The Effect of Video Use in the Problem-Based Learning Model on Students' Mathematical Representation Abilities

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Abstract

This study investigated the effect of video-assisted Problem-Based Learning (PBL) on students' mathematical representation abilities. The study population consisted of all Grade VIII students of SMP Negeri 14 Bandar Lampung in the 2025/2026 academic year, encompassing eleven classes (VIII-A to VIII-K). Using purposive random sampling, 30 students from class VIII-I and 32 students from class VIII-J were selected as the research sample. The study adopted a pretest–posttest control group design, in which class VIII-J served as the experimental group and received video-assisted PBL, while class VIII-I served as the control group and received PBL without video assistance. Quantitative data were obtained through a mathematical representation ability test. The results of the t-test revealed that the increase in mathematical representation ability among students in the experimental group was significantly higher than that of students in the control group. Therefore, video-assisted PBL has a significant positive effect on students' mathematical representation abilities.

Keywords: effect, Problem Based Learning, mathematical representation

Introduction

In the 21st century, mathematics learning requires students to master not only procedural skills but also higher-order thinking skills, one of which is mathematical representation. Mathematical representation skills play a crucial role in helping students understand problems, present information, and communicate mathematical ideas in various forms, such as symbols, graphs, tables, images, and verbally (NCTM, 2024). However, the results of the Program for International Student Assessment (PISA) international study show that many students still experience difficulties in using mathematical representations flexibly, particularly in the context of solving real-life problems (OECD, 2023). This condition impacts students' low ability to model problems and determine appropriate solution strategies.

Low mathematical representation skills are also caused by a learning process that is still teacher-centered and does not actively involve students in building conceptual understanding. Conventional learning tends to make students simply follow examples and procedures without understanding the meaning of the representations used (Putra & Murni, 2020). Several studies show that students often have difficulty translating verbal information into symbolic or visual forms, such as graphs and tables, resulting in errors in problem solving (Nurhadida et al., 2021; Silviani et al., 2021). Therefore, learning innovations are needed that can encourage active student involvement and facilitate the meaningful use of various forms of representation..

Among various learning approaches, Problem-Based Learning (PBL) is considered relevant for addressing these issues. The PBL model emphasizes learning through contextual problem solving that is closely related to students' daily lives, thereby encouraging students to think critically, engage in discussion, and construct knowledge independently (Hamilton et al., 2023). Through PBL, students are required to present and communicate mathematical ideas using various forms of representation during the problem-solving process. Previous studies have shown that the implementation of PBL has a positive effect on students' mathematical representation abilities, particularly in constructing mathematical models and graphs. (Pratiwi et al., 2021; Amalia & Rahayu, 2022).

In addition to learning models, the use of learning media also plays a crucial role in supporting the understanding of mathematical concepts. Learning videos can help students visualize problems, present concrete contexts, and increase learning motivation (Dahiana et al., 2023). The integration of video into problem-based learning has been shown to improve students' conceptual understanding and mathematical representation skills compared to learning without the aid of visual media (Rahmananda et al., 2024). Learning videos enable students to connect verbal, visual, and symbolic representations more systematically, thus supporting the mathematical modeling process.

Based on this description, this study aims to determine the effect of video use in the PBL model on students' mathematical representation skills. This research is expected to provide theoretical and empirical contributions to the development of mathematics learning oriented towards strengthening students' mathematical representation skills in accordance with the demands of 21st century education.

Method

This study was a quasi-experimental study with the independent variable being a learning model and the dependent variable being mathematical representation ability. The research design used was a pretest-posttest control group design, with a pretest to measure initial ability and a posttest to measure students' final ability after treatment.

This research was conducted in the odd semester of the 2025/2026 academic year at SMP Negeri 14 Bandar Lampung. The research population was all 341 eighth grade students spread across 11 classes (VIII-A to VIII-K) with relatively homogeneous mathematical abilities based on the results of the previous academic year's Mathematics End of Year Summative. The research sample was selected using a cluster random sampling technique, so that class VIII- J (31 students) was selected as the experimental class that received video-assisted PBL and class VIII-I (32 students) as the control class that received video-assisted PBL.

The data in this study are quantitative data on students' mathematical representation abilities. The data collected consisted of pretest scores, which reflect students' initial abilities, and posttest scores, which reflect students' abilities after learning. The data collection technique used was a test technique, consisting of a pretest and a posttest. This test was administered to two groups: the experimental class and the control class.

This research instrument consists of a test in the form of descriptive questions that have been adapted to competency achievement indicators and mathematical representation ability indicators. Each question can contain one or more indicators of mathematical representation ability. To obtain accurate data, the research instrument must meet the criteria for a good test. A good instrument is a test instrument that meets the requirements for validity and reliability, as well as meeting the specified criteria for difficulty level and discriminatory power. To ensure consistent assessment, each question is accompanied by scoring guidelines. These scoring guidelines contain assessment criteria that are in accordance with the indicators of mathematical representation ability. Based on the results of the validity, reliability, difficulty level and differentiating power tests that have been carried out, a recapitulation of the quality of the test instrument items was obtained as presented in Table 1.

Table 1. Recapitulation of Test Instrument Test Results

No.	Validity	Reliability	Distinguishing Power	Difficulty Level	Conclusion
1.	Valid	0,74 (Reliable)	0,22 (Fair)	0,31 (Moderate)	Usetable
2.			0,42 (Good)	0,44 (Moderate)	
3.			0,69 (Good)	0,30 (Difficult)	

In this study, the data were analyzed using statistical tests to determine the effect of video use in the PBL model on students' mathematical representation abilities. To support this analysis, a gain score calculation was used, taking into account the students' initial and final scores. Before conducting a hypothesis test, prerequisite tests were required. These prerequisite tests were the normality test and the homogeneity test, so that the appropriate formula for the hypothesis test could be determined.

Results and Discussion

Data processing begins with a pretest in the experimental and control classes to determine students' initial mathematical representation abilities. Then, posttest data is processed in the experimental and control classes to determine students' final mathematical representation abilities. Furthermore, from the pretest and posttest data, an improvement score (gain) is obtained which is used to determine the increase in students' mathematical representation abilities achieved. The results of the calculation of students' mathematical representation ability gains are presented in Table 2.

Table 2. Data Gain on Students' Mathematical Representation Abilities

Class	**Number of Students**	**Average**	***Lowest Gain***	***Highest Gain***	**Standar Deviation**
Experiment	30	0,70	0,52	0,93	0,11
Control	28	0,49	0,24	0,88	0,15

Table 2 shows that the average mathematical representation ability of students in the experimental class was higher than the average mathematical representation ability of students in the control class. The pretest and posttest standard deviations of students in the experimental class were higher than the pretest and posttest standard deviations of students in the control class. This indicates that the pretest and posttest mathematical representation ability of students in the experimental class was more diverse than the pretest and posttest mathematical representation ability of students in the control class. Meanwhile, the standard deviation of the gain in mathematical representation ability of students in the experimental and control classes was the same. This means that the gain data for students in the experimental and control classes had the same diversity.

From the gain calculation results, the data must then undergo a prerequisite test. This test was conducted to determine whether the two gains in students' mathematical representation abilities came from a normally distributed population and whether they had the same variance. Therefore, normality and homogeneity tests were required before being used for hypothesis testing. Therefore, normality and homogeneity tests were conducted before the data were used in hypothesis testing. The results of these prerequisite tests are presented in Table 3.

Table 3. Prerequisite Test Results

Class	Normality		Homogeneity	
	χ^2_{hitung}	χ^2_{tabel}	F_{hitung}	F_{tabel}
Experiment	3,55	7,81	1,92	2,14
Control	4,69			

Table 3 shows that both classes of values $\chi^2_{hitung} < \chi^2_{tabel}$ so that H_0 are accepted. This means that both gains come from normally distributed populations. Furthermore, the value of $F_{hitung} < F_{tabel}$ so that H_0 is accepted. This means that both gains have the same variance.

Based on the results of the prerequisite test, the hypothesis was tested using a parametric t-test. This hypothesis test was conducted to determine whether the improvement in students' mathematical representation skills in the experimental and control classes was the same, or whether the improvement in students' mathematical representation skills in the experimental class was higher than the improvement in students' mathematical representation skills in the control class. The results of hypothesis testing using the parametric t-test are presented in Table 4.

Table 4. Hypothesis Test Results

Class	N	$\bar{x}$	s^2	t_{hitung}	t_{tabel}
Experiment	30	0,70	0,012	6,21	1,67
Control	28	0,49	0,23		

Table 4 shows that the value $t_{hitung} > t_{tabel}$ so that H_0 are accepted. This means that the improvement in students' mathematical representation skills in the experimental class was higher than that in the control class.

The results of the hypothesis testing in this study demonstrated that students who participated in PBL using videos experienced a greater improvement in their mathematical representation skills compared to students who participated in problem-based learning without videos. This finding is confirmed by the results of research conducted by Prima et al., (2024), which found that the problem-based learning model using videos significantly impacted students' mathematical representation skills. Classes that participated in the PBL model using videos became more active. Students were trained to express their opinions based on the videos presented, exchange ideas, and collaborate in groups, thus improving their mathematical representation skills. The achievement of students' mathematical representation ability indicators is presented in Table 5.

Table 5. Achievement of Students' Mathematical Representation Ability Indicators

Mathematical Representation Ability Indicator	PBL with Video (%)		PBL without Video (%)	
	Pretest	Posttest	Pretest	Posttest
Symbolic	34,72	86,11	41,96	75,60
Visual	10,42	75,00	23,66	66,07
Verbal	3,89	64,72	14,58	53,57

Based on Table 5, it can be seen that there was an increase in each indicator, for symbolic indicators in classes that implement PBL using videos increased by 51.39% and in PBL classes without videos increased by 33.64% where the increase in classes that implement PBL using videos was 17.75% higher than PBL classes without videos. For visual indicators in classes that implement PBL using videos increased by 64.58% and in PBL classes without videos increased by 42.41% where the increase in PBL classes using videos was 22.17% higher than PBL classes without videos. Furthermore, verbal indicators in classes that implement PBL using videos increased by 60.83% and in PBL classes without videos increased by 38.99% where the increase in PBL classes using videos was 21.84% higher than PBL classes without videos.

Based on the analysis of the final achievement of the indicators, the percentage of students' mathematical representation ability indicators, both in total and for each indicator, was higher in the class that participated in video-based learning. This indicates that the implementation of the PBL model using video has a higher influence on students' mathematical representation ability compared to the implementation of the problem-based learning model without video. In the class that implemented the PBL model using video, the mathematical representation indicator with the highest percentage was the symbolic indicator, while the lowest percentage was found in the verbal indicator. A similar condition was also found in the class that implemented PBL without video.

Overall, each indicator of students' mathematical representation ability in the class using the problem-based learning model with video showed higher results than in the class using the problem-based learning model without video. The use of video helped students understand contextual problems and increased their interest in learning. This activity reflects students' mastery of the indicators of mathematical representation ability, namely symbolic, visual, and verbal, as described in the research by Syamsinar et al. (2023).

The results indicate that the use of video in the problem-based learning model positively contributed to improving students' mathematical representation ability. This finding aligns with Sari & Wardani (2021) opinion, which states that problem-based learning is effective in building in-depth understanding through authentic problem exploration. In the initial stages of learning, video is used as a contextual problem trigger. The video presents real-life situations close to students' lives, such as buying and selling activities or group divisions related to the application of mathematical concepts. This problem visualization strengthens students' initial understanding, consistent with Arends' (2012) view that visual media enhances students' ability to understand the context of problems.

The use of video as a problem trigger also aligns with the multimedia learning principles proposed by Mayer (2024), which assert that the combination of visual and verbal information can enhance knowledge. Observational findings in this study support this theory, as students appeared more focused and motivated when problems were presented through video compared to text or teacher explanations. This provided students with the opportunity to better identify and represent problems, as PBL requires students to organize information and present it in a meaningful representation.

After the problem-solving process, video was again used as a reinforcement medium. This reinforcement video contained a systematic explanation of the correct solution steps. This finding is consistent with research by Widodo and Wahyudi (2021), which found that video can help correct students' misconceptions after the learning process. Several students who initially made procedural errors were able to improve their understanding after comparing the strategy with the solution in the video. This aligns with the findings of Nonthamand (2024) that videos explaining steps can improve the accuracy of students' symbolic and visual representations.

Furthermore, previous research by Nasution (2017) and Mulyatiningsih (2019) showed that the use of video in mathematics learning can increase motivation and facilitate students' visual understanding of relationships between concepts. This finding aligns with the findings of this study, where the use of video facilitates students' understanding of the problem context and enhances their focus in constructing mathematical representations. Similarly, research by Sari and Wardani (2021) and Indriyani et al. (2023) shows that PBL supported by digital media, including video, is more effective in improving mathematical thinking and representation skills than PBL without media.

The integration of video into two crucial stages of PBL—the problem orientation stage and the analysis and evaluation stage of the problem-solving process—has been shown to enhance meaningful learning. Therefore, the findings of this study reinforce the significant relationship between the implementation of PBL using video and improved students' mathematical representation skills, as also supported by various previous studies (Mayer, 2005; Sari & Wardani, 2021). Overall, the use of video in learning not only serves as a supplement, but also becomes a crucial component that plays a role in helping students construct meaning around the given problems. By presenting visual context and real-world situations, videos help students understand information before entering the problem-solving stage. This condition has a positive impact on students' mathematical representation skills, both visual representation through pictures or diagrams, symbolic representation through mathematical models and equations, and verbal representation in explaining ideas and solutions coherently. Thus, the use of video supports students in connecting contextual problems with mathematical concepts in a more meaningful way.

After the problem-solving process, videos were used again as reinforcement. These reinforcement videos contained systematic explanations of the correct solution steps. This finding is consistent with research by Widodo and Wahyudi (2021), which found that videos can help correct students' misconceptions after the learning process. Some students who initially made procedural errors were able to improve their understanding after comparing the strategy with the solution in the video. This aligns with the findings of Putra and Murni (2020), who found that videos explaining steps can improve the accuracy of students' symbolic and visual representations.

Furthermore, previous research by Maryanti et al., (2024) showed that using videos in mathematics learning can increase motivation and facilitate students' visual understanding of relationships between concepts. This aligns with the findings of this study, where the use of videos makes it easier for students to understand the context of the problem and provides more direction in constructing mathematical representations. Similarly, research by Sari and Hidayat (2020) and Indriyani et al. (2023) showed that PBL assisted by digital media, including video, was more effective in improving mathematical thinking and representation skills than PBL without media.

The integration of video into two crucial stages of PBL, namely the problem orientation stage and the analysis and evaluation stage of the problem-solving process, has been shown to make learning more meaningful. Thus, the results of this study confirm the significant relationship between the implementation of PBL using video and improvements in students' mathematical representation skills, as also supported by various previous studies (Mayer, 2005; Fitriani & Ramlah, 2022). Overall, the use of video in learning not only functions as a supplement but also becomes a crucial component that plays a role in helping students construct meaning for the problems presented. By presenting visual contexts and real-life situations, videos help students understand information before entering the problem-solving stage. This positively impacts students' mathematical representation skills, including visual representations through pictures or diagrams, symbolic representations through mathematical models and equations, and verbal representations in explaining ideas and solutions coherently. Thus, the use of videos supports students in connecting contextual problems with mathematical concepts in a more meaningful way.

The implementation of video-based PBL in the eighth grade of SMP Negeri 14 Bandar Lampung took place over five meetings. During the PBL video-based learning, several obstacles were identified that impacted the learning process and outcomes. In the initial meeting, some students still struggled to understand the context of the problems presented in the videos due to their unfamiliarity, requiring the teacher to provide additional explanations to ensure a shared understanding. Furthermore, students tended to focus on the visual aspects of the videos, resulting in less attention being paid to the mathematical information contained within them. During the stages of organizing information and constructing mathematical models, several students encountered difficulties determining variables and converting verbal information into SPLDV equations, resulting in group discussions lasting longer than planned. Another obstacle arose when solving SPLDV using the substitution and elimination methods, where procedural errors such as misplaced signs or incorrect substitutions were still quite common.

Obstacles were also evident in the development and presentation stages of the results. Some students lacked confidence in presenting their group work, particularly in presenting graphs or verbal explanations. There were still inaccuracies in determining the intercepts and the graph scale. Presentations between groups were also uneven, as some groups appeared more dominant than others. In the final meeting, the reinforcement video used for the evaluation and reflection process was not fully utilized because some students did not focus on the video, resulting in misconceptions despite the visual presentation of the solution steps. Furthermore, technical constraints such as inadequate internet connection and device availability also impacted the effectiveness of the reflection activity.

In the second to fifth meetings, the video-assisted PBL process began to run actively and optimally. The steps for completing the student worksheet (LKPD) were clearly legible and understandable, so students did not ask the teacher about the method. The problems and questions presented in the LKPD were also clearly and accurately addressed, so they did not ask the teacher many questions. This was because students were becoming accustomed to being presented with problems in the LKPD. Students also began to express their opinions based on the problems in the LKPD, resulting in optimal discussions. However, the teacher-maintained control over the discussion to ensure that the topic did not deviate from the context of the problem being studied.

In general, these obstacles indicate that implementing video-assisted PBL requires good time management, intensive mentoring, and appropriate reinforcement strategies to ensure optimal development of students' independent learning and mathematical representation skills. However, these obstacles can be overcome through adjustments to learning strategies, ensuring that the PBL process remains effective and improves students' understanding of the system of linear equations in two variables material.

In the control class, which implemented the PBL model without video, a number of obstacles were found that were quite different from those in the experimental class. Without visual aids, some students struggled to understand the context of the given problem. Problem situations presented through readings required students to spend more time identifying important information, determining variables, and formulating mathematical models. This resulted in a suboptimal problem-orientation process, as students had to imagine the contextual situation without the support of visualizations. During the inquiry stage, some students appeared less focused on organizing information, requiring teachers to provide additional guidance to help students understand the relationship between problem information and the system of linear equations in two variables concept. Furthermore, without video reinforcement, the reflection process in the control class was more limited, as students only compared their answers based on teacher explanations rather than systematic visual representations.

Another difficulty arose during the presentation of their work, where some students lacked confidence in their mathematical representations due to the lack of visual comparison. Differences in reading ability also affected students' comprehension; those with lower literacy skills tended to struggle to grasp the context of the problem and develop solutions. Some students quickly lost focus, especially with abstract explanations. This resulted in ineffective group discussions, as students frequently questioned the meaning of the problem. Overall, PBL without video was still feasible, but the process required more intensive support and more time for students to achieve the same understanding as those in the experimental class.

Based on the explanation above, students achieved higher levels of mathematical representation ability in the class with PBL using video than in the class without PBL. This is because PBL using video provides more visual support, helping students understand the context of the problem more concretely. Videos present realistic situations, making it easier for students to identify important information, determine variables, and connect the problem to the system of linear equations in two variables concept being studied.

Conclusion and Suggestion

Based on the research results and discussion, the problem-based learning model using videos has an effect on the mathematical representation ability of eighth grade students of SMP Negeri 14 Bandar Lampung in the odd semester of the 2025/2026 academic year. This is indicated by the increase in the mathematical representation ability of students who follow the PBL model using videos is higher than the increase in the mathematical representation ability of students who follow the PBL model without videos.

Based on the research results and discussion, the following recommendations can be put forward, teachers wishing to implement the PBL model using videos are advised to use videos that focus on important mathematical information and provide more intensive guidance during the problem identification, mathematical model development, and presentation stages to optimally develop students' mathematical representation skills and researchers wishing to conduct research using the PBL model using videos are advised to develop student worksheet (LKPD) guidelines containing videos as effectively as possible to reduce the likelihood of student confusion and errors during investigations.

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