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DEVELOPMENT OF PROBLEM-BASED LEARNING INSTRUCTIONAL VIDEOS ON UNIFORM AND UNIFORMLY ACCELERATED LINEAR MOTION FOR JUNIOR HIGH SCHOOL STUDENTS

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Abstract
Physics learning at the junior secondary school level on the topics of Uniform Linear Motion and Uniformly Accelerated Linear Motion often shows low conceptual understanding due to limited use of contextual and visual instructional media. This study aims to develop and examine the effectiveness of Problem-Based Learning (PBL) instructional videos in improving students' conceptual understanding. The research employed a Research and Development approach using the ADDIE model and adopted a pre-experimental design with a one-group pretest–posttest involving 36 students as trial subjects. The instruments included expert validation sheets, conceptual understanding tests, and student response questionnaires. Data were analyzed using descriptive statistics, normality tests, paired-sample t-tests, and N-Gain analysis. The results showed that the instructional video product was categorized as highly feasible based on expert validation and student responses (89.7%). The students' mean scores increased from 57.97 to 69.44, with a reduction in variance and standard deviation, indicating a more even distribution of conceptual understanding. The normality test confirmed that the data were normally distributed, and the paired-sample t-test revealed a significant difference between pretest and posttest scores ($p < 0.001$). The N-Gain value of 0.27 was in the low–moderate category, indicating initial effectiveness. Therefore, the developed PBL instructional videos indicate initial effectiveness in enhancing students' conceptual understanding and can be considered a feasible instructional innovation for junior secondary school physics learning.

Keyword: learning video, Problem-Based Learning, conceptual understanding, junior high school physics, instructional innovation

INTRODUCTION

Physics, as an integral part of Natural Sciences, plays a strategic role in developing students' critical, analytical, inductive, and deductive thinking skills in understanding and solving various phenomena encountered in everyday life (Alnursa et al., 2022; Setiyadi, 2023). However, numerous findings indicate that the quality of science learning in Indonesia, particularly in the domain of conceptual understanding of physics, remains at a concerning level. Field observations conducted at SMPK Immanuel II Sungai Raya reveal that students' mastery of conceptual understanding in the topics of Uniform Linear Motion (ULM) and Uniformly Accelerated Linear Motion (UALM) reaches only 26%, while other studies report that overall mastery of science learning outcomes is still around 40% (Salsabila & Muqowim, 2024; Yulianti et al., 2025). These low achievement levels reflect weaknesses in fundamental cognitive domains remembering, understanding, and applying which serve as the primary foundation of science learning.

The topics of ULM and UALM are characterized by abstract and conceptual content and rely heavily on students' understanding of mathematical representations and real-life motion phenomena. Conceptual understanding is a crucial prerequisite, as it functions as the foundation of students' scientific thinking in constructing new knowledge (Prabandari, 2023). Without strong conceptual mastery, students are prone to misconceptions that systematically affect their problem-solving abilities and learning outcomes.

This condition is further exacerbated by instructional practices that remain dominated by the use of PowerPoint (PPT) as the primary medium for content delivery. Pre-research findings indicate that approximately 90% of teachers rely on PPT in teaching ULM and UALM. Although PPT offers advantages as a presentation tool, several studies have demonstrated that its excessive use may reduce instructional effectiveness, particularly when slides contain excessive text and irrelevant visual effects (Styowati & Utami, 2022). Such media have been shown to inadequately facilitate the visualization of dynamic motion concepts, thereby limiting their effectiveness in supporting students' conceptual construction (Mukarromah & Andriana, 2022).

In contrast, instructional videos offer significantly greater pedagogical potential. Audio-visual media are capable of presenting complex concepts in a concrete, engaging, and contextual manner while simultaneously enhancing the quality of students' cognitive interactions. Research indicates that video-based learning achieves an effectiveness level of 72.67%, as evidenced by material validity, communicative language use, attractive visual displays, and the integration of learning evaluation components. Furthermore, instructional videos have been proven to significantly improve conceptual understanding and science learning outcomes at the junior secondary school level (Fridayanti et al., 2022; Yuwana & Indarti, 2023).

The advantages of instructional videos lie not only in their visual appeal but also in their ability to address and correct students' misconceptions by providing concrete representations of abstract concepts. Visualization of motion processes, adjustable playback speed, and content repetition enable multisensory engagement that strengthens retention and learning motivation (Okpatrioka, 2023; Toni & Sudin, 2024). Accordingly, video serves as a medium aligned with the demands of 21st-century science education, which emphasizes conceptual understanding and higher-order thinking skills.

Nevertheless, the effectiveness of instructional media cannot be separated from the learning model employed. Meaningful physics learning requires an approach that positions students as active agents in constructing knowledge. Problem-Based Learning (PBL) is one instructional model that has been proven effective in enhancing students' conceptual understanding and problem-solving skills through the presentation of authentic, real-life problems (Afrilia et al., 2022; Styowati & Utami, 2022). Studies have shown that 61% of students experience improved conceptual understanding of physics through PBL-based instructional videos Styowati & Utami (2022), and that improvements in science conceptual understanding can reach up to 30% when PBL-based videos are systematically implemented (Hafiza et al., 2025; Hatimah et al., 2022).

Field findings further reinforce the urgency of integrating these two approaches. Interviews with seventh-grade students at SMPK Immanuel II Sungai Raya indicate that they are more interested and better supported when learning involves interactive video media. Needs analysis results also confirm that students expect dynamic, contextual, and easily accessible learning media. These conditions underscore the importance of developing PBL-based instructional videos as an innovative pedagogical solution to enhance students' conceptual understanding of ULM and UALM.

Therefore, this study focuses on the development of Problem-Based Learning–based instructional videos designed contextually by presenting real-life events as the starting point of learning, visualizing motion concepts concretely, and stimulating students' scientific thinking processes. The indicators of conceptual understanding employed include the abilities to provide examples, explain concepts, and draw conclusions as representations of students' comprehensive cognitive achievement.

This development is expected not only to contribute to improving the quality of physics learning at the junior secondary school level but also to enrich the body of pedagogical innovations grounded in technology and constructivism that are relevant to the demands of 21st-century learning.

Despite the growing use of instructional videos and the implementation of Problem-Based Learning (PBL) in science education, previous studies have generally examined these two components separately, with limited focus on the systematic development of PBL-integrated instructional videos specifically for abstract physics topics such as Uniform Linear Motion (ULM) and Uniformly Accelerated Linear Motion (UALM) at the junior secondary school level. Moreover, empirical studies that combine a structured development model with pre-experimental testing to measure students' conceptual understanding in these topics remain scarce, particularly in the Indonesian junior secondary school context. Therefore, this study aims to develop PBL-based instructional videos on ULM and UALM using the ADDIE development model and to examine their initial effectiveness in improving students' conceptual understanding through a pre-experimental one-group pretest–posttest design. The novelty of this study lies in the integration of contextual real-life problem scenarios, dynamic motion visualization, and PBL learning stages within a single instructional video product that is systematically developed, validated by experts, and empirically tested. This contribution is expected to provide an innovative, feasible, and pedagogically grounded instructional media alternative that supports conceptual understanding and aligns with constructivist and 21st-century science learning demands.

METHOD

This study aims to develop and examine the feasibility and initial effectiveness of Problem-Based Learning (PBL)–based instructional videos on the topics of Uniform Linear Motion (ULM) and Uniformly Accelerated Linear Motion (UALM) in improving junior high school students' conceptual understanding, particularly in the indicators of providing examples, explaining concepts, and drawing conclusions (Hafiza et al., 2025; Hatimah et al., 2022).

The research employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). To examine the effectiveness of the developed product, the study adopted a pre-experimental one-group pretest–posttest design, in which students' conceptual understanding was measured before and after the implementation of the PBL-based instructional videos. This design was selected to determine the initial effectiveness of the developed media within a limited-scale trial setting.

The analysis stage involved needs assessment, curriculum analysis, and identification of students' characteristics. The design stage included the preparation of video scripts integrating authentic real-life problems aligned with PBL stages (problem orientation, investigation, presentation, and reflection). The development stage produced the instructional video, followed by expert validation. The implementation stage consisted of classroom trials using the one-group pretest–posttest procedure. The evaluation stage examined product feasibility and students' learning gains.

The research population comprised all seventh-grade students of SMPK Immanuel II Sungai Raya in the current academic year. The sample consisted of 36 students, selected through purposive sampling based on class homogeneity and representativeness of prior academic performance. Demographically, the participants included 19 female students (52.8%) and 17 male students (47.2%), with heterogeneous prior achievement levels categorized as high (22%), moderate (50%), and low (28%) based on previous semester science scores. The study was conducted during the second semester over approximately three months. The research instruments included:

a. Expert validation sheets (content and media experts) assessing material accuracy, construct validity, language clarity, visual design, and alignment with the PBL model.
b. Student and teacher response questionnaires to measure practicality and attractiveness.
c. A conceptual understanding test

consisting of 15 multiple-choice and 5 open-ended items designed to measure the indicators of providing examples, explaining concepts, and drawing conclusions.

Prior to implementation, the conceptual understanding test underwent item validity and reliability testing. Item validity was analyzed using product–moment correlation, and items with correlation coefficients above the critical value were retained. The reliability of the instrument was examined using Cronbach's Alpha, yielding a coefficient of $\alpha > 0.70$, indicating acceptable internal consistency.

An example of a multiple-choice item is: "A motorcycle moves with a constant velocity of 10 m/s. Which statement correctly describes its acceleration?" An example of an open-ended item is: "Explain the difference between uniform linear motion and uniformly accelerated linear motion based on daily life examples."

Data analysis was conducted using descriptive statistics to determine product validity and practicality. To assess effectiveness, pretest and posttest scores were analyzed using normality testing, paired-sample t-tests, and N-Gain calculations to measure the magnitude of learning improvement.

The research procedures were carried out systematically from needs analysis to final evaluation, resulting in a validated instructional video product and empirical evidence indicating its initial effectiveness in enhancing students' conceptual understanding of ULM and UALM.

RESULTS AND DISCUSSION

In accordance with the initial stage of the R&D process through the ADDIE model framework, a curriculum analysis was conducted to ensure that the development of PBL-based instructional videos aligns with junior high school science learning outcomes, particularly in the topics of Uniform Linear Motion (ULM) and Uniformly Accelerated Linear Motion (UALM). This alignment emphasizes conceptual mastery, the development of scientific thinking skills, and the integration of learning with real-life phenomena (Jamaludin et al., 2023).

Table 1. Results of Curriculum Analysis

No.	Curriculum Component	Key Findings	Implications for PBL Video Design
1	Science Learning Outcomes	Students are expected to understand the concept of motion and apply it in real-life contexts.	The video presents contextual problems based on real-world phenomena.
2	Characteristics of Uniform Linear Motion (ULM) and Uniformly Accelerated Linear Motion (UALM) Content	The concepts are abstract, mathematical, and dynamic in nature.	The video visualizes the concepts through motion animations and simulations.
3	Learning Profile	Learning requires active, collaborative, and meaningful engagement.	PBL is employed as the framework for learning activities in the video.
4	Learning Approach	Oriented toward problem-solving.	The video structure follows the stages of PBL.
5	Learning Assessment	Emphasizes conceptual understanding and thinking processes.	Video evaluation measures students' ability to provide examples, explain concepts, and draw conclusions.

The results of the analysis indicate that the development of PBL-based instructional videos is fully aligned with the requirements of the junior high school science curriculum, as it supports conceptual, contextual, and problem-solving-oriented learning. The integration of dynamic visualizations and authentic problems within the videos strengthens the achievement of learning objectives related to uniform linear motion (GLB) and uniformly accelerated linear motion (GLBB) and promotes a meaningful improvement in students' conceptual understanding.

Following the curriculum analysis, a needs analysis was conducted to obtain a factual overview of students' characteristics, learning constraints related to GLB and GLBB, and instructional media requirements. This analysis was carried out through classroom observations, interviews with teachers and students, and a review of instructional documents, which served as the basis for formulating the specifications of the PBL-based instructional video (Fridayanti et al., 2022; Hatimah et al., 2022).

Table 2. Results of Learning Needs Analysis

No	Analysis Aspect	Main Field Findings	Implications for PBL Video Design
1	Student Characteristics	Students prefer visual, interactive media and experiential learning	Videos are designed to be engaging, contextual, and easily accessible
2	GLB & GLBB Learning Problems	Low conceptual understanding, frequent misconceptions, and difficulty visualizing motion	Videos include motion animations, simulations, and everyday phenomena
3	Learning Practices	Dominance of lectures and less effective PowerPoint-based instruction	Videos replace PowerPoint as the primary learning media
4	Media Needs	The need for concrete, engaging media that supports PBL	Videos are structured according to PBL stages
5	Student Preferences	Students show greater enthusiasm when using video-based learning	Videos are accessible anytime and anywhere

The findings demonstrate that students require instructional media capable of visualizing motion concepts in a concrete, engaging, and contextual manner, integrated with a PBL approach, in order to optimally and meaningfully enhance their understanding of GLB and GLBB concepts.

The next stage involved product design to ensure that the developed instructional video is not only visually appealing but also possesses a strong pedagogical structure, is integrated with the syntax of Problem-Based Learning (PBL), and is relevant to both the characteristics of GLB and GLBB content and students' learning needs (Hatimah et al., 2022; Styowati & Utami, 2022).

Table 3. Results of Product Design Analysis

No	Design Component	Design Specifications	Achievement Indicators
1	Learning Model	Video fully integrated with PBL syntax (problem orientation, investigation, solution, reflection)	All PBL stages explicitly appear in the video flow
2	Video Scenario	Based on real-life GLB–GLBB phenomena	Students are able to relate concepts to real contexts
3	Problem Flow	Contextual problems arranged progressively from simple to complex	Problems stimulate critical thinking and problem-solving
4	Storyboard	Visualization of motion, graphs, animations, and simulations	Abstract concepts are concretely visualized
5	Language & Narration	Communicative and simple language	Learning messages are easily understood by students
6	Evaluation Structure	Questions based on conceptual understanding indicators	Measures the ability to provide examples, explain, and draw conclusions

The product design confirms that each video component serves a measurable pedagogical function and is mutually integrated, ensuring that the PBL-based instructional video functions not merely as an information delivery medium but also as a means of knowledge construction that promotes meaningful conceptual understanding of GLB and GLBB.

The research instruments were designed to ensure that the quality of the PBL-based instructional video product could be objectively assessed and that its impact on students' conceptual understanding could be comprehensively measured, particularly through indicators of the ability to provide examples, explain concepts, and draw conclusions, which represent the depth of students' conceptual understanding (Forester et al., 2024; Hatimah et al., 2022).

Table 4. Research Instrument Design

No	Instrument Type	Measurement Purpose	Assessed Indicators	Scale / Technique
1	Expert Validation Sheet	Assess the feasibility of the instructional video	Content suitability, PBL structure, language, visualization, and technical quality	Likert scale 1–5
2	Student and Teacher Response Questionnaire	Measure practicality and attractiveness of the media	Ease of use, attractiveness, usefulness	Likert scale 1–5
3	Conceptual Understanding Test	Measure learning impact	Providing examples, explaining, and drawing conclusions	Structured essay test

The design of these instruments ensures that all aspects of product quality and learning outcomes are measured systematically and reliably, and are aligned with the characteristics of conceptual physics learning, thereby enhancing the academic validity and practical relevance of the research findings.

The video production stage was conducted to realize the PBL-based instructional design into a concrete, communicative, and contextual audiovisual medium capable of effectively facilitating students' conceptual understanding of GLB and GLBB (Fitri, 2024).

Table 5. Learning Video Production Results

No	Production Component	Product Specifications	Quality Indicators
1	Content Material	Uniform Linear Motion (GLB) and Uniformly Accelerated Linear Motion (GLBB) based on real-life phenomena	Alignment with curriculum and scientific concepts
2	PBL Structure	Problem orientation – investigation – solution – reflection	Complete PBL syntax presented in the video
3	Visualization	Motion animations, simulations, graphs	Abstract concepts become concrete
4	Narration & Language	Simple and communicative language	Easily understood by students
5	Technical Production	Clear audio, stable visuals, effective duration	Viewing comfort
6	Evaluation Component	Integrated conceptual questions	Measurement of conceptual understanding

The production results indicate that the learning video not only meets the technical standards of instructional media but also demonstrates strong pedagogical value in visualizing motion concepts and consistently integrating the Problem Based Learning (PBL) approach. Consequently, the video effectively supports meaningful physics learning oriented toward conceptual understanding.

Validation was conducted to ensure that the developed PBL-based learning video met academic and pedagogical quality standards, including material relevance, PBL structure, language clarity, visualization quality, and technical media aspects, prior to classroom implementation (Hatimah et al., 2022; Styowati & Utami, 2022).

Table 6. Product Validation Results

No	Assessment Aspect	Main Indicators	Mean Score	Category	Expert Recommendation
1	Format & Content Feasibility (Content Expert)	Accuracy of GLB–GLBB concepts, learning objectives, presentation structure	3.72	Very Good	Suitable for trial without substantial revision
2	Language Feasibility (Content Expert)	Language clarity, terminology accuracy, absence of ambiguity	3.65	Very Good	Minor revisions in sentence formulation
3	Visual Feasibility (Media Expert)	Image/video quality, display clarity, support for PBL	3.78	Very Good	Optimization of color contrast and graphics
4	Audio Feasibility (Media Expert)	Sound clarity, audio–visual synchronization, intonation	3.69	Very Good	Adjustment of background music volume
5	Technical Media Feasibility	Video stability, device compatibility	3.74	Very Good	Suitable for field testing

Scores were based on a 1–4 scale: 4 = Very Good; 3 = Good; 2 = Fair; 1 = Poor.

The content expert validation results indicate that the learning video presents GLB and GLBB materials accurately, systematically, and in alignment with learning objectives, and that the content is well integrated within the Problem Based Learning framework. The language used was assessed as communicative, easy to understand, and free from ambiguity. Meanwhile, media experts evaluated the visual and audio quality as very good, noting that motion visualizations and graphical elements effectively supported conceptual understanding, while the audio was clear and well synchronized with the visuals. Several minor improvement suggestions were provided, particularly regarding color contrast optimization and background music volume adjustment. Overall, the experts concluded that the PBL-based learning video product is feasible for implementation testing in instructional settings.

The implementation of the Problem Based Learning (PBL)-based learning video was conducted with 36 students as the research sample, aiming to improve students' conceptual understanding of Uniform Linear Motion (GLB) and Uniformly Accelerated Linear Motion (GLBB). The implementation process began with a pretest to measure students' initial conceptual understanding, followed by instruction using the structured PBL-based video through stages of problem orientation, exploration, problem-solving, and reflection. The process concluded with a posttest to assess changes in conceptual understanding after the intervention.

Table 7. Descriptive Statistical Analysis Results

Statistics	Pretest	Posttest
N (Valid)	36	36
N (Missing)	0	0
Mean	57.97	69.44
Std. Error of Mean	1.67	0.90
Median	58.00	69.00

Mode	50	65
Std. Deviation	10.04	5.38
Variance	100.83	29.00
Skewness	0.06	0.62
Std. Error of Skewness	0.39	0.39
Kurtosis	–0.25	0.76
Std. Error of Kurtosis	0.77	0.77
Range	45	25
Minimum	37	60
Maximum	82	85
Sum	2,087	2,500

The descriptive statistical analysis results indicate a significant and meaningful improvement in learning quality. The mean student score increased from 57.97 on the pretest to 69.44 on the posttest, reflecting an increase of 11.47 points. This improvement demonstrates that the application of PBL-based learning videos effectively enhances students' conceptual understanding of GLB and GLBB materials.

The reduction in standard deviation from 10.04 to 5.38, accompanied by a decrease in variance from 100.83 to 29.00, indicates that the improvement in students' abilities was not limited to a small proportion of learners but was distributed across nearly all students. In other words, the learning process not only improved achievement levels but also reduced disparities in conceptual understanding, resulting in more stable and homogeneous learning outcomes.

From a distributional perspective, the pretest skewness value of 0.06 and posttest value of 0.62, along with kurtosis values close to zero (−0.25 and 0.76), indicate that the data distribution approximates normality. This condition strengthens the statistical validity of the learning outcome data and suggests that the observed improvement represents a systematic effect of the instructional intervention rather than a data anomaly.

Substantively, the increase in the minimum score from 37 to 60 and the narrowing of the score range from 45 to 25 indicate that students with lower initial abilities experienced the most substantial progress. This finding represents a critical indicator of the success of the inclusive and problem-oriented PBL approach.

These findings are consistent with Dzulfiansyah et al (2025), who reported that problem-solving-based learning videos significantly improve students' conceptual understanding of physics, and further reinforce the results of Hatimah et al (2022) and Hafiza et al (2025), which demonstrated that integrating learning videos with the PBL model leads to conceptual understanding improvements of more than 30%.

Additionally, the results support the findings of Fridayanti et al (2022), who emphasized the crucial role of learning videos in visualizing abstract concepts, correcting misconceptions, and enhancing student motivation. The stability of learning outcomes, as reflected in the reduced variance and standard deviation, also corroborates Weng & Zheng (2023), who argued that strong conceptual learning produces more robust and evenly distributed student understanding.

Prior to conducting inferential statistical analysis using parametric tests, a prerequisite normality test was performed on the student learning outcome data. This test aimed to ensure that the data distribution met the assumption of normality, thereby allowing subsequent analyses particularly the paired sample *t*-test to be conducted in a statistically valid and accountable manner.

Table 8. Results of the Normality Test

Statistics	Value
Test Variable	Unstandardized Residual
N	36
Normal Parameters	
Mean	11.47

Std. Deviation	6.88
Most Extreme Differences	
Absolute	0.106
Positive	0.072
Negative	–0.106
Test Statistic	0.106
Asymp. Sig. (2-tailed)	0.200
Monte Carlo Sig. (2-tailed)	
Significance	0.745
99% Confidence Interval – Lower Bound	0.731
99% Confidence Interval – Upper Bound	0.759

Based on the results of the One-Sample Kolmogorov–Smirnov Test applied to the unstandardized residuals, the Asymp. Sig. (2-tailed) value is 0.200 and the Monte Carlo Sig. (2-tailed) value is 0.745. Both significance values exceed the critical threshold of 0.05, indicating that the residual data are normally distributed.

The Test Statistic value of 0.106, along with relatively small values of the Most Extreme Differences (Absolute = 0.106; Positive = 0.072; Negative = −0.106), demonstrates that the discrepancy between the empirical data distribution and the theoretical normal distribution is minimal. This finding suggests that the distribution of students' learning outcome data does not deviate significantly from a normal distribution pattern.

Furthermore, the residual distribution parameters show a mean value of 11.47 and a standard deviation of 6.88, reflecting a reasonable and proportional variation in the improvement of students' learning outcomes. The 99% Monte Carlo confidence interval, with a lower bound of 0.731 and an upper bound of 0.759, further strengthens the reliability of the normality test results.

Since the normality assumption has been satisfied, the students' learning outcome data are appropriate for further analysis using parametric statistical techniques. This provides a strong methodological basis to ensure that the research conclusions regarding the effectiveness of Problem-Based Learning (PBL)-based instructional videos in improving students' conceptual understanding possess high statistical validity and are scientifically defensible.

After meeting the normality assumption, the analysis was continued using a paired-sample t-test to empirically examine whether the implementation of Problem-Based Learning (PBL)-based instructional videos had a significant effect on improving students' conceptual understanding of Uniform Linear Motion (Gerak Lurus Beraturan/GLB) and Uniformly Accelerated Linear Motion (Gerak Lurus Berubah Beraturan/GLBB).

Table 9. Results of the Paired t-Test

Pair	Variable	Mean	N	Std. Deviation	Std. Error Mean	Correlation	Sig. (One-Sided p)	Sig. (Two-Sided p)
Pair 1	Pretest	57.97	36	10.04	1.67	0.82	< 0.001	< 0.001
	Posttest	69.44	36	5.38	0.90			

Paired Samples Statistics
The results of the Paired Samples Statistics indicate that the students' mean score increased consistently from 57.97 in the pretest to 69.44 in the posttest. The mean difference of 11.47 points suggests a substantial improvement in students' cognitive achievement following the implementation of PBL-based instructional videos. In addition, the standard deviation decreased from 10.04 to 5.38, indicating that students' performance became more homogeneous after the learning intervention.

Paired Samples Correlations
The Paired Samples Correlations show a correlation coefficient of 0.82 with a

significance level of $p < 0.001$ for both one-tailed and two-tailed tests. This very strong correlation indicates that the increase in posttest scores is closely associated with students' initial pretest conditions, thereby confirming that the observed improvement is a direct effect of the instructional treatment rather than random fluctuation.

With a significance value far below the 0.05 threshold, it can be concluded that there is a statistically significant difference between students' learning outcomes before and after the implementation of PBL-based instructional videos. Therefore, the hypothesis stating that the application of PBL-based instructional videos has a positive effect on students' conceptual understanding is statistically accepted.

These findings are consistent with the study by Dzulfiansyah et al (2025), which reported that problem-solving-based instructional videos significantly improve students' understanding of physics concepts. The results also strengthen the findings of Hatimah et al (2022) and Hafiza et al (2025), who found that the integration of instructional videos with the PBL model significantly enhances students' science conceptual understanding, both in terms of academic achievement and the equalization of learning outcomes.

Furthermore, the increased homogeneity of learning outcomes, as reflected by the reduction in standard deviation, supports the findings of Fridayanti et al (2022) and Hafiza et al (2025), who emphasized that video-based learning media not only improve test scores but also help correct misconceptions and strengthen students' conceptual structures through dynamic visualization and more contextual learning experiences.

In addition to the t-test used to examine the significance of learning outcome improvements, this study also employed N-Gain analysis to measure the effectiveness level of students' conceptual understanding improvement after the implementation of Problem Based Learning (PBL)-based instructional videos on the topics of Uniform Linear Motion (ULM) and Uniformly Accelerated Linear Motion (UALM). This analysis provides a proportional description of the extent of improvement achieved relative to students' initial abilities.

Table 10. Results of the N-Gain Analysis

No.	Component	Value
1	Mean Pretest Score	57.97
2	Mean Posttest Score	69.44
3	Mean N-Gain	0.27
4	N-Gain Category	Low–Moderate

The calculation results show that the average pretest score of 57.97 increased to 69.44 in the posttest, resulting in an average N-Gain value of 0.27, which falls within the low–moderate category. Quantitatively, this value indicates that the implementation of PBL-based instructional videos had a positive impact on improving students' conceptual understanding, although the level of improvement has not yet reached the high category.

The pedagogical significance of this low–moderate category is noteworthy. It indicates that PBL-based instructional videos were successful in improving students' conceptual understanding structures, particularly among students with low to moderate initial abilities, as reflected by the increase in the minimum score from 37 to 60 and the narrowing of the score range after the intervention. Nevertheless, these results also suggest that there is still room for further development in optimizing video design, increasing the intensity of conceptual practice, and deepening students' reflective activities during the learning process.

These findings are consistent with Dzulfiansyah et al (2025), who reported that problem-solving-based instructional videos lead to gradual and progressive improvements in conceptual understanding, particularly when students are still in the early stages of adapting to the learning model. The results are also in line with Hatimah et al (2022) and Hafiza et al (2025), who stated that although PBL-based videos can significantly enhance students' conceptual understanding, the maximum effectiveness is strongly influenced by the duration of implementation, the intensity of problem-solving exercises, and the quality of teacher facilitation during the learning process.

Moreover, Fridayanti et al (2022) and Hafiza et al (2025) emphasized that the success of instructional videos in improving learning outcomes largely depends on consistent media use and the reinforcement of students' reflective activities. Thus, the low–moderate N-Gain value obtained in this study reflects a healthy pedagogical transition process, in which students begin to construct more robust conceptual understanding through visual-based learning and contextual problem-solving.

After the implementation of Problem Based Learning (PBL)-based instructional videos and the administration of pretests and posttests, students' responses were measured to determine their level of acceptance, practicality, and perceptions regarding the quality of the instructional materials and media used in learning Uniform Linear Motion (ULM) and Uniformly Accelerated Linear Motion (UALM).

Table 11. Results of Student Response Questionnaire Analysis (n = 36)

Aspect	Main Indicators	Percentage of Positive Responses	Category
Content	Clarity, ease of understanding, communicative language	88%	Very Good
Media	Attractive appearance, clear audio, realistic visuals	91%	Very Good
Practicality	Supports understanding, increases interest, self-confidence, and thinking activity	90%	Very Good
Overall Average	—	89.7%	Very Good

Criteria: 81–100% = Very Good; 61–80% = Good; 41–60% = Fair; ≤40% = Poor

The analysis results indicate that students gave a very positive response to the implementation of PBL-based learning videos. Most students stated that the GLB and GLBB materials were presented clearly, were easy to understand, and employed communicative language. The video presentation was perceived as attractive, supported by clear audio quality and realistic visualizations that helped clarify motion concepts. In addition, the practicality aspect received very high ratings, as reflected in increased learning interest, thinking activities, self-confidence in solving problems, and the perception that learning became more enjoyable and meaningful. These findings reinforce the results of the learning effectiveness test, demonstrating that PBL-based learning videos not only improve learning outcomes quantitatively but also enhance the overall quality of students' learning experiences.

Findings, Implications, and Recommendations

This study yielded three main findings. First, the development of PBL-based learning videos was proven to be valid and feasible for use. Expert validation results showed that all major components content, language, visualization, PBL structure, and technical media aspects were classified as very good, with mean scores ranging from 3.65 to 3.78, indicating that the product was suitable for classroom implementation (Hatimah et al., 2022; Khoirunnisa, 2022; Styowati & Utami, 2022).

Second, the implementation of PBL-based learning videos significantly improved students' conceptual understanding. The average score increased from 57.97 to 69.44, with a gain of 11.47 points. The decrease in standard deviation from 10.04 to 5.38 and variance from 100.83 to 29.00 indicates that the improvement was not only individual but also evenly distributed and more homogeneous across the class. The data distribution met the normality assumption (Asymp. Sig. = 0.200; Monte Carlo Sig. = 0.745), ensuring the statistical reliability of the t-test results. A strong pretest–posttest correlation of 0.82 ($p < 0.001$) confirms that the score changes were a direct effect of the learning intervention. These findings corroborate previous studies showing that the integration of video and PBL significantly enhances conceptual understanding (Agustina et al., 2022; Hafiza et al., 2025).

Third, learning effectiveness was classified in the low–moderate category based on an N-Gain value of 0.27. This indicates that the PBL-based video successfully established a solid foundation of conceptual understanding, particularly for students with low initial ability, as evidenced by the increase in minimum scores from 37 to 60 and the narrowing of the score range from 45 to 25. This pattern aligns with the findings of (Dzulfiansyah et al., 2025), who reported that dynamic visualization and contextual problem-solving help correct misconceptions and strengthen conceptual understanding structures.

Beyond cognitive outcomes, affective and practicality aspects also showed very positive results. Student responses fell into the very good category, with an overall percentage of 89.7%, reflecting that students perceived learning as more engaging, easier to understand, and capable of enhancing learning interest, self-confidence, and thinking activities. These results support the findings of Fridayanti et al (2022) and Hafiza et al (2025), who emphasized that pedagogically designed video media improve the overall quality of learning experiences.

From a theoretical perspective, this study reinforces the constructivist learning paradigm that positions students as active knowledge constructors through contextual problem-solving. The integration of video with PBL syntax was shown to effectively transform abstract concepts of GLB and GLBB into concrete and meaningful learning experiences, as highlighted by Yani & Rahmi (2023) and Styowati & Utami (2022).

From a practical standpoint, these findings indicate that PBL-based learning videos function not merely as supplementary media but as core pedagogical instruments that orchestrate students' scientific thinking processes. This implication is particularly important for junior high school science teachers in designing instruction that not only improves achievement scores but also promotes equitable understanding, learning motivation, and cognitive engagement.

Recommendations

This study has several limitations that should be acknowledged. First, the research employed a pre-experimental one-group pretest–posttest design without a control group, which limits the ability to establish strong causal inferences regarding the effectiveness of the PBL-based instructional videos. Second, the sample size was relatively small and drawn from a single class at one junior secondary school, which may affect the generalizability of the findings. Third, the implementation period was limited to a short duration, which may not fully capture long-term impacts on students' conceptual understanding. In addition, the study focused only on the topics of Uniform Linear Motion (GLB) and Uniformly Accelerated Linear Motion (GLBB), so the applicability of the developed videos to other physics topics remains untested.

Based on the research findings, several recommendations are proposed. First, schools and teachers are encouraged to consistently integrate PBL-based learning videos into science instruction, particularly for abstract and dynamic topics such as GLB and GLBB. Second, to enhance learning effectiveness from the low–moderate N-Gain category to a moderate–high level, instructional design optimization is needed, focusing on: (a) increasing the duration and intensity of problem-solving practice, (b) deepening conceptual reflection, and (c) facilitating more structured discussions during the PBL stages (Hatimah et al., 2022; Rika Widianita, 2023). Third, future research is recommended to examine the effects of PBL-based videos on other science topics, involve larger and more diverse samples, and employ quasi-experimental or experimental designs combined with diagnostic assessment and differentiated instruction to improve the robustness and generalizability of learning outcomes.

CONCLUSION

This study concludes that the development and implementation of Problem-Based Learning (PBL)–based instructional videos on the topics of Uniform Linear Motion and Uniformly Accelerated Linear Motion demonstrate initial effectiveness in improving junior high school students' conceptual understanding. The developed product was shown to be valid, feasible, and practical based on evaluations from subject-matter experts, media experts, and student responses, all categorized as “very good.”

Empirical findings indicate a measurable improvement in students’ learning outcomes, reflected in an increase in the mean score from 57.97 to 69.44, accompanied by a reduction in variance and standard deviation, suggesting a more even distribution of conceptual understanding. The paired-sample t-test revealed a statistically significant difference between pretest and posttest scores. However, given the pre-experimental design and limited scope of implementation, these findings should be interpreted as evidence of initial instructional effectiveness rather than definitive proof of long-term impact. The N-Gain value (0.27), categorized as low-to-moderate, further indicates that while meaningful learning gains occurred, there remains substantial room for instructional optimization.

Beyond cognitive outcomes, students reported positive learning experiences characterized by increased engagement and motivation. Nevertheless, broader implementation over longer instructional periods and across diverse student populations is necessary to more comprehensively evaluate the sustainability and scalability of this approach. Future refinement may focus on strengthening problem-solving depth, extending learning duration, and integrating complementary assessment strategies to enhance conceptual mastery.

Overall, the integration of instructional video media with the PBL approach shows promising potential as an innovative and constructivist-oriented strategy in junior high school physics learning, while requiring further development and extended implementation to maximize its educational impact.

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