Jurnal Pembelajaran Dan Biologi Nukleus p-ISSN: 2442-9481
Vol 11 (4): 1320 - 1333, December 2025 e-ISSN: 2685-7332

Improving High School Students' Problem-Solving Skills in Ecosystem Learning through Problem-Based Learning Supported Instructional Videos

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Submitted September 10 Th 2025, and Accepted November 30 Th 2025

Abstract

Background: *Problem-Based Learning (PBL) has been shown to enhance higher-order thinking skills; however, its implementation still predominantly relies on worksheets, printed modules, or static media, which have not comprehensively facilitated all stages of the PBL process. Preliminary observations at senior high school (SMA Negeri 1 Toari and SMA Negeri 1 Latambaga) revealed that more than 60% of students experienced difficulties in identifying problems, and only about 35% were able to systematically formulate problem-solving strategies.* **Methodology:** *A Research and Development (R&D) approach based on the ADDIE framework was adopted in this study, encompassing the stages of analysis, design, development, implementation, and evaluation. Information was obtained through classroom observations, semi-structured interviews, expert validation procedures, as well as questionnaires administered to teachers and students to capture their responses.* **Findings:** *The results demonstrated that the instructional media developed in this study attained a validity index of 87.5%, which was classified as highly valid, while its practicality reached 90%, placing it within the highly practical category. Furthermore, the effectiveness analysis conducted using the Wilcoxon Signed-Rank Test produced a significance value of 0.000 (< 0.05), thereby confirming the effectiveness of the media in enhancing students' problem-solving abilities.* **Contribution:** *The findings indicate that the PBL-based instructional video developed in this research was both feasible and effective in improving students' understanding of problem-solving skills. The innovative contribution of this study is reflected in the instructional design of the video, in which learners are systematically directed through each phase of the PBL framework to facilitate the development of problem-solving abilities within biology learning.*

Keywords: *Ecosystem; Instructional video media; Problem solving skills; Problem-Based Learning*

https://doi.org/10.36987/jpbn.v11i4.8420

INTRODUCTION

Within the context of 21st-century learning, educational practices are expected to extend beyond knowledge acquisition and place equal emphasis on the cultivation of critical thinking, creativity, communication, and collaboration skills, commonly referred to as the 4C competencies. Mastery of these competencies plays a crucial role in preparing students to face future challenges and supporting their readiness for the workforce (Awaluddin, 2025). Critical and creative thinking skills have become core competencies in the era of technological advancement, as students are expected to evaluate information, select credible sources, and apply them in solving complex problems. In addition, effective collaboration and communication skills are essential for enabling students to work optimally within diverse learning environments (Muliana et al., 2024). Therefore, learning should be directed toward strengthening problem-solving skills through structured activities. This condition highlights the importance of developing validated, flexible, and systematic instructional media to effectively enhance students' problem-solving abilities.

The advancement of 4C competencies may be facilitated through the application of innovative and context-based instructional approaches, including Problem-Based Learning (PBL). This pedagogical model is oriented toward real or specific problems and is designed to strengthen students' critical thinking abilities in the process of identifying and resolving diverse challenges (Muliana et al., 2022). PBL is a pedagogical approach that emphasizes learning through the resolution of real-world problems related to everyday experiences, thereby initiating an innovative learning process that actively engages students (Kurniawan et al., 2023). As such, PBL is considered one of the learning models capable of increasing students' participation in developing skills relevant to the 21st century. Through a student-centered, real-problem-based learning approach, PBL is believed to provide more meaningful and contextual learning experiences (Muliana et al., 2024). However, the PBL learning process requires a relatively longer time, depending on the complexity of the problems and students' readiness to resolve them. In addition, not all students possess adequate self-directed learning skills or the ability to optimally utilize learning resources, which may result in varying levels of PBL effectiveness among learners. Teachers' difficulties in facilitating problems that align with students' contexts also present challenges, particularly when available instructional media are limited.

Biology learning on ecosystem topics, particularly ecosystem structure, is well suited to be developed through an environment-based Problem-Based Learning (PBL) approach, given its close relationship with students' surrounding conditions. This approach emphasizes the use of real environmental issues as contexts for problem solving (Awaluddin, 2025). Through environmentally oriented learning, students not only gain theoretical understanding of concepts but also actively engage in observing, analyzing, and formulating solutions to contextual problems. Consequently, this approach contributes to improving conceptual mastery while simultaneously strengthening students' environmental awareness and concern (Melati et al., 2023).

The results of observations at SMA Negeri 1 Toari indicate that the biology learning process is still predominantly dominated by lecturing methods and written assignments, resulting in relatively low levels of student engagement. The limited use

of attractive and interactive learning resources has also contributed to students' low learning motivation, particularly in ecosystem topics that require a contextual approach. Furthermore, the availability of learning resources that are aligned with the surrounding environmental conditions remains limited. These conditions highlight the need for instructional innovations capable of creating active and meaningful learning experiences while supporting the development of 21st-century skills.

One viable alternative that can be implemented is the development of creative, digitally based instructional media. Instructional media can stimulate students' thoughts, emotions, interests, and attention, thereby enabling effective educational interaction between teachers (as media developers) and students (Kurniawan et al., 2018). Animated instructional videos represent one form of digital learning media that is considered effective in presenting content in a visual, engaging, and easily comprehensible manner for learners. Through visual presentation, instructional videos are able to concretize abstract or difficult concepts, thus assisting students in achieving a more optimal understanding of the material (Adijaya, 2023).

Numerous studies demonstrated that the integration of visual illustrations, case-based examples, and explanatory content within instructional videos supports the comprehension of complex subject matter, stimulates learner curiosity, and promotes higher levels of student engagement throughout the learning process (Fitri & Ardipal, 2021). Other studies have also revealed that innovative instructional videos are effective in increasing students' learning interest and learning outcomes, particularly for complex subject matter (Wardani et al., 2024). When combined with a Problem-Based Learning (PBL) approach, video media can serve as a highly supportive tool for developing problem-solving skills. This approach further enables learning to become more contextual and meaningful, as students can directly relate the material to real-life situations visualized through the videos.

Several studies indicate that the use of interactive media, instructional videos, and project-based strategies can enhance students' critical thinking and problem-solving abilities (Agustien et al., 2018). However, most previous studies exhibit several limitations, including small sample sizes, a lack of comprehensive expert validation, and a focus on a single type of media or specific school contexts. Moreover, some studies have not thoroughly evaluated the effectiveness of instructional media in improving problem-solving skills, thereby limiting the generalizability of their findings.

Based on the above considerations, it is important to conduct a research and development study focusing on the creation of environment-based PBL instructional video media, particularly for ecosystem topics at SMA Negeri 1 Toari. This development aims to assist students in understanding the material more easily and engagingly, while also serving as a means to foster problem-solving skills. Accordingly, students are expected not only to achieve optimal cognitive mastery but also to develop into individuals with reflective thinking abilities who demonstrate responsible attitudes and actions toward the environment. Moreover, a contribution to the advancement of context-based biology instructional models that correspond with the implementation of the Merdeka Curriculum is anticipated from this research. This study is expected to produce Problem-Based Learning (PBL)–based instructional video media for ecosystem topics, to determine its validity through expert evaluation, to examine its practicality based on teachers' and students' responses, and to analyze its effectiveness

in enhancing students' problem-solving skills. The novelty of this research lies in the development of PBL-oriented video media that is specifically designed to support the improvement of students' problem-solving abilities in ecosystem learning. This study seeks to address the limitations of biology instructional media that tend to be passive and insufficiently promote students' critical engagement in problem-solving activities, thereby offering an innovative contribution to the advancement of biology education.

METHOD

This study employed a development research method using the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation (Agustien et al., 2018). This model represents a systematic approach designed to produce effective instructional products. The ADDIE model is frequently used as a foundational framework in instructional design due to its high level of flexibility and broad applicability across various educational contexts (Marliani, 2021). There fore, the ADDIE model was selected for this study because of its systematic, flexible, and comprehensive characteristics, as well as its widespread use in instructional development.

Sample or Participant

In this research, participants were selected using a purposive sampling strategy, whereby research subjects were intentionally chosen according to predetermined criteria, including Biology teachers actively involved in the instructional process and students who had previously learned ecosystem-related content. Practicality data for the instructional media were obtained through response questionnaires distributed to both teachers and students. The study involved 25 tenth-grade students from SMA Negeri 1 Toari during the 2025/2026 academic year as research subjects. Meanwhile, the media trial, serving as the practicality assessment, was implemented at the same institution with the participation of 19 tenth-grade students in the corresponding academic year. SMA Negeri 1 Toari was selected as the research site because video-based instructional media were still infrequently utilized in its learning activities.

The effectiveness test of the media on problem-solving skills was conducted at SMA Negeri 1 Latambaga, involving 25 students. SMA Negeri 1 Toari was not selected for the effectiveness test because, during the practicality trial at this school, it was found that the facilities for using video were inadequate. Furthermore, SMA Negeri 1 Latambaga was chosen due to its relatively large student population, allowing for a more optimal evaluation of the media's effectiveness in enhancing students' problem-solving skills.

Instrument

The validity assessment instrument in this study consisted of 17 statements covering three main aspects: media validity, content validity, and language validity. Media validity was evaluated based on the appropriateness of the display, the quality of visual and audio elements, the alignment of the design with learning objectives, and the attractiveness of the presentation. Content validity was examined in terms of the

accuracy and alignment of the material with the curriculum, the depth of the concepts presented, the accuracy of data and examples, and their relevance to contextual problems that characterize Problem-Based Learning (PBL). Language validity was assessed based on clarity of language use, suitability to students' developmental levels, adherence to linguistic conventions, and readability in supporting students' understanding of the presented material.

The practicality instrument consisted of 10 statement items completed by students and 14 items administered to teachers. Meanwhile, the learning effectiveness instrument, specifically for measuring problem-solving skills, comprised five test items encompassing four main domains of problem solving: (1) identifying the problem, (2) formulating and selecting problem-solving strategies, (3) executing the strategy, and (4) evaluating the solution by reviewing both the outcomes and the problem-solving process. Data obtained from expert validation, student response questionnaires, and teacher responses were analyzed in the form of percentages using the formula proposed by Ikhwani & Kuntjoro (2021) (found on formula 1). The percentage of the validation sheets were categorized based on Table 1. The product that has obtained expert validation will subsequently be trialed as an instructional medium. The analysis of the practicality of the video media based on students' and teachers' responses is presented in table 2.

$$\text{Score} = \frac{Obtained\ Score}{Maximum\ Possible\ Score} \times 100\ \% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

Table 1. Validity Assessment Criteria by Andriani & Suhandi (2022)

Percentage (%)	Validation Criteria
81.5 – 100	Highly Valid
62.5 – 81.5	valid
43.5 – 62.5	Less Valid
25.0 – 43.5	Invalid

Table 2. Practicality Criteria by Putri & Sulistyanigrum (2022)

Practicality Score (%)	Criteria
76 - 100	Highly practical
51 - 75	Practical
26 - 50	Less practical
20 - 25	Not practical

Data collection

Data collection in this study was conducted using observation, interviews, response questionnaires, and expert validation sheets. Observations and interviews were employed to identify and analyze learning-related problems encountered in the field. The expert validation sheets were used to obtain information regarding the validity of the instructional media, content, and language aspects, as assessed by two expert validators. Furthermore, response questionnaires were administered to collect teachers' and students' evaluations of the developed media. In addition, a problem-solving test was administered to students as an instrument to measure the effectiveness of the developed instructional media.

Procedure

The initial stage of this study was the analysis phase. Based on the results of the analysis obtained from Grade X teachers at SMA Negeri 1 Toari High Schhol, it was found that the learning process was still focused on conventional content delivery and was not supported by the use of instructional video media, while the implementation of problem-solving–based learning models had not been carried out optimally. One factor contributing to the limited use of instructional videos was teachers' insufficient technological proficiency. The analysis of student characteristics indicated that students tend to prefer innovative learning approaches, as these increase their engagement in the learning process. In addition, students showed a strong interest in the use of digital-based media. Findings from interviews with students of Class XB at SMA Negeri 1 Toari revealed that they preferred instructional media that could facilitate their understanding of biology content, particularly through innovative learning approaches. Budiman et al., (2020) stated that one form of support provided by educational institutions is the strengthening of technology utilization. This effort aims to equip teachers with the ability to optimize the use of technology in learning activities (Setiyadi, 2019). In line with this, the curriculum in Indonesia continues to be refined to prepare students' competencies in responding to global technological developments (Nisa & Liestyasari, 2025; Santika, 2021).

The second stage of this study was the video media design phase. The design process in this development research began with selecting learning materials, followed by preparing a plan aligned with the predetermined learning objectives and indicators. The video media were systematically designed to include an opening section, content presentation, and a closing section.

The third stage of this study was the development phase. The developed Problem-Based Learning (PBL)–based instructional video media were organized into three main components—opening, content presentation, and closing—which were aligned with the PBL model's stages. The media development process was based on previously prepared learning materials while considering technical aspects such as recording techniques, lighting quality, and audio clarity. Subsequently, the editing stage was carried out using *CapCut, Canva*, and *Animaker* applications, with the final video was produced in *MP4 format*. During the editing process, the video was enhanced with text, visual effects, transitions, animations, and background music to clarify content delivery and increase students' interest. After the development process was completed, the instructional media were validated to assess their feasibility (Fitri & Ardipal, 2021; Zulfianor et al., 2022). The validation process involved three validators consisting of a language expert, a subject-matter expert, and a media expert (Ami & Yanti 2024). Each validator provided assessments and feedback that served as the basis for refining the developed product.

The fourth stage of this study was the implementation phase. In research and development studies, the implementation phase is conducted through field trials. At this stage, the instructional video media were tested with one biology teacher and all students of Class X B at SMA Negeri 1 Toari, totaling 19 students. The classroom trial was intended to determine the practicality level of the developed instructional video

media. Prior to their use in the learning process, the video media were reviewed and evaluated by the subject teacher.

The fifth stage was the evaluation phase. At this stage, the researcher compiled all data obtained from the validity and practicality tests conducted during the field trials. Subsequently, questionnaires were administered to teachers and students to gather information about their responses to the developed instructional video media. The collected data were then analyzed to determine the practicality level of the instructional video media.

Data Analysis

Data analysis in this study on the development of instructional video media to enhance problem-solving skills in ecosystem topics was conducted using descriptive and inferential analyses. Qualitative descriptive analysis was employed to assess the validity and practicality levels of the developed media. Meanwhile, inferential analysis was performed using the Shapiro–Wilk and Wilcoxon tests to examine the research data.

RESULT AND DISCUSSION

Validty Test

Based on validation results from two expert validators of the environment-based instructional video media for ecosystem topics, an average score of 87.5% was obtained, placing it in the highly valid category, indicating that the media are suitable for field testing. Nevertheless, prior to the implementation of the trial, the instructional media were revised in accordance with the suggestions and feedback provided by the validators to ensure optimal product quality in supporting the clearning process.

Table 3. Analysis of the Results of Instructional Video Media Validation by Expert Validators

Expert Validator	Content (%)	Media (%)	Languange (%)	Average (%)	Category
Validator 1	90	85	89	88	Highly Valid
Validator 2	88	86	87	87	Highly Valid
Average	89	85.5	88	87.5	Highly Valid

Practicality Test

Table 4. Results of the Biology Teacher Response Questionnaire

No.	Indicator	Percentage (%)	Category
1.	Content	83	Very Practical
2.	Media	91	Very Practical
3.	Language	87	Very Practical
	Average	87%	Very Practical

Table 5. Results of the Student Response Questionnaire for Class XB

No.	Indicator	Percentage	Category
1.	Content	89%`	Very Practical
2.	Media	90%	Very Practical
3.	Language	100%	Very Practical
	Average	93%	Very Practical

Table 6. Analysis of Teachers' and Students' Response Questionnaire Results

Respondent	Percentage	Category
Teacher Response	93%	Highly Practical
Student Response	87%	Highly Practical
Average	90%	Highly Practical

Based on the practicality trial data, derived from teachers' and students' responses to the development of environment-based instructional video media for ecosystem topics, an average practicality score of 90% was obtained, which falls into the highly practical category.

Effectiveness Result (Normality Test and Wilcoxon Test)

A descriptive analysis of the problem-solving skills of Grade X students at SMA Negeri 1 Latambaga on ecosystem topics (presented in Table 10). This study involved 25 students as the sample. The descriptive analysis indicated an improvement in students' problem-solving abilities. To examine the data distribution characteristics, a normality test was conducted. Subsequently, hypothesis testing was performed using SPSS software with the Wilcoxon Signed-Rank Test, and the results are presented in Table 7.

Table 7. Normality Test Description

Test of Normality			
	Shapiro-Wilk		
	Statistic	df	Sig
Pretest	.810	25	.000
Posttest	.945	25	.192

Table 8. Wilcoxon Signed-Rank Test Description

Ranks				
		N	Mean Rank	Sum of Ranks
Posttest - Preetest	Negative Ranks	0[a]	.00	.00
	Positive Ranks	22[b]	11.50	253.00
	Ties	3[c]		
	Total	25		

Test Statistic[a]		
	Z	Asymp.Sig. (2-tailed)
Posstest- Pretest	-4.153[b]	.000

Discussion

The results of the study indicate that the environment-based Problem-Based Learning (PBL) instructional video media for ecosystem topics developed at SMA Negeri 1 Toari achieved a very high level of validity, with an average expert evaluation score of 87.5%. In addition, the media were also deemed highly practical for use in learning, based on teacher and student responses, with an average practicality score of 90%. These findings suggest that the developed instructional video media not only meet theoretical feasibility criteria but are also easy to implement and effective in learning practice. In terms of validity, the components of content, media, and language all met the established criteria. The validators provided particularly high ratings for content and language, indicating that the video content aligns well with the learning objectives and competency indicators. Adijaya (2023); Vela et al., (2021) stated that practicality assessments include aspects of learning activities, ease of use, and the usefulness of the media. The practicality test of the animated instructional video media showed that teacher responses during the limited trial obtained a score of 92%, categorized as highly practical, while the extended trial received a score of 90%, also categorized as highly practical. Overall, the average practicality score based on teacher responses reached 91%, qualifying as highly practical.

Furthermore, in terms of practicality, teacher and student responses indicated that the developed instructional video media are easy to use, aligned with learning needs, and capable of supporting the implementation of innovative learning. Agustien et al., (2018); Indriyanti et al., (2023) stated that instructional videos belong to audiovisual media that function as a means of delivering information, particularly instructional content. Thus, instructional videos can be understood as audiovisual media that communicate learning messages to support students' understanding. The use of these instructional videos has been shown to enhance learning motivation and academic achievement. Teachers reported that the media significantly facilitated more effective and efficient content delivery, while students experienced increased motivation, engagement, and interest in studying biology.

The effectiveness test of the instructional video media in biology learning at SMA Negeri 1 Latambaga demonstrated that the developed video media were effective in enhancing students' problem-solving skills. The implementation of video media in ecosystem learning using the Problem-Based Learning (PBL) model increased students' interest in understanding the presented problems (Panigoro & Alwi, 2024). Through the use of video media, students are directed toward real-world contexts, enabling them to analyze problems and formulate problem-solving solutions more systematically (Fayzah et al., 2025; Hasanah et al., 2019). The use of instructional video media benefits not only students but also facilitates teachers in explaining concepts and delivering learning content. Problems presented in the videos for ecosystem topics assist students in the problem-solving process by providing realistic depictions of environmental conditions and phenomena. Visualizations of issues such as environmental pollution, food chain imbalances, and habitat destruction make it easier for students to understand cause-and-effect relationships within an ecosystem. The presentation of these problems also fosters the development of critical thinking skills, stimulating students to analyze the causes and impacts of issues and formulate appropriate solutions based on ecological concepts. Thus, video media containing

contextual problems not only clarify learning content but also enhance students' abilities to identify, analyze, and solve problems independently and collaboratively.

The findings of this study are consistent with previous research Rahmawati & Atmojo (2021) which confirmed that the use of instructional video media is effective in enhancing students' conceptual understanding as well as their engagement in the learning process. Fitri & Ardipal (2021) emphasized that the success of learning activities is not solely determined by the sophistication of the media used, but instead by the appropriateness and effectiveness of educators' utilization of the media. Instructional video media is a form of audiovisual media that conveys learning messages through a combination of audio and visual elements, presented as moving images and mechanically projected to appear more realistic. This presentation method can increase students' learning motivation, enrich learning resources, and stimulate students' interest and imagination (Nasution & Taufik, 2025; Sinurat et al., 2025).

The collaboration between instructional video media and supporting learning materials has been shown to enhance problem-solving abilities. In addition, interactive multimedia, including videos, has been proven to improve students' skills in drawing conclusions and solving problems (Astiti et al., 2021; Rahmawati & Atmojo, 2021). Instructional videos are effective for improving problem-solving skills in physics. Previous studies also reported that PBL-based video learning models are effective because they successfully enhance students' physics problem-solving abilities (Barus et al., 2025; Muchib, 2018) Physics learning, in this context, serves as a means to develop critical thinking and problem-solving skills applicable to daily life (Gusmania & Dari, 2018; Melati et al., 2023; Oktalia et al., 2024). Problem-solving ability is considered one of the key competencies that must be developed in students (Muliana et al., 2022; Safithri et al., 2021).

According to Fitri & Ardipal (2021), research on the use of animation in mathematics learning demonstrated that the practicality test yielded very practical results, with student response scores of 90.57% and teacher response scores of 95%. Based on validation and practicality testing, this animated instructional media was declared highly valid, practical, and feasible for use in learning.

CONCLUSION

The Problem-Based Learning (PBL)–based instructional video media for ecosystem topics was found to be feasible, practical, and effective for use in senior high school biology learning. Expert validation results indicated a validity level of 87.5%, categorized as highly valid, while the practicality test yielded a score of 90%, classified as highly practical. Furthermore, the effectiveness test, analyzed using the Wilcoxon Signed-Rank Test, showed a significance value of 0.000 ($p < 0.05$), indicating a significant improvement in students' problem-solving skills following the implementation of the instructional media. Academically, the development of PBL-based video media enables the delivery of learning materials in an interactive and systematic manner and plays an effective role in supporting the enhancement of students' problem-solving abilities in biology learning.

ACKNOWLEDGEMENTS

The author would like to express sincere gratitude to the supervising lecturers, expert validators from the Biology Education Study Program, as well as the teachers and students of SMA Negeri 1 Toari and SMA Negeri 1 Latambaga for their support and contributions of data throughout the research process. Appreciation is also extended to the school authorities for providing facilities and assistance, which enabled the research to be carried out successfully. All of this support and collaboration has made a significant contribution to the completion of this study.

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How To Cite This Article, with *APA style* :

Oktaviani, P. M., Pratiwi, S., Tendrita, M., Kaliu, S., & Ernawati, E. (2025). Improving High School Students' Problem-Solving Skills in Ecosystem Learning through Problem-Based Learning Supported Instructional Videos. *Jurnal Pembelajaran dan Biologi Nukleus*, *11*(4), 1320-1333. https://doi.org/10.36987/jpbn.v11i4.8420

Conflict of interest : The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions : All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft of the manuscript was submited by [**Putu Meta Oktaviani**]. All authors contributed on previous version and revisions process of the manuscript. All authors read and approved the final manuscript.