Table 2. Percentage Distribution of Grade V Pre-Test Scores

Score Interval	Frequency	Percentage
35–44	2	7%
45–54	6	22%
55–64	7	26%
65–74	7	26%
75–85	5	19%
Total	27	100%

Table 2. shows that the score intervals 55–64 and 65–74 had the highest frequency, each representing 26% (7 students) of the sample. The score interval 45–54 accounted for 22% (6 students), while 19% (5 students) achieved scores between 75 and 85. The lowest percentage was found in the 35–44 interval, representing only 7% (2 students).

Overall, the distribution indicates that most students obtained scores ranging from 55 to 74. However, the average pre-test score (61.30) was below the school's Minimum Learning Achievement Criteria (KKTP) of 65, indicating that the students had not yet achieved the expected level of mastery before the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media.

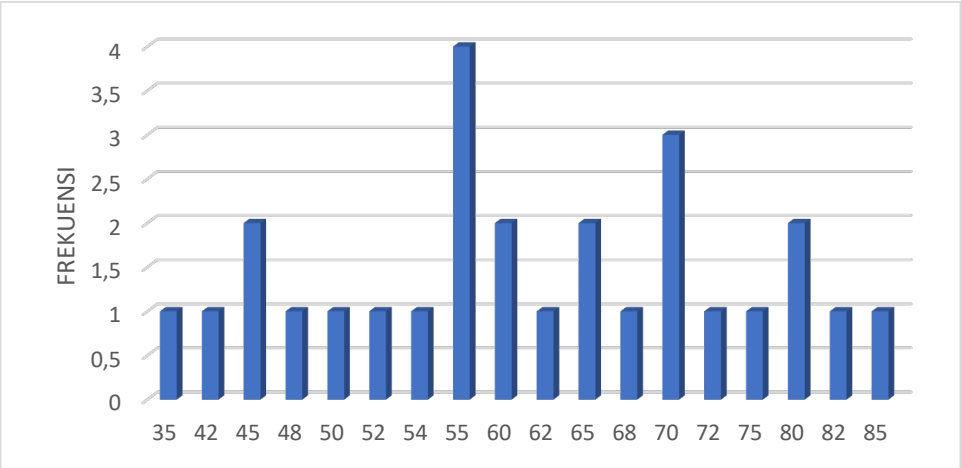

Figure 1. Distribution of Grade V Pre-Test Scores

Figure 1. illustrates the distribution of students' pre-test scores. The highest score obtained was 85, whereas the lowest score was 35. The descriptive statistical analysis yielded a mean score of 61.30, a standard deviation of 13.14, and a standard error of 2.485. These findings indicate that students' initial mathematics achievement was generally below the expected level and exhibited moderate variability. Consequently, the pre-test results confirmed the need for an instructional intervention aimed at improving students' understanding of the concepts of perimeter and area of plane figures.

This version is suitable for inclusion in an international journal article, using formal academic English, APA-style reporting, and interpretation consistent with educational research publications.

Grade V Post-Test Results

Following the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media, a post-test was administered to all Grade V students to determine the extent to which the instructional treatment improved their mathematics learning outcomes. The post-test assessed students' mastery of the topic Perimeter and Area of Plane Figures after the learning intervention. The distribution of the post-test scores is presented in Table 3.

Table 3. Frequency Distribution of Grade V Post-Test Scores

Score (X)	Frequency (F)	FX	X – Mean	$(X - Mean)^2$	$F(X - Mean)^2$
56	2	112	-17.63	310.82	621.64
60	2	120	-13.63	185.78	371.56
64	1	64	-9.63	92.74	92.74
68	3	204	-5.63	31.70	95.10
72	4	288	-1.63	2.66	10.64
76	5	380	2.37	5.62	28.10
80	6	480	6.37	40.58	243.48
84	3	252	10.37	107.54	322.62
88	1	88	14.37	206.50	206.50
Total	27	1,988			1,992.38

Based on Table 3, descriptive statistics, including the mean, standard deviation, and standard error, were calculated to summarize the students' mathematics achievement after the instructional treatment. The mean score of 73.62 indicates that students' mathematics achievement improved after participating in learning activities using the Pair Check Cooperative Learning Model assisted by Wordwall media. Compared with the pre-test mean of 61.30, the average score increased by 12.32 points, suggesting a substantial improvement in students' conceptual understanding of perimeter and area of plane figures. The standard deviation of approximately 8.75 indicates that the post-test scores were less dispersed than the pre-test scores, suggesting that students' learning outcomes became more consistent

after the instructional intervention. The standard error of 1.654 indicates that the sample mean is a reliable estimate of the population mean and reflects a relatively high level of measurement accuracy.

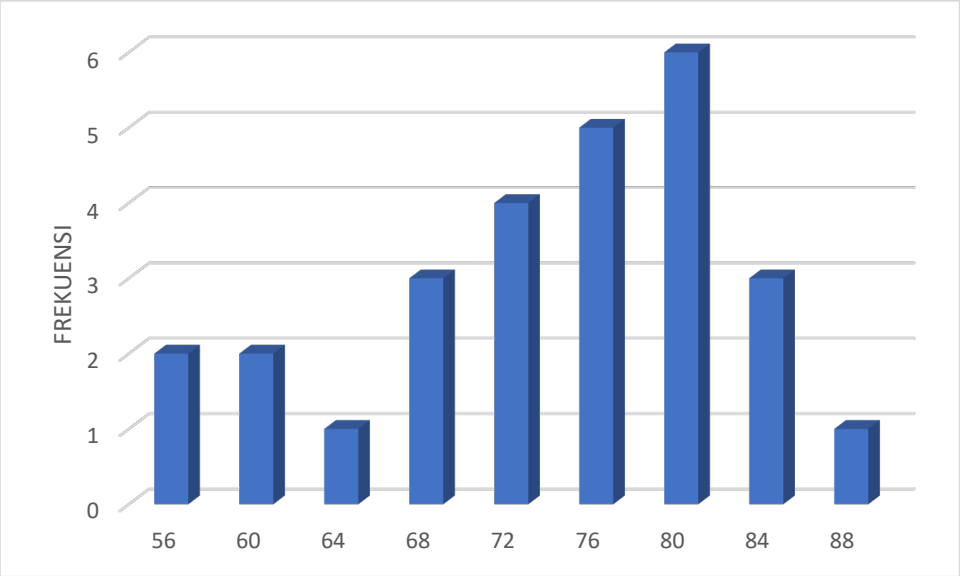

Figure 2. Distribution of Grade V Post-Test Scores

Figure 2. illustrates the distribution of the post-test scores obtained by Grade V students after the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media. The highest score achieved was 88, while the lowest score was 56. The descriptive statistical analysis produced a mean score of 73.62, a standard deviation of approximately 8.75, and a standard error of 1.654. Compared with the pre-test results, the post-test scores demonstrate a noticeable improvement in students' mathematics achievement and a more homogeneous distribution of learning outcomes.

Table 4. Percentage Distribution of Grade V Post-Test Scores

Score Interval	Frequency	Percentage
50–61	4	15%
62–67	1	4%
68–73	7	26%
74–79	5	19%
80–85	9	33%
86–91	1	4%
Total	27	100%

Table 4. shows that the largest proportion of students (33%, or 9 students) obtained scores within the 80–85 interval. Furthermore, 26% (7 students) scored between 68 and 73, while 19% (5 students) achieved scores ranging from 74 to 79. Only 15% (4 students) scored between 50 and 61, whereas the 62–67 and 86–91 intervals each contained one student (4%).

Overall, the post-test score distribution indicates that most students achieved moderate to high levels of performance, demonstrating a clear improvement in mathematics

learning outcomes after the instructional treatment. The predominance of scores above 70 suggests that the Pair Check Cooperative Learning Model assisted by Wordwall media effectively enhanced students' conceptual understanding and problem-solving abilities.

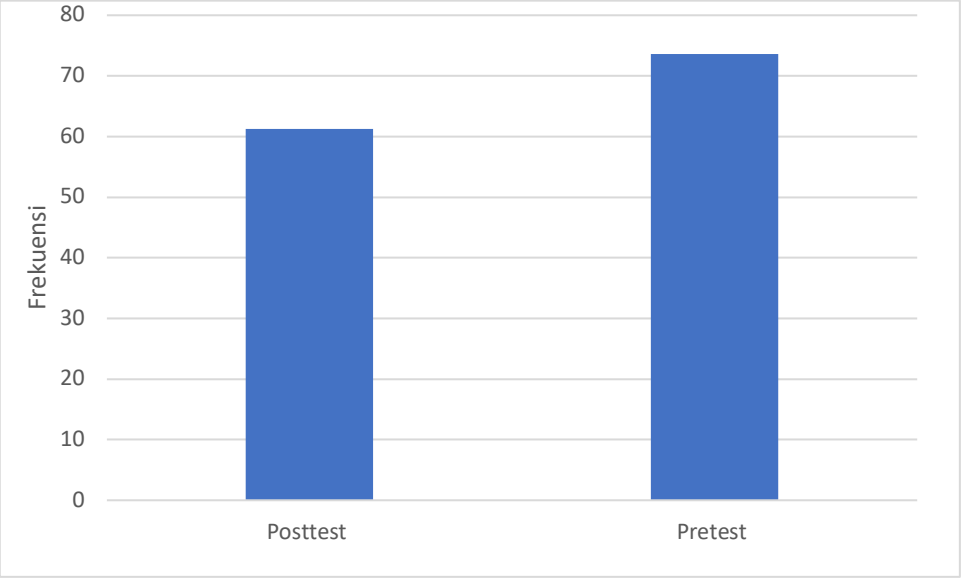

Figure 3. Comparison of Mean Pre-Test and Post-Test Scores

Figure 3. compares the average pre-test and post-test scores. The mean pre-test score was 61.30, whereas the mean post-test score increased to 73.62 following the implementation of the instructional treatment. This increase of 12.32 points demonstrates a substantial improvement in students' mathematics achievement. The findings indicate that the Pair Check Cooperative Learning Model assisted by Wordwall media contributed positively to students' learning outcomes and supported more effective mathematics instruction.

To facilitate the interpretation of students' achievement levels, the score categories used in this study are presented in Table 5.

Table 5. Achievement Classification Criteria

Score Range	Achievement Level
80–100	Excellent
70–79	Good
60–69	Fair
50–59	Poor
0–49	Fail

Based on the achievement classification presented in Table 5, the average pre-test score (61.30) fell within the Fair category, indicating that students possessed only a moderate level of prior mathematical understanding before the intervention. Following the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media, the average post-test score increased to 73.62, which falls within the Good category. This improvement demonstrates that the instructional treatment successfully enhanced students' mathematics learning outcomes and enabled them to achieve a higher level of academic performance.

Grade V Questionnaire Results

At the end of the mathematics learning activities, a questionnaire was administered to all Grade V students to evaluate their perceptions of the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media. The questionnaire aimed to determine students' responses to the learning process, including their participation, collaboration, motivation, and engagement throughout the instructional activities. The questionnaire findings provide additional evidence regarding the effectiveness and acceptability of the instructional model from the students' perspective. The distribution of the questionnaire scores is presented in Table 6.

Table 6. Frequency Distribution of Students' Responses to the Pair Check Cooperative Learning Model

Score (X)	Frequency (F)	FX	X – Mean	$(X - Mean)^2$	$F(X - Mean)^2$
70	3	210	-14.81	219.34	658.02
75	1	75	-9.81	96.24	96.24
76	1	76	-8.81	77.62	77.62
80	1	80	-4.81	23.14	23.14
84	4	336	-0.81	0.66	2.64
85	1	85	0.19	0.04	0.04
86	2	172	1.19	1.42	2.84
87	4	348	2.19	4.80	19.20
88	4	352	3.19	10.18	40.72
90	2	180	5.19	26.94	53.88
92	1	92	7.19	51.70	51.70
94	2	188	9.19	84.46	168.92
96	1	96	11.19	125.22	125.22
Total	27	2,290		721.76	1,320.18

Table 6. presents the frequency distribution of students' questionnaire scores following the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media. Descriptive statistical analyses, including the mean, standard deviation, and standard error, were computed to summarize students' perceptions of the learning model. The mean score of 84.81 indicates that students generally expressed highly positive perceptions of the Pair Check Cooperative Learning Model assisted by Wordwall media. This result suggests that the instructional strategy successfully encouraged active participation, collaborative learning, and meaningful classroom interaction. The standard deviation of 7.83 indicates that students' responses were relatively homogeneous, demonstrating that most participants shared similar positive opinions regarding the instructional model. The standard error of 1.48 indicates that the sample mean provides a reliable estimate of the population mean and reflects a satisfactory level of measurement precision.

Overall, the descriptive statistics demonstrate that students responded positively to the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall

media. The relatively high mean score, together with the low standard deviation and standard error, suggests that the instructional model was consistently well received by the majority of students.

Table 7. Percentage Distribution of Students' Questionnaire Scores

Score Interval	Frequency	Percentage
70–75	4	15%
76–81	2	7%
82–87	12	44%
88–93	7	26%
94–99	2	7%
Total	27	100%

Table 7. shows that the largest proportion of students (44%, or 12 students) obtained questionnaire scores within the 82–87 interval. Furthermore, 26% (7 students) scored between 88 and 93, while 15% (4 students) obtained scores ranging from 70 to 75. Only 7% (2 students) fell within the 76–81 interval, and another 7% (2 students) achieved scores between 94 and 99.

The distribution demonstrates that the majority of students obtained relatively high questionnaire scores, indicating favorable perceptions of the learning process. These findings suggest that the Pair Check Cooperative Learning Model assisted by Wordwall media effectively promoted student engagement, collaboration, and active participation throughout the mathematics lessons.

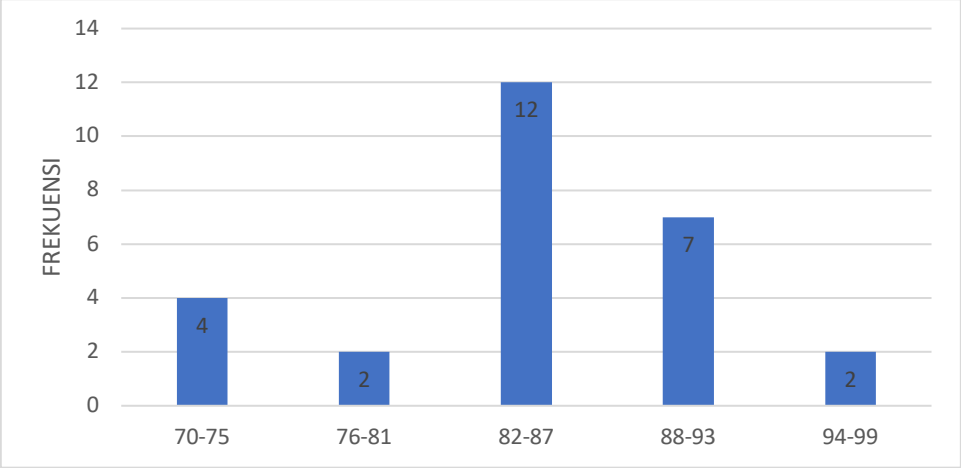

Figure 4. Distribution of Students' Questionnaire Scores

Figure 4. illustrates the distribution of students' questionnaire scores following the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media. The highest questionnaire score was 96, whereas the lowest score was 70. The descriptive analysis yielded a mean score of 84.81, a standard deviation of approximately 7.83, and a standard error of approximately 1.48.

These findings indicate that students demonstrated consistently positive perceptions of the instructional model. The relatively high average score and low variability suggest that the Pair Check Cooperative Learning Model assisted by Wordwall media created an

engaging, collaborative, and supportive learning environment. The positive questionnaire responses further support the quantitative findings obtained from the pre-test and post-test analyses, indicating that the instructional intervention not only improved mathematics learning outcomes but also enhanced students' learning experiences and classroom participation.

Assumption Testing

Normality Test

Before testing the research hypothesis, a normality test was conducted to examine whether the post-test data followed a normal distribution. Testing the normality assumption is an important prerequisite for parametric statistical analyses because these methods require that the sample data be normally distributed. In this study, the normality of the Grade V students' mathematics post-test scores was evaluated using the Lilliefors test. The analysis was performed using IBM SPSS Statistics Version 25 and subsequently verified through manual calculations using Microsoft Excel. The significance level adopted in this study was $\alpha = 0.05$.

The hypotheses for the normality test were formulated as follows:

- H_0: The post-test scores are normally distributed.
- H_1: The post-test scores are not normally distributed.

The decision criteria were established as follows:

- If Lcount ≤ Ltable, H_0 is accepted, indicating that the data are normally distributed.
- If Lcount > Ltable, H_0 is rejected, indicating that the data are not normally distributed.

The results of the Lilliefors normality test are presented in Table 8.

Table 8. Lilliefors Normality Test Results of Grade V Mathematics Post-Test Scores

No.	Score (X)	Z	F(Z)	S(Z)	|F(Z) − S(Z)|
1	56	-2.01	0.02	0.04	0.02
2	56	-2.01	0.02	0.07	0.05
3	60	-1.56	0.06	0.11	0.05
4	60	-1.56	0.06	0.15	0.09
5	64	-1.10	0.14	0.19	0.05
6	68	-0.64	0.26	0.22	0.04
7	68	-0.64	0.26	0.26	0.00
8	68	-0.64	0.26	0.30	0.04
9	72	-0.19	0.43	0.33	0.09
10	72	-0.19	0.43	0.37	0.06
11	72	-0.19	0.43	0.41	0.02
12	72	-0.19	0.43	0.44	0.02
13	76	0.27	0.61	0.48	0.13
14	76	0.27	0.61	0.52	0.09
15	76	0.27	0.61	0.56	0.05
16	76	0.27	0.61	0.59	0.01
17	76	0.27	0.61	0.63	0.02
18	80	0.73	0.77	0.67	0.10
19	80	0.73	0.77	0.70	0.06
20	80	0.73	0.77	0.74	0.03
21	80	0.73	0.77	0.78	0.01

22	80	0.73	0.77	0.81	0.05
23	80	0.73	0.77	0.85	0.09
24	84	1.18	0.88	0.89	0.01
25	84	1.18	0.88	0.93	0.04
26	84	1.18	0.88	0.96	0.08
27	88	1.64	0.95	1.00	0.05

As shown in Table 8, the post-test scores produced a mean of 73.63 with a standard deviation of 8.754. The largest absolute difference between the theoretical cumulative distribution function and the empirical cumulative distribution function was 0.085, which represents the calculated Lilliefors statistic (Lcount). For a sample size of 27 students at a 5% significance level, the critical value obtained from the Lilliefors table 8. was 0.171.

Since Lcount (0.085) was lower than Ltable (0.171), the null hypothesis (H_0) was accepted. Therefore, the post-test scores were considered to be normally distributed. These findings indicate that the mathematics learning outcome data met the normality assumption required for subsequent parametric statistical analyses, particularly the hypothesis testing conducted using the t-test.

The same procedure was applied to all 27 observations. The largest absolute difference obtained from the calculations was 0.085, which became the value of Lcount. Because this value was smaller than the critical Lilliefors value (0.171), the post-test scores were concluded to follow a normal distribution.

The consistency between the manual calculations and the SPSS output confirms the accuracy of the statistical analysis. Consequently, the assumption of normality was satisfied, allowing further inferential analyses using parametric statistical techniques to be conducted with confidence.

Data Analysis

Pearson Correlation Analysis

To determine whether there was a relationship between the implementation of the Pair Check Cooperative Learning Model (X) and students' mathematics learning outcomes (Y), a Pearson Product-Moment correlation analysis was conducted. This analysis was intended to measure both the strength and direction of the relationship between the independent variable and the dependent variable. The correlation analysis was performed manually using Microsoft Excel and verified using IBM SPSS Statistics Version 25.

The hypotheses for the correlation analysis were formulated as follows:

- H_0: There is no significant relationship between the Pair Check Cooperative Learning Model and students' mathematics learning outcomes.
- H_1: There is a significant relationship between the Pair Check Cooperative Learning Model and students' mathematics learning outcomes.

The correlation results obtained from SPSS are presented in Table 9.

Table 9. Pearson Product–Moment Correlation Results

Variables	**Pair Check Cooperative Learning Model**	**Mathematics Learning Outcomes**
Pair Check Cooperative Learning Model	1	0.757

Variables		Pair Check Cooperative Learning Model	Mathematics Learning Outcomes
Sig. (2-tailed)		–	0.000
N		27	27
Mathematics Outcomes	Learning	0.757	1
Sig. (2-tailed)		0.000	–
N		27	27

Table 9. indicates that the Pearson correlation coefficient between the Pair Check Cooperative Learning Model and students' mathematics learning outcomes was r = 0.757, with a significance value of 0.000, which is lower than the significance level of 0.05. This result indicates that the relationship between the two variables is statistically significant.

According to the commonly accepted interpretation of correlation coefficients, an r-value of 0.757 falls within the strong positive correlation category. This finding suggests that the implementation of the Pair Check Cooperative Learning Model was strongly associated with improved mathematics learning outcomes. In other words, higher levels of student engagement in Pair Check learning activities tended to be accompanied by higher mathematics achievement scores.

Furthermore, the obtained correlation coefficient (r = 0.757) exceeded the critical correlation value (rtable = 0.381, n = 27, α = 0.05). Therefore, the null hypothesis was rejected, confirming that a statistically significant positive relationship exists between the Pair Check Cooperative Learning Model and students' mathematics learning outcomes.

Coefficient of Determination

To determine the contribution of the Pair Check Cooperative Learning Model to students' mathematics learning outcomes, the coefficient of determination (R^2) was calculated using the correlation coefficient.

The coefficient of determination (R^2 = 0.573) indicates that approximately 57.3% of the variance in students' mathematics learning outcomes can be explained by the implementation of the Pair Check Cooperative Learning Model. The remaining 42.7% of the variance is attributable to other factors that were not investigated in the present study, such as students' learning motivation, prior mathematical knowledge, cognitive ability, family support, classroom environment, and other instructional factors.

These findings demonstrate that the Pair Check Cooperative Learning Model contributed substantially to improving students' mathematics achievement and can therefore be considered an effective instructional approach for Grade V mathematics learning.

Hypothesis Testing

Following the confirmation that the research data met the normality assumption, hypothesis testing was conducted using the t-test to determine whether the Pair Check Cooperative Learning Model had a statistically significant effect on students' mathematics learning outcomes.

The research hypotheses were formulated as follows:

- H_0: The Pair Check Cooperative Learning Model does not have a significant effect on students' mathematics learning outcomes.
- H_1: The Pair Check Cooperative Learning Model has a significant positive effect on students' mathematics learning outcomes.

The decision criteria were established as follows:

- If tcount > ttable, H_0 is rejected and H_1 is accepted.
- If tcount ≤ ttable, H_0 is accepted.

The hypothesis testing results generated by IBM SPSS Statistics Version 25 are presented in Table 10.

Table 10. Results of the t-Test (Regression Coefficients)

Model	Unstandardized Coefficients (B)	Standard Error	Standardized Coefficient (Beta)	t	Sig.
Constant	-5.279	13.655	—	-0.387	0.702
Questionnaire (Pair Check)	0.930	0.160	0.757	5.798	0.000

Table 10. shows that the regression coefficient for the Pair Check Cooperative Learning Model was 0.930, indicating a positive relationship between the independent and dependent variables. The standardized regression coefficient (β = 0.757) further confirms that the instructional model had a substantial positive effect on students' mathematics achievement.

The significance value obtained from the SPSS analysis was 0.000, which is lower than the significance level of 0.05. Therefore, the effect of the Pair Check Cooperative Learning Model on students' mathematics learning outcomes was statistically significant.

The manually calculated t-value (5.796) is consistent with the SPSS output (t = 5.798), confirming the accuracy of the statistical analysis. For n = 27 (degrees of freedom = 25) at a significance level of α = 0.05, the critical value from the t-distribution table is approximately ttable = 2.060 (two-tailed). Since tcount = 5.798 is substantially greater than ttable = 2.060, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted.

These findings demonstrate that the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media had a statistically significant positive effect on the mathematics learning outcomes of Grade V students at UPT SD Negeri 018 Aeklung. The instructional model effectively enhanced students' understanding of the concepts of perimeter and area of plane figures through collaborative learning, peer interaction, and active classroom participation.

Discussion

The findings of this study demonstrate that the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media significantly improved Grade V students' mathematics learning outcomes on the topic of the area and perimeter of plane figures. During the learning process, students were actively engaged in collaborative learning activities in which they worked in pairs to solve mathematical problems, checked

each other's answers, exchanged ideas, and discussed alternative solution strategies. After completing the paired activities, students participated in evaluation and reinforcement exercises using Wordwall, an interactive digital learning platform that provided immediate feedback and encouraged greater participation. This instructional process transformed learning from a teacher-centered approach into a student-centered environment, allowing students to become active participants in constructing mathematical knowledge.

The effectiveness of the instructional model is evident from the comparison of the pre-test and post-test results. Prior to the intervention, students completed a pre-test to measure their initial understanding of the concepts of area and perimeter of plane figures. The results showed a mean score of 61.30, indicating that most students had not yet achieved the Minimum Learning Achievement Criteria (KKTP) established by the school. After the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media, the mean post-test score increased to 73.63, demonstrating a considerable improvement in students' mathematics achievement. Furthermore, the highest post-test score reached 88, while the lowest score increased to 56. The post-test standard deviation (SD = 8.590) and standard error (SE = 1.684) indicate that students' achievement became relatively consistent after the intervention, suggesting that the instructional model was effective for students with different academic abilities. These findings imply that collaborative learning supported by interactive digital media enables students to understand mathematical concepts more effectively than conventional instructional approaches.

The improvement in students' learning outcomes can be explained through Slavin's Cooperative Learning Theory (Slavin, 2015), which emphasizes that cooperative learning enhances academic achievement through positive interdependence, individual accountability, promotive interaction, interpersonal skills, and group processing. These essential components were clearly reflected during the implementation of the Pair Check learning model. Students were responsible not only for completing their own work but also for checking their partners' answers, discussing misconceptions, and reaching a shared understanding of mathematical concepts. Such collaborative interactions encourage students to explain their reasoning, evaluate alternative solutions, and construct knowledge collectively. As argued by Slavin, learning becomes more meaningful when students actively participate in collaborative activities rather than passively receiving information from the teacher. Therefore, the significant improvement in students' mathematics achievement observed in this study supports the theoretical assumptions of cooperative learning.

The findings are also consistent with Piaget's Theory of Cognitive Development (Piaget, 1972), which states that elementary school students generally operate within the concrete operational stage of cognitive development. At this developmental stage, students understand concepts more effectively through direct experiences, active exploration, and concrete learning activities. The Pair Check Cooperative Learning Model provided opportunities for students to manipulate mathematical ideas through discussion, collaborative problem-solving, and peer interaction. Rather than memorizing formulas mechanically, students actively explored mathematical relationships and constructed conceptual understanding through authentic learning experiences. Consequently, students

demonstrated better comprehension of the concepts of area and perimeter because learning occurred through meaningful cognitive engagement.

The results can also be interpreted using Vygotsky's Sociocultural Theory (Vygotsky, 1978), particularly the concept of the Zone of Proximal Development (ZPD). Vygotsky argued that students learn more effectively when interacting with peers or more knowledgeable individuals who provide instructional scaffolding. Throughout the Pair Check learning activities, students continuously exchanged ideas, clarified misconceptions, and supported one another in solving mathematical problems. These peer interactions functioned as scaffolding, enabling students to complete learning tasks that they would have found difficult to accomplish independently. Through repeated collaboration, students gradually internalized mathematical concepts and developed greater confidence in explaining their reasoning. The findings therefore reinforce Vygotsky's assertion that social interaction plays a crucial role in cognitive development and meaningful learning.

The positive impact of Wordwall media observed in this study is supported by Mayer's Cognitive Theory of Multimedia Learning (Mayer, 2009). Mayer explains that learning becomes more effective when verbal explanations are integrated with visual representations and interactive multimedia elements. Wordwall combines colorful visual displays, interactive quizzes, game-based activities, and immediate feedback, thereby increasing students' motivation, attention, and engagement during the learning process. Interactive multimedia also reduces unnecessary cognitive load by organizing information in ways that facilitate understanding and long-term retention. Consequently, students were more enthusiastic about participating in mathematics lessons and demonstrated improved conceptual understanding compared with conventional classroom instruction.

The inferential statistical analysis further confirmed the effectiveness of the instructional model. Pearson Product–Moment correlation analysis produced a correlation coefficient of $r = 0.972$, while the critical value of r-table was 0.171. Because the calculated correlation coefficient exceeded the critical value ($0.972 > 0.171$), there was a very strong and statistically significant relationship between the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media and students' mathematics learning outcomes. This finding indicates that improvements in instructional quality through cooperative learning were closely associated with improvements in students' academic performance.

Similarly, hypothesis testing using the independent t-test demonstrated that the calculated t-value (20.68) was substantially higher than the critical value (1.708). Consequently, the alternative hypothesis (Ha) was accepted, while the null hypothesis (H_0) was rejected. These results provide strong statistical evidence that the Pair Check Cooperative Learning Model assisted by Wordwall media had a significant positive effect on Grade V students' mathematics learning outcomes at UPT SD Negeri 018 Aeklung, Humbang Hasundutan Regency.

The coefficient of determination further revealed that $R^2 = 0.9448$, indicating that approximately 94% of the variation in students' mathematics learning outcomes could be explained by the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media. The remaining 6% may have been influenced by other variables that were

beyond the scope of this study, including students' learning motivation, prior mathematical knowledge, cognitive ability, parental support, classroom environment, and individual learning characteristics. This remarkably high coefficient of determination suggests that the instructional model contributed substantially to improving students' academic achievement.

The present findings are consistent with previous empirical studies. Hikmah (2025) concluded that the Pair Check learning model significantly improved elementary students' mathematics learning outcomes by increasing students' responsibility, collaborative skills, and conceptual understanding. Likewise, Desi (2025) reported that integrating the Pair Check Cooperative Learning Model with Wordwall media significantly enhanced students' understanding of mathematical concepts related to the area and perimeter of plane figures. The consistency between the present findings and previous studies strengthens the empirical evidence supporting the effectiveness of Pair Check as an instructional model for elementary mathematics education. However, this study extends previous research by demonstrating that integrating cooperative learning with digital educational media creates a more engaging, interactive, and technology-supported learning environment that promotes both academic achievement and active student participation.

During the implementation of the study, several challenges were encountered. Initially, many students were unfamiliar with the Pair Check learning procedure and lacked confidence when explaining mathematical concepts to their partners. Collaborative discussions also required more instructional time than conventional teacher-centered instruction. Furthermore, the successful implementation of Wordwall depended on stable internet connectivity and the availability of digital devices. To address these challenges, the researcher introduced the Pair Check procedures before the intervention, provided continuous guidance during collaborative activities, motivated students to participate actively in discussions, carefully managed instructional time, and ensured that all technological resources were prepared before each learning session. These strategies enabled the instructional activities to proceed effectively despite the practical constraints encountered during implementation.

This study provides several important implications for mathematics education at the elementary school level. First, the Pair Check Cooperative Learning Model creates meaningful opportunities for students to develop conceptual understanding through peer interaction and collaborative problem-solving. Second, integrating Wordwall into mathematics instruction enhances students' learning motivation, engagement, and digital literacy while making abstract mathematical concepts easier to understand. Third, the combination of cooperative learning and interactive educational technology supports the implementation of 21st-century learning, which emphasizes collaboration, communication, critical thinking, creativity, and the meaningful integration of digital technology into classroom practice. Therefore, this instructional approach represents an innovative and effective alternative for improving mathematics learning outcomes in elementary schools.

Overall, the findings demonstrate that the Pair Check Cooperative Learning Model assisted by Wordwall media is an effective instructional strategy for improving Grade V students' mathematics learning outcomes. The combination of collaborative learning and interactive digital media not only enhanced students' academic achievement but also

fostered communication skills, teamwork, critical thinking, and active participation during the learning process. Consequently, this study concludes that the implementation of the Pair Check Cooperative Learning Model assisted by Wordwall media has a significant positive effect on mathematics learning outcomes among Grade V students at UPT SD Negeri 018 Aeklung, Humbang Hasundutan Regency, and therefore can be recommended as an effective instructional approach for elementary mathematics education.

Conclusion

The findings of this study demonstrate that the Pair Check Cooperative Learning Model assisted by Wordwall media has a significant positive effect on Grade V students' mathematics learning outcomes in the topic of the area and perimeter of plane figures at UPT SD Negeri 018 Aeklung, Humbang Hasundutan Regency. The implementation of the instructional model created an active, collaborative, and engaging learning environment in which students worked in pairs to solve problems, verify each other's answers, and discuss mathematical concepts. This collaborative process, supported by interactive Wordwall activities, contributed to a substantial improvement in students' conceptual understanding and academic performance. The statistical analyses confirmed the effectiveness of the instructional intervention, as evidenced by the increase in students' post-test scores and the significant correlation and hypothesis testing results, indicating that the integration of cooperative learning and digital media effectively enhances mathematics learning.

This study contributes both theoretically and practically to elementary mathematics education. The findings support the principles of Cooperative Learning Theory, Cognitive Development Theory, Sociocultural Theory, and Multimedia Learning Theory by demonstrating that collaborative learning combined with interactive digital media promotes meaningful learning, active participation, critical thinking, and effective communication among students. Practically, the Pair Check Cooperative Learning Model assisted by Wordwall media can serve as an innovative instructional alternative for elementary school teachers seeking to improve mathematics learning outcomes while fostering students' collaboration and digital literacy. Future research is recommended to involve larger samples, different educational contexts, additional mathematics topics, and comparative or experimental designs to further validate and extend the findings of the present study.

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