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Enhancing Numeracy Abilities through Problem-Based Learning Model with Augmented Reality Flipbook Media in Drupadi Cluster

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Abstract: This study examines how effectively the Problem-Based Learning framework, combined with flipbook-based augmented reality media, improves students numerical abilities. This study used a quantitative approach with a non-equivalent quasi-experimental control group design. The participants were fourth-grade students in the Drupadi cluster, Gunungpati sub-district, with 16 students as the experimental and 22 as the control classes. To assess their numeracy abilities, the students first completed a pre-test. After the practical actualization of the Problem-Based Learning model with the integration of flipbook-based augmented reality media, a subsequent test was conducted to measure their improvement. The learning process was completed with a class discussion and question and answer session. The findings show a significant improvement in numeracy abilities. The Problem-Based Learning approach integrated with flipbook-based augmented reality media effectively supports students in mastering all three levels of numeracy abilities: knowing, applying, and reasoning. This is evidenced by the average N-Gain value for the experimental class of 0.70 with a high category, while the control class N-Gain value is 0.30 with an ineffective category. So, this finding shows that this model is very effective in improving the quality of education, especially in developing the numeracy abilities of grade IV primary school students.

Keywords: problem-based learning, flipbook, augmented reality, numeracy.

▪ INTRODUCTION

As educational institutions, schools serve not only as centers for imparting knowledge but also as environments that foster personal growth and character development, equipping students with the skills necessary to compete and overcome challenges in the future (Suciyati et al., 2022). Digitalization and the 4.0 Industrial Revolution, which is now growing, require education units to prepare students who can master numeracy abilities as an asset to face the dynamics of modern life (Priambudi et al., 2024). To make this happen, the Indonesian government has launched a program called Computer-Based National Assessment as a program that replaces the National Exam (Indreswari et al., 2022). Computer-Based National Assessment does not focus on assessing individual learners but is designed to evaluate each school's overall quality of education. Computer-Based National Assessment results are used to improve the education system, not as a determinant of students graduation (Kemendikbudristek, 2021). The statement is stated through the National Education System Law (UU Sisdiknas) Article 57 paragraph 1 and Article 59 paragraph 1, which explains that "National Assessment is a form of accountability for education practical actualization carried out by the government and local governments for managers, units, pathways, levels, and types of education” (Murdiyaningrum et al., 2022).

“The National Assessment is divided into three things: the Environmental Survey, the Traits Survey, and the Minimum Competency Assessment” (Fitri et al., 2023). This study focuses on Minimum Competency Criteria to determine students numeracy ability

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levels. The practical actualization of the Minimum Competency Criteria program aims to enhance students reading and numeracy abilities (Rohim, 2021). Educators can use the results of the Minimum Competency Criteria to design optimal and quality learning strategies and students learning outcomes (Purnomo et al., 2022). The term numeracy represents a students ability to leverage algebraic concepts, operations, data, and tools about actual problems in domestic and worldwide circumstances (Kemendikbudristek, 2020).

The Minimum Competency Criteria numeracy covers four domains: values, geometries and gauges, algebra, and data and uncertainty (Fitri et al., 2023). Then, the numeracy Minimum Competency Criteria consists of several contexts that are useful for students to identify various functions of mathematics in everyday life, ranging from individual socio-cultural to science issues (Khairi & Desnita, 2023). The cognitive level of Minimum Competency Criteria Numeration consists of three levels, including (a) knowing, which is a level that measures the capacity of students essential insight and understanding; (b) applying, which is a level that measures the capacity in mathematics how to apply knowledge and understanding related to conception in solving problems by choosing strategies, (c) reasoning is the highest level because students are not only able to understand and apply mathematical concepts in life, but need reasoning in solving mathematical problems by examining the data found, drawing conclusions, and expanding their understanding related to the latest conditions, including what they did not know before or concepts that have complexity (Syaifuddin, 2022).

The ideal state of numeracy abilities is based on the exposure of Kemendikbudristek (2021), namely numerical knowledge, metaphors, and the interpretation of numerical data (displays, charts, graphical representations, etc. (Tari et al., 2023). According to Lubis and Irawan (2022), through adequate numeracy abilities, students can practice mathematical knowledge in their daily lives (Susriyanti et al., 2022). The actual situation experienced by students is that many of them are unable to solve mathematical problems that have been connected to daily issues, which is interpreted as an inadequate ability so that they cannot develop their knowledge with confidence in every aspect of life (Mufidah et al., 2023).

Given the importance of numeracy abilities for students, learning models and media are needed. The criteria for the required learning model must be students-oriented, encourage group discussions to solve problems, increase self-confidence, and build independence in constructing knowledge (Juandi, 2021). The Problem Based-Learning model is derived from students comprehension of problem analysis, identifying pertinent information, and applying their knowledge and expertise to address current issues (Seibert, 2021).

The Problem Based-Learning model is considered appropriate for improving students numeracy abilities because each syntax aligns with the development of cognitive levels in the Minimum Competency Criteria, namely knowing, applying, and reasoning. At the problem orientation stage, students are trained to recognize numerical data and information (learning); when organizing students and guiding investigations, they begin to formulate strategies and apply mathematical concepts (applying); then, through developing and presenting results and analyzing the process, students are invited to reason, evaluate and reflect on solutions (reasoning). Thus, Problem Based Learning encourages understanding concepts and the ability to apply and reason mathematics in a real context in an active, collaborative, and meaningful way.

The learning media in the 21st century is technology-based (Mobrur & Hamed, 2024). Flipbook media centered around augmented reality is media that combines digital book media that is systematically arranged to contain subject matter presented in the bone form of passage, icon, aural, video, and so on by involving the TPACK approach through augmented reality (Ekasafitri et al., 2024). Augmented reality is a mechanized innovation framework that allows users to perceive reality through presented digital information (Avila-Garzon et al., 2021).

From the final semester assessment results at Sadeng State Primary School, Gunungpati District, 41% of the 120 students had scores below the passing grade, and 59% of the 120 had above the passing grade. Therefore, a common thread can be drawn that the numeracy abilities of students at Drupadi Cluster Public Primary School are still relatively low.

This challenge is explicitly evident in mathematics, where students struggle to effectively solve bona fide mathematical messes. One of the main contributing factors is their difficulty in analyzing contextual problems. Additionally, the use of instructional media has not fully leveraged IT-based resources to engage students, leading to decreased motivation and difficulty in understanding the concepts taught by the teacher.

Several studies, including those by (Mawarsari & Wardani, 2022) and (Sari et al., 2022), have examined primary school students problem-solving and numeracy abilities. However, previous research has primarily focused on a single element, such as the Problem Based Learning model, without considering the integration of learning media aligned with technological advancements. This study addresses the deficiencies of numeracy abilities among fourth-grade students at State Primary School Drupadi Cluster in the Gunungpati sub-district by implementing the Problem Based Learning model supported by augmented reality-based flipbook media. Additionally, it seeks to prepare students for participation in the Computer-Based National Assessment.

Augmented reality based flipbook media specifically supports the Problem Based Learning model by strengthening students understanding of contextual problems, often a significant obstacle in improving numeracy abilities. The three-dimensional visualization offered by augmented reality allows students to see mathematical objects such as spatial figures, graphs, or data in a real and interactive form. This helps them understand the context of the problem more concretely, connect verbal and visual information, and facilitate the mathematical modeling process, especially in the problem orientation and inquiry stages of the Problem Based Learning syntax.

Flipbook augmented reality also helps develop data representation abilities and mathematical concepts essential in visual numeracy. With its interactive features, students can explore data, observe patterns, and evaluate information dynamically, which strongly supports the application and reasoning processes in the Minimum Competency Criteria cognitive level. Through a more tangible, engaging, and multimodal learning experience, this media allows students to actively engage in problem-solving and bridge the gap between abstract concepts and real-life applications.

▪ METHOD

Participants

Population refers to a group of individuals or objects that share specific characteristics and attributes selected by the researcher for study, from which conclusions are drawn (Sugiyono, 2017). Accordingly, the research population for this study consisted of fourth-grade students from Sadeng 03 State Primary School and Sadeng 01 State Primary School, who served as the subjects of the investigation.

Cluster random sampling was used in this study by selecting 38 fourth-grade students from a total of 120 students in the Drupadi primary school cluster located in the Gunungpati sub-district. Sixteen participants were selected in the experimental class. Meanwhile, 22 participants were in the control class. These students underwent homogeneity and normality tests to group the numeracy scores in the Drupadi cluster by considering relatively similar academic characteristics and facilities and representing the general condition of schools in the cluster.

The normality test results for student numeracy scores in the Drupadi Cluster showed that Sadeng 01 State Primary School, Sadeng 02 State Primary School, and Sadeng 03 State Primary School had significance values of 0.484, 0.392, and 0.353, respectively. All three values are greater than 0.05, so the data from these three schools are typically distributed. Meanwhile, Sukorejo 01 State Primary School and Sukorejo 02 State Primary School have significance values of 0.020 and 0.040, respectively, below 0.05. Therefore, the data from these two schools were not normally distributed.

Furthermore, the results of the homogeneity test for the numeracy scores of the three normally distributed schools (Sadeng 01 State Primary School, Sadeng 02 State Primary School, and Sadeng 03 State Primary School) show that they have significance values of 0.080, 0.107, and 0.108 below 0.05, respectively. Therefore, the data from these two schools are not normally distributed. Since all of these values are greater than 0.05, it can be concluded that the three schools have homogeneous data, making them suitable for use as samples in quantitative research that requires the assumptions of normality and homogeneity.

Research Design and Procedure

“The impact of the Problem-Based Learning model supported by augmented reality-based flipbook media on students' numeracy abilities was analyzed using a quantitative approach with a quasi-experimental design using a non-equivalent control group” (Pakpahan et al., 2021). This design was chosen because it allows assessment of the impact of changes in learning interventions on students' numeracy abilities and provides measurable changes. An outline of the non-equivalent control group design is illustrated in Table 3.

Table 1. Non-Equivalent control group design chart

Group	Pre-test	Treament	Post-test
Experiment Class	O_1	X_1	O_2
Control Class	O_3	X_2	O_4

This analysis defines Group A as the experimental group of fourth-grade students from Sadeng 03 State Primary School. Group B is the control group of fourth-grade students from Sadeng 01 State Primary School. Before the intervention, both groups took initial tests (O1 and O3) to assess students' basic numeracy abilities. The experimental class applied the Problem-Based Learning model with augmented reality flipbook media (X1). The control class applied the Numbered Heads Together model and learning video media (X2). Finally, during the intervention period, both groups were administered post-tests (O2 and O4) to analyze the learning objectives and changes in results. After that, the results of both groups were examined in terms of the different teaching methods and students' numeracy achievement.

The total duration of intervention for each class in this study was four meetings, each meeting for two lesson hours (70 minutes). In applying the Problem-Based Learning model assisted by augmented reality-based flipbook media in the experimental class, students actively learn, from analyzing to solving a mathematical problem using an augmented reality-based flipbook that visualizes mathematical material. As for applying the Numbered Heads Together model assisted by learning videos in the control class, the teacher helps students apply math material using learning videos.

The research was conducted at Sadeng 03 State Primary School and Sadeng 01 State Primary School, which are located in Gunungpati Subdistrict, Semarang City. The experimental class was conducted at Sadeng 03 State Primary School, at Jogoprono 1 Street, while the control class was conducted at Sadeng 01 State Primary School, at Sugiarto Street. The research was conducted from January 9 to March 6, 2025.

Instruments

To collect data, test techniques (before and after the test) that have been evaluated for validity and reliability, observation, interviews, and documentation in the learning process are used to enrich the description of the learning process.

Test questions covering 30 items about numeracy ability are the research tools utilized. “The research instrument must pass the instrument validity process before use, and the data is considered well-distributed if the table value achieved is more than 0.2759” (Rahmadi et al., 2024). The instrument will also undergo a reliability test, with the provision that the instrument will be considered reliable if Cronbach's Alpha exceeds 0.6. Fifty-one students from the research sample with a significance level of 5% who were not in the control or experimental class participated in the instrument trial. With a Cronbach's Alpha value of 0.840 and a calculated value greater than 0.2759, all thirty test items tested for validity were considered valid, passing the criterion of high reliability.

Data Analyses

Two data analysis techniques were employed in this study. The first step involved conducting prerequisite tests for normality and homogeneity to determine whether the population was normally distributed and homogeneous. The second step applied an independent samples t-test to evaluate significant differences in post-test results between the experimental and control groups. Data analysis was carried out using SPSS version 27, with a significance level of 5%. After the test, the central tendency of post-test scores was analyzed. A difference in post-test scores was identified if the experimental group outperformed the control group. An independent samples t-test was used to examine the significance column to determine if this difference was statistically significant. The two-tailed significance value of the independent samples t-test played a key role in this analysis. If the sig. (2-tailed) value was below 0.05. It indicated a statistically significant difference between the post-test results of the two groups. However, if the sig. (2-tailed) value exceeded 0.05; the difference was not statistically significant.

The paired samples t-test data analysis method is then used to determine if the experimental and control classes differ before and after the test scores. The first step in this approach is to administer a prior test before the intervention and a subsequent test following it. The SPSS version 27 program was used to analyze the acquisition of the prior test and after the test results. The significance level for this paired samples t-test is set at 5%. The central values of the test, before and after the test, will be examined following the test. It can be inferred that there was a difference before and after the intervention if the subsequent test scores were higher than the prior test values. The data must be analyzed in the paired samples t-test table in the sig (2-tailed) column to determine whether the difference is significant. There is a relationship between the prior and after the test in this test if the sig (2-tailed) is less than 0.05. On the other hand, there is no correlation between the two if the sig (2-tailed) > 0.05.

The N-Gain test was utilized to gauge the produced product's efficacy using SPSS version 27. N-Gain testing was employed to assess the developed product's effectiveness. This test is conducted by calculating the gap between the prior and subsequent test scores and comparing it to the ideal scoreless prior outcomes. The initial and subsequent test scores were normalized by calculating each participant's initial and subsequent test scores, then converting them to a uniform scale to make comparisons between individuals more accurate. After normalization, N-gain was calculated to measure the improvement between the prior and subsequent test scores. Three categories can be used to define the achievement category once the N-Gain value has been obtained: low ($G < 0.3$), medium ($0.3 < G < 0.7$), and high ($G > 0.7$). According to percentage, the product's efficacy can be divided into four degrees of N-Gain: ineffective if $G < 40\%$, less effective if $40\% < G < 55\%$, moderately successful if $56\% < G < 75\%$, and effective if $G > 76\%$ (Azriati et al., 2021).

▪ RESULT AND DISSCUSSION

This study evaluates how well the Problem-Based Learning paradigm improves the numeracy abilities of fourth-grade students when paired with augmented reality-based flipbook media. “Through observations of pre-and post-test results, this study explicitly aimed to ascertain whether there were substantial differences in students' numeracy abilities before and after the intervention” (Eviota & Liangco, 2020).

The practical actualization of the problem-based learning model combined with augmented reality-based flipbook media in mathematics learning encourages numeracy abilities while providing a meaningful learning process for students. The reason is that the Problem-Based Learning model can foster students' curiosity and critical thinking related to a phenomenon that is relevant to everyday life, coupled with the help of augmented reality-based flipbook media by displaying 3D images that can arouse students' enthusiasm in receiving lessons because the presentation of subject matter is not limited to printed books (Saputra et al., 2024).

Description of Improved Learning Outcomes

A numeracy test of thirty questions in various formats- multiple choice, complex multiple choice, matching, and descriptive- was conducted to assess the pre-and post-test results. A summary of students' learning achievements is presented below.

Table 2. Students learning outcomes

Class	Pre-test		Post-test	
	Control	**Experiment**	**Control**	**Experiment**
Mean	42.14	57.69	60.09	87.38
Score Max	64	68	73	98
Score Min	25	44	37	73
Std. Deviation	9.79	6.63	10.27	6.91

The experimental class, which used augmented reality-based flipbook media to execute the Problem-Based Learning paradigm, had a pre-test mean score of 57.69, as shown in Table 2. In contrast, the mean value of the control group before the test was 42.14. This group used video learning materials with the Numbered Heads Together method. After the intervention, the experimental class had an average numeracy achievement score of 87.38, while the control group scored 60.09. Based on these results, the experimental class outperformed the control group regarding numeracy abilities.

The Problem-Based Learning model, with the help of augmented reality-based flipbook media, is proven effective in improving students' numeracy abilities at various cognitive levels of Minimum Completion Criteria, with an average N-Gain of 0.70, classified as high. The highest increase occurred at the reasoning level because Problem-Based Learning emphasizes the process of reasoning, analysis, and complex problem-solving, which is reinforced by augmented reality media's interactive and explorative features. At the application level, students showed improvement because they were directly involved in real contexts that demanded the application of mathematical concepts. Meanwhile, at the knowing level, improvement still occurs, although it is lower because the primary focus of Problem-Based Learning is mastery of basic information, deep understanding, and critical thinking skills. These data suggest that the Problem-Based Learning approach and augmented reality technology efficiently build overall numeracy abilities, especially in developing higher-order thinking skills.

Effectiveness Test Results

A set of statistical computations was conducted to analyze the effectiveness of the PBL model augmented with flipbook media on students numeracy abilities. These included students achievement of passing grades, the Independent Samples t-test, the paired sample t-test, and the N-gain test (Triyono et al., 2024). The first step of testing the pre-test and post-test results is known as normalcy testing. We apply a parametric test like the independent samples t-test to identify normal distribution. For samples under 50 respondents, the Shapiro-Wilk test is more suitable, so it will be applied to evaluate the student's numeracy proficiency normality. The analysis will be done by SPSS 27, and the significance level will be set at > 0.05 (Sintia et al., 2022). Table 3 below illustrates the results of the standard distribution check for both the experiment and control groups.

According to Table 3, the significance values for the experimental and control groups' pre-test and post-test results (Sig.) are greater than the 0,05 threshold. This implies that the two clusters' data have a normal distribution. Homogeneity testing must be performed in addition to normalcy testing to ascertain whether the variances of the two

Table 3. Test of normality pre-post test

Tests of Normality			
Class	**Shapiro-wilk**		
	Statistic	**df**	**Sig.**
Pre-test A (Control)	.980	22	.909
Post-test A (Control)	.935	22	.159
Pre-test B (Experiment)	.916	16	.143
Post-test B (Experiment)	.899	16	.078

classes are equal. Homogeneity is evaluated using Levene's parametric test with a significance threshold of 5% (0.05). Table 4 displays the findings of the homogeneity analysis, which was performed with SPSS 27.

Table 4. Homogeneity test results before and after student counting ability tests

Tests of Homogeneity of Variances					
		Levene Statistic	**df1**	**df2**	**Sig.**
Result	Based on Mean	2.262	3	72	.088
	Based on Median	1.895	3	72	.138
	Based on Median and with adjusted df	1.895	3	67.136	.139
	Based on trimmed mean	2.188	3	72	.097

The homogeneity test results are shown in Table 4, showing that the significant values of the experimental and control classes before and after the test are both 0.088. This implies that there is no discernible difference between the two sample groups and that the test results are homogeneous before and after the test. The Independent Samples t-test was used to examine any variations after the test mean scores once it was established that the before and after the test data in both groups had a regular and uniform distribution. Table 5 presents the results of this analysis, which was conducted with the assistance of the SPSS 27 software.

Table 5. Independent sample t-test results

Independent Samples T-Test for Equality of Means				
t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
9.196	36	< 0.001	27.284	2.967
9.775	35.841	< 0.001	27.284	2.791

When the sig (2-tailed) value is less than 0.05, the null provisional premise (H_0) is rejected, per the test findings shown in table 5. This suggests that the experimental and control groups' improvements in numeracy abilities differ significantly, supporting the acceptance of the alternative provisional premise (Ha). Consequently, the PBL approach that integrates augmented reality-based flipbooks is more successful in improving numeracy abilities than the Numbered Heads Together (NHT) model, which is supported by learning video material.

The Problem-Based Learning Model, with the help of augmented reality-based flipbooks, is effective for improving the numeracy abilities of grade IV primary school students because it is in the cognitive development stage of students who are still at the concrete operational stage. Through a contextual problem-based approach, students are encouraged to actively think, find solutions, and apply mathematical concepts in real situations. The augmented reality flipbook strengthens this process by presenting the material visually, interactively, and easily understood, making it easier to understand basic concepts (knowing), application in everyday contexts (applying), and development of reasoning and problem-solving skills (reasoning). The combination of this model and media pedagogically and cognitively encourages students to build an understanding of counting gradually and thoroughly so that learning becomes more meaningful and engaging and meets the learning needs of primary school-age children.

The next step is to evaluate the impact of the Problem-Based Learning model supported by augmented reality-based flipbooks using the Paired Samples t-test. Table 6 presents the results of this analysis, which was conducted with the help of SPSS 27 software.

Table 6. Paired samples t-test result

Paired Samples Test									
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pre-Experiment – Post-Experiment	-29.687	8.522	2.131	-34.229	-25.146	-13.934	15	< .001
Pair 2	Pre-Control – Post-Control	-17.955	11.299	2.409	-22.964	-12.945	-7.453	21	< .001

Table 6 shows a difference between the mean scores of the experimental and control classes, including meditation circles and post-test results. This finding supports the alternative hypothesis, indicating that the students numeracy abilities are high when the PBL approach is applied in the experimental class, which supports augmented reality-based flipbook media. This is further emphasized by the increase of central value scores, In which the pre-test central value, 57.69, improves to 87.38 post-test, reflecting a difference of 29.69. Hence, the PBL approach with augmented reality-based flipbooks improves students numeracy abilities more effectively than the PBL approach with the NHT model integrated with learning video media.

"N-Gain testing was conducted to analyze changes in experimental class scores between the first and second tests. This difference shows the estimated development of the experimental group's numeracy abilities" (Sukarelawan et al., 2024). A summary of N-Gain values is shown in the following table.

Table 7. N-Gain score of experimental and control class learning

Class	N-gain		% N-gain	
	Experiment	Control	Experiment	Control
Mean	0.70	0.30	70.07	30
Minimum	0.34	-0.03	34	-3
Maximum	0.95	0.60	95	60

Table 7 shows that the experimental class had a high N-Gain value of 0.70. Meanwhile, the control group has a median value of 0.30, which puts it in the average category.

The N-Gain percentage can be used to measure the effectiveness of teaching and media use in improving the numeracy abilities of fourth-grade students. The median N-Gain percentage for the experimental class was 70.07, or 70%, with N-Gain scores ranging from a minimum of 34% to a maximum of 95%; this class was classified as moderately practical. The mean N-Gain percentage for the control class was 30%, which is considered ineffective, with N-Gain scores ranging from a minimum of -3% to a maximum of 60%. These results are by research Riandhany & Puadi (2023), which resulted in treatment using the Problem-Based Learning model; the experimental class had an N-gain score of 62% and was classified as moderate.

The Problem-Based Learning model assisted by augmented reality-based flipbook media is more effective than Number Head Together with learning videos because it can facilitate active, contextual, and in-depth learning. The Problem-Based Learning syntax encourages students to be directly involved in solving real problems. At the same time, the augmented reality-based flipbook provides an interactive learning experience through 3D visualization, animation, and simulation that can be explored independently. This synergy supports improving students' numeracy abilities at all cognitive levels of the Minimum Completeness Criteria. At the knowing level, augmented reality flipbooks help students recognize basic concepts through visual displays that are interesting and easy to understand. At the applying level, students can apply math concepts in a real context that is presented interactively. Meanwhile, at the reasoning level, students are trained to reason and construct arguments through data exploration and complex problem-solving scenarios. Compared to Numbered Heads Together, which is competitive, and video, which tends to be passive, Problem Learning with augmented reality flipbooks provides a more flexible, personalized learning experience and encourages students to think critically.

In addition to using N-gain to determine the improvement of numeracy abilities, it is necessary to see the significance of the difference in the improvement of numeracy abilities before and after applying the Problem-Based Learning model assisted by augmented reality-based flipbook media to the experimental group.

Qualitative evidence from interviews and observations showed that using a Problem-Based Learning model with the help of augmented reality flipbooks markedly improved grade IV primary school students' engagement and understanding of numeracy. The students revealed that the interactive visualizations in the augmented reality flipbook made understanding concepts such as measurement, numbers, algebra, and data interpretation easier. During learning, students were active in exploring the materials, discussing in groups, and able to present mathematical arguments with more confidence. Observations also noted increased participation, perseverance in solving problems, and proper use of mathematical terms. These findings corroborate the quantitative data showing that combining Problem-Based Learning and augmented reality flipbooks is numerically effective and promotes meaningful and profound learning experiences at all three levels of numeracy: knowing, applying, and reasoning.

▪ CONCLUSION

The significant value (2-tailed) of <0.001 indicates a substantial difference between the initial and final test scores. This confirms that the learning model involving augmented reality-based flipbook media can significantly improve students' numeracy abilities. With a median after-test score of 87.38, statistics also showed that 100% of students participating in the experiment met the passing standard. In addition, the results showed that the Numbered Heads Together model using learning video media was less successful than the augmented reality-based flipbook-assisted learning model. This is reinforced by the N-Gain percentage, which shows that the experimental group is quite effective, with a median N-Gain value of 70%.

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