THE EFFECTIVENESS OF YOUTUBE-ASSISTED PROJECT-BASED DEEP LEARNING IN IMPROVING SCIENCE CONCEPT UNDERSTANDING AMONG JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT

This study aimed to analyze the effectiveness of the Deep Learning instructional model integrated with the Project-Based Learning (PjBL) approach assisted by YouTube media in improving junior high school students' understanding of science concepts. The study employed a quasi-experimental design using a pretest-posttest control group design. The sample consisted of 60 eighth-grade students at SMP Negeri 1 Sungai Penuh divided into an experimental class and a control class. The experimental group received YouTube-assisted PjBL based on deep learning, while the control group received conventional instruction. The research instrument was a HOTS-based multiple-choice conceptual understanding test with a validity coefficient of 0.83 and reliability of 0.79. Data analysis was conducted using the Independent Sample T-Test and N-Gain Score after passing normality and homogeneity tests. The results showed that the experimental class achieved a higher average posttest score (84.13) than the control class (69.87). The t-test result indicated a significant difference between the two groups ($t = 7.234$; $p < 0.05$). Furthermore, the experimental class obtained a higher N-Gain score (0.66) compared to the control class (0.38). Therefore, integrating Deep Learning, PjBL, and YouTube media effectively improved students' understanding of science concepts.

Keywords : *Deep Learning, Project-Based Learning, YouTube, Concept Understanding, Junior High School Science*

INTRODUCTION

The 21st century represents a new direction and challenge for education, particularly in preparing a generation capable of critical, creative, collaborative, and communicative thinking to compete within the rapid development of technology. This condition encourages the transformation of learning paradigms from teacher-centered to student-centered approaches based on the development of deeper competencies. In this context, Deep Learning as a meaningful learning approach emerges as a response to the phenomenon of surface learning that still dominates science classrooms at the junior high school level. Surface learning is often driven only by shallow student motivation, such as passing examinations. Students learn merely to know the material without truly understanding what is being studied and the processes occurring within the material. (Hatima,2025)

Deep Learning in the educational context differs from Deep Learning as an artificial intelligence technique. It refers to a learning approach that encourages students not only to memorize facts but also to understand, analyze, evaluate, and create new knowledge as a result of classroom learning processes (Fullan et al., 2018). Deep learning is an approach that emphasizes comprehensive conceptual mastery, interconnection among concepts, and the ability to transfer knowledge into various contextual situations. (Diputera et al., 2024) emphasized that deep learning is not merely oriented toward superficial understanding but also encourages holistic and applicable knowledge integration, thereby shaping lifelong learners. The implementation of this approach has proven to significantly improve active participation, learning achievement, and students' ability to adapt and apply knowledge in new contexts.

In an increasingly dynamic educational landscape, deep learning has become more relevant because it shifts the orientation of learning from merely accumulating information toward constructing deep and sustainable meaning. Furthermore, this approach contributes to the development of students' creativity through connecting ideas, exploring alternative solutions, and forming original thinking based on reflective and independent knowledge construction. This approach aligns with the demands of the Merdeka Curriculum, which emphasizes the development of the Pancasila Student Profile through contextual and meaningful learning. However, its implementation in schools still faces various obstacles, particularly the limitations of learning models and media capable of facilitating students' higher-order thinking processes. Moreover, not all schools in Indonesia possess adequate learning media facilities to help teachers visualize existing theories.

Project-Based Learning (PjBL) emerges as one of the learning models considered aligned with the principles of Deep Learning. Through PjBL, students are directly involved in solving authentic real-world projects, thereby encouraging deeper cognitive activation (Nurazizah et al., 2025). Various studies have proven the advantages of PjBL in improving learning motivation, critical thinking skills, and students' conceptual understanding (Kokotsaki et al., 2016). Through solving real-world problems, PjBL encourages analysis, evaluation, and information synthesis while also improving students' collaboration and communication skills, even increasing students' critical thinking skills by up to 80% (Sholeh et al., 2024). Nevertheless, effective implementation of PjBL requires support from rich and easily accessible learning resources for students.

In its implementation, the effectiveness of Project-Based Learning (PjBL) is strongly influenced by the availability of varied, contextual, and easily accessible learning resources. The project completion process requires students to independently explore information, construct knowledge, and connect concepts with real-world phenomena. However, the limitations of conventional classroom learning resources often become obstacles in optimizing this process. Therefore, digital learning media are needed to function as scaffolding to strengthen exploration processes, visualize abstract concepts, and expand learning access beyond the classroom. Students not only imagine existing concepts but also visualize the theories they study.

In the context of science learning, the dominance of conventional teacher-centered methods tends to limit students' cognitive engagement and is less capable of developing higher-order thinking skills. Various studies indicate that the implementation of Project-Based Learning (PjBL) supported by digital technology can serve as a strategic solution for improving learning quality. A study by (Putri et al., 2023) revealed that the integration of PjBL with digital platforms such as YouTube can enhance learning engagement and student creativity through more contextual and interactive learning presentations. In addition, the use of interactive video media in project-based learning has proven effective in improving higher-order thinking skills (HOTS) and students' conceptual understanding because it is capable of visualizing abstract concepts (Wibowo et al., 2024). Furthermore, the integration of technology in PjBL aligns with the demands of 21st-century learning, which emphasizes the mastery of critical thinking, collaboration, and problem-solving skills in real-world contexts (Wahyudi et al., 2024). Moreover, project-based learning has been proven effective in improving students' conceptual understanding through meaningful learning experiences based on real-world problems (Tian et al., 2023). These findings strengthen the idea that the integration of deep learning approaches, PjBL, and YouTube media has great potential to support the implementation of more meaningful learning while bridging the gap between theoretical concepts and real-world phenomena in science education.

YouTube media emerges as a promising solution to support the implementation of PjBL in this digital era. As the world's largest video-sharing platform with more than 2.5 billion active users (YouTube, 2025), YouTube possesses high pedagogical potential due to its ability to present information in engaging audiovisual formats, facilitate the visualization of abstract concepts, and support diverse learning styles. Its high accessibility enables students to learn independently outside the classroom, strengthen conceptual understanding acquired at school, and further explore knowledge according to their needs and interests.

Turiman et al. (2020) found that the use of YouTube videos integrated with active learning activities significantly improved students' conceptual understanding compared to conventional text-based learning. This finding is supported by Mayer's Cognitive Theory of Multimedia Learning (CTML) (Nurhatmi, 2025), which states that learning becomes more effective when information is presented simultaneously through verbal (audio) and visual channels. In the context of PjBL, YouTube functions as a scaffold that assists students during the investigation and project planning phases. Students can access tutorial videos, project examples, and relevant conceptual explanations as references in completing their projects. The flexibility of YouTube access, which allows videos to be watched anytime and anywhere, also supports the principle of independent learning that forms an integral part of PjBL.

Based on the explanation above, there is still a research gap related to the implementation of integrative Deep Learning, the Project-Based Learning (PjBL) model, and the utilization of YouTube media in junior high school science learning. Previous studies generally focused on each variable separately, so the synergy among these three components in improving students' understanding of science concepts has not been comprehensively explored. This condition indicates the need for more systematic empirical studies to examine the effectiveness of learning approaches that integrate deep cognitive aspects, project-based learning, and digital technology as supporting learning media.

In line with this issue, this study was designed to analyze the effect of optimizing Deep Learning through YouTube-assisted PjBL on junior high school students' understanding of science concepts at SMP Negeri 1 Sungai Penuh. This study employed a quantitative approach with a quasi-experimental design to examine differences in learning outcomes between the experimental and control classes. Theoretically, this study is expected to enrich discussions regarding innovative learning models in science education. Practically, the findings are expected to serve as a reference for teachers in developing science learning strategies that are more meaningful, contextual, and adaptive to the development of digital technology and the demands of 21st-century competencies.

METHOD

Research Design

This study employed a quantitative approach using a quasi-experimental method with a pretest-posttest control group design. This design was selected to examine the effectiveness of integrating Deep Learning with the Project-Based Learning (PjBL) model assisted by YouTube media in improving students' conceptual understanding in science learning. The experimental design involved two groups, namely the experimental group and the control group, which were compared based on their learning outcomes.

Participants / Sample

The population of this study consisted of all eighth-grade students at SMP Negeri 1 Sungai Penuh. The sampling technique used was cluster random sampling, in which intact classes were randomly selected from a relatively homogeneous population. The sample consisted of 60 students divided into two groups: 30 students in the experimental class and 30 students in the control class. The experimental group received treatment in the form of Deep Learning-based PjBL assisted by YouTube media, while the control group received conventional learning. Ethical considerations were maintained by ensuring that the learning process followed school regulations and did not disadvantage any group of students.

Instruments

The research instrument used was a multiple-choice test measuring students' conceptual understanding of the circulatory system material at the Higher Order Thinking Skills (HOTS) level. The instrument consisted of questions related to the structure and function of the circulatory system, blood components, blood circulation processes, and disorders of the circulatory system. The instrument had been validated by experts, resulting in a content validity coefficient of 0.83, indicating high validity. Instrument reliability was tested using reliability analysis, resulting in a

coefficient of 0.79, categorized as reliable. Thus, the instrument was considered suitable for data collection.

Procedure

The research procedure was conducted in several stages. First, preparation was carried out by developing lesson plans, learning materials, and research instruments. Second, a pretest was administered to both the experimental and control groups to determine initial abilities. Third, the experimental group was taught using Deep Learning-based PjBL assisted by YouTube media, while the control group was taught using conventional methods. Fourth, after the learning process was completed, a posttest was administered to both groups to measure learning outcomes. Finally, the collected data were statistically analyzed to determine the effectiveness of the treatment.

Data Analysis

Data analysis was conducted using descriptive and inferential statistics. Before hypothesis testing, prerequisite tests were conducted, including normality testing using the Kolmogorov-Smirnov test and homogeneity testing using the Levene test. The results showed that the data were normally distributed (Sig. = 0.200 > 0.05) and homogeneous (Sig. = 0.273 > 0.05), thus fulfilling the assumptions for parametric testing. Hypothesis testing was conducted using the Independent Sample T-Test, while improvements in learning outcomes were analyzed using the N-Gain Score.

RESULT AND DISCUSSION

Description of Research Data Results

The following presents the descriptive statistics of the pre-test and post-test results in both research groups:

Table 1. Descriptive Statistics of Pre-test and Post-test Results

Parameter	Experimental Class	Control Class
Group	Experimental	Control
N	30	30
Pre-test Mean	52.67	51.33
Post-test Mean	84.13	69.87
Highest Score	96	84
Lowest Score	72	56

Based on Table 1, it can be observed that the initial abilities (pre-test) of both groups were relatively equivalent, with the experimental class obtaining an average score of 52.67 and the control class obtaining 51.33.

Prerequisite Test Results

The normality test using Kolmogorov-Smirnov showed that the post-test data of the experimental class (D = 0.142, p = 0.132) and the control class (D = 0.118, p = 0.248) were both normally distributed (p > 0.05). The homogeneity of variance test using Levene's Test produced an F value of 0.683 (p = 0.412 > 0.05), indicating that the variances of both groups were homogeneous. Since both assumptions were fulfilled, the Independent Sample T-Test could be validly conducted.

Table 2. Independent Sample T-Test Results

Testing Aspect	Value	Description
Levene's Test (Sig.)	0.412	Homogeneous Variance
t-count	7.234	
t-table (df = 58, α = 0.05)	2.002	
Sig. (2-tailed)	0.000	Significant
Conclusion	H_1 Accepted	Significant Difference Exists

Based on Table 2, the calculated t-value (7.234) was greater than the t-table value (2.002) with a significance value of 0.000 < 0.05. Therefore, H_1 was accepted, indicating that there was a significant difference in science conceptual understanding between students who learned using the YouTube-assisted PjBL model and those who learned through conventional methods.

N-Gain Score Analysis

To analyze the effectiveness of conceptual understanding improvement, the N-Gain Score was calculated for each group with the following results:

Table 3. Distribution of N-Gain Score Categories

N-Gain Category	Experimental Class	Control Class
High (g > 0.7)	17 (56.7%)	4 (13.3%)
Moderate (0.3 ≤ g ≤ 0.7)	11 (36.7%)	18 (60.0%)
Low (g < 0.3)	2 (6.6%)	8 (26.7%)
Average N-Gain	0.66	0.38

Table 3 shows that the majority of students in the experimental class (56.7%) achieved the high N-Gain category, whereas only 13.3% of students in the control class reached the same category. The average N-Gain score of the experimental class was 0.66, which falls within the moderate-to-high category, while the control class only achieved 0.38, categorized as moderate-to-low. This difference indicates that the implementation of YouTube-assisted PjBL had a much greater impact on improving students' understanding of science concepts compared to conventional learning methods.

Discussion

The research findings indicate that the integration of the deep learning model significantly affected students' understanding of science concepts. Based on the posttest data, the experimental class achieved an average score of 84.13, considerably outperforming the control class, which only obtained 69.87. Statistical testing using the Independent Sample T-Test produced a t-count value of 7.234, which was greater than the t-table value of 2.002 at a significance level of 0.05. This proves that there was a statistically significant difference between the two groups. The effectiveness analysis through the N-Gain Score further strengthened this finding, where the experimental class recorded a score of 0.66 (moderate-high category) compared to the control class, which only reached 0.38 (moderate-low category).

The superiority of the experimental class can be explained through the internalization mechanism of the mindful, meaningful, and joyful pillars. The mindful learning element plays an important role in training students' focus and reflective awareness of their own thinking processes

(Amrullah et al., 2025). This self-awareness practice helps students manage cognitive challenges in complex science material, which is aligned with findings that daily mindfulness practice can improve academic achievement in science without reducing instructional time (Putri, 2024; Saputro et al., 2023). By becoming mindful learners, students at SMPN 1 Sungai Penuh demonstrated greater accuracy in analyzing experimental variables during project implementation.

The strength of this model also derives from the pillar of meaningful learning. Learning becomes meaningful when students are able to connect new concepts with daily experiences through PjBL activities carried out in the classroom (Rahma et al., 2025). This is supported by constructivist theory, which emphasizes that knowledge is built through active interaction and reflection (Sudarmono et al., 2025). The integration of YouTube during the project phase functions as visual scaffolding that bridges scientific abstraction with visual reality (Desiyanti et al., 2025). Video media enable real visualization of abstract concepts, increase attractiveness, and allow repeated access to material in order to strengthen understanding. This strengthening process occurs when theories presented are visualized with the help of YouTube videos selected by the teacher during the learning process, making initially abstract concepts clearer and more imaginable for students.

Furthermore, the joyful learning aspect creates a pressure-free, safe, and enjoyable learning environment. This positive emotional atmosphere has proven to increase students' concentration and intrinsic motivation (Hayati et al., 2025). When students feel happy and emotionally engaged, their affective barriers decrease, allowing cognitive functions to work more efficiently in absorbing challenging HOTS material. Overall, this approach activates not only students' cognitive faculties but also their metacognitive faculties, thereby facilitating the construction of comprehensive and contextually relevant understanding (Rahmiaty et al., 2025).

Comparisons with previous studies show consistency in the findings. The implementation of PjBL assisted by interactive multimedia significantly contributes to facilitating students' collaboration and creativity skills (Dumiyati et al., 2024). The implementation of PjBL becomes even more optimal when supported by visualization from YouTube videos. In addition, project-based learning models have proven not only to improve cognitive learning outcomes but also to strengthen critical thinking skills (aisyah, 2024). Thus, the results of this study conducted at SMPN 1 Sungai Penuh confirm that deep learning integrating humanistic pillars (affective) and active strategies (cognitive) is an effective solution for overcoming low scientific literacy as reported by PISA.

The findings of this study consistently support the hypothesis that Deep Learning implemented through the YouTube-assisted PjBL model is significantly more effective in improving junior high school students' understanding of science concepts compared to conventional learning. This superiority can be explained through several mutually reinforcing pedagogical mechanisms.

The finding of an average N-Gain score of 0.66 in the experimental class is consistent with previous research results. Marliani and Saputra (2022), in their study on video-assisted PjBL in junior high school, found an N-Gain score of 0.61, while Putri et al. (2021) reported an N-Gain score of 0.68 in the implementation of PjBL with digital media. The slightly higher N-Gain score in this study was likely caused by the more intensive integration of specifically curated YouTube content supporting each stage of the project.

The pedagogical implications of these findings are highly relevant to the development of science learning in the digital era. Junior high school science teachers need to develop competencies in: (1) designing authentic and meaningful driving questions; (2) curating quality YouTube content aligned with the curriculum; (3) facilitating productive student collaboration in PjBL; and (4) designing assessments capable of capturing the depth of conceptual understanding rather than merely memorization mastery. In the context of the Merdeka Curriculum, this integration also supports the achievement of the Pancasila Student Profile, particularly the dimensions of critical reasoning and independence.

Although the findings of this study are quite convincing, several limitations need to be acknowledged. First, this study only involved one school in one city, so the generalization of findings should be conducted carefully. Second, the relatively short duration of the study (eight meetings) may not have been sufficient to capture the long-term effects of this learning model on retention and transferability of conceptual understanding. Third, confounding variables such as students' initial motivation, parental support, and home internet access were not fully controlled within the research design.

CONCLUSION

Based on the research findings and discussion presented above, it can be concluded that there is a significant difference in science conceptual understanding between students in the experimental class who learned using the YouTube-assisted Project-Based Learning (PjBL) model and students in the control class who received conventional learning, as evidenced by the value of t-count = 7.234 > t-table = 2.002 ($p = 0.000 < 0.05$). In addition, the YouTube-assisted PjBL model proved more effective in improving students' understanding of science concepts, with an average N-Gain score of 0.66 (moderate-high category), compared to the control class, which only achieved 0.38 (moderate-low category). These findings indicate that the synergy among Deep Learning principles, the PjBL model, and YouTube media is capable of creating a learning ecosystem that encourages deeper cognitive engagement, strengthens the visualization of abstract concepts, and increases students' intrinsic learning motivation in science learning.

Based on these findings, several suggestions can be proposed. Junior high school science teachers are advised to integrate the YouTube-assisted PjBL model as a learning strategy, particularly for visually oriented topics such as organ systems, ecosystems, and astronomy. Schools also need to support this implementation by providing technological infrastructure and adequate internet access so that digital learning implementation can run optimally. Furthermore, future studies are recommended to examine the effectiveness of this model on different topics, educational levels, or learning contexts such as blended learning with stronger research designs, as well as to develop more comprehensive conceptual understanding assessment instruments capable of capturing Deep Learning dimensions more deeply, including knowledge transfer and metacognitive reflection.

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