



## **Evaluation of Understanding of The Concept of Light and Its Properties In Elementary School Students Through A Simple Experiment**

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DOI: <https://doi.org/10.47435/jpdk.v10i02.4017>

### **Abstract**

This study aims to evaluate elementary school students' understanding of the concept of light and its properties through problem-based learning (PBL) with a simple experimental approach. The method used was a descriptive quantitative approach with 20 fourth-grade students as research subjects. Learning was conducted in one meeting, without a pre-test, and student understanding was evaluated through a post-test compared to the Minimum Completion Criteria (KKM). The results showed that all students achieved scores above the Minimum Competency (KKM), indicating that this approach was effective in improving student understanding. Furthermore, observations of group activities and presentations indicated improvements in critical thinking, collaboration, and communication skills. These results reinforce that the application of PBL integrated with simple experiments is an effective learning strategy for building conceptual understanding in abstract science material.

**Keywords:** Conceptual Understanding, Light and its Properties, Simple Experiments, Problem Based Learning, Learning Evaluation.

### **1. Introduction**

Natural Sciences (IPA) is a subject that plays an important role in increasing curiosity, critical thinking, and problem-solving skills in students, especially at the elementary school level. One of the fundamental topics in science learning is the concept of light and its properties, such as reflection, refraction, and absorption. Students need to understand and master the concepts in this material in depth because it is closely related to various phenomena in everyday life. (Okpatrioka & Nusantari, 2022).

However, in reality, many students still lack a grasp of abstract concepts like light when presented solely through lectures or memorization. Even at the college level, misconceptions about light persist despite formal instruction, such as the belief that light is emitted from the eye or that color is imparted by the eye, not reflected by objects. (Djanette & Fouad, 2014). Therefore, students need a more active and contextual learning approach, such as through problem-based learning models (PBL).

PBL allows students to learn through more exploratory activities, problem solving, and creating real products, so that science concepts become more enjoyable and easier to understand in depth. (Kusmiyati, 2021). Furthermore, PBL has been shown to help students understand concepts more deeply because it involves solving real-life problems in groups and fosters critical thinking skills. By using everyday contexts, students will be more engaged and motivated in the learning process.

Previous research has shown that PBL can improve learning outcomes, student engagement, and critical thinking skills. According to Nur Raida (2021) the application of PBL in elementary school science learning can directly improve students' understanding through experiments and observations that are appropriate to their real-life context. Research conducted by Inel dan Balim (2010) also shows



that the use of the PBL method in science teaching significantly improves students' academic achievement and ability to build scientific concepts in a meaningful and sustainable manner.

Additionally, simple experiments are an effective strategy for connecting scientific concepts with students' real-world experiences. Through experiments, students can directly observe and see the properties of light, such as the shadows it forms, the phenomenon of light reflection, the phenomenon of light traveling in a straight line, and refraction when light passes through water. This activity aligns with the constructivist approach, where students can construct knowledge through direct experience. Furthermore, the use of relevant and contextual visual images in science textbooks has been shown to help students understand abstract concepts such as light (Kang & Kim, 2023).

In the context of evaluation, it is crucial to determine a student's understanding of the material they have learned. This evaluation can be conducted through a post-test, which is analyzed to determine whether the student has achieved the minimum passing grade (KKM). If a student's score exceeds the KKM, it can be concluded that the learning approach used has been successful in improving student understanding.

Based on this background, this study aims to evaluate elementary school students' understanding of the concept of light and its properties through problem-based learning with simple experiments. The evaluation focuses on students' post-test results after participating in the learning process to determine the effectiveness of this approach in improving their understanding of scientific concepts.

## **2. Metode**

This study uses a quantitative approach to evaluate elementary school students' understanding of the concept of light and its properties after participating in problem-based learning through simple experiments. The quantitative approach was chosen because this study focuses on measuring and analyzing numerical data in the form of students' post-test scores to determine their level of understanding of the material taught.

The subjects of this study were fourth-grade students at a Pekanbaru State Elementary School, which served as the observation location. Learning was conducted in a single meeting using the PBL learning model designed to encourage students to solve problems related to light by conducting direct experiments. Although no pre-test was conducted, student understanding was still evaluated by administering a post-test at the end of the activity. Data analysis was conducted by comparing students' post-test results to the Minimum Completion Criteria (KKM) determined by the school, which was 75. Students were said to understand the material if their post-test score was higher than or equal to the KKM.

During the learning process, researchers also conducted observations to record student activities, their involvement in group discussions, their ability to design and conduct experiments, and their ability to present experimental results. The post-test results were used as primary data to measure the effectiveness of problem-based learning in improving students' understanding of the concept of light and its properties. Data analysis was carried out descriptively by calculating the number of students who completed and did not complete the task, as well as calculating the percentage of learning completion in a classical manner. This learning model is in line with the constructivist approach that positions students as active subjects in the learning process through direct experience.

## **3. Results and Discussion**

### **3.1 Results**

#### **a. Explanation of PBL Steps**

Problem-Based Learning is a learning model that addresses real-world, open-ended, and unstructured problems. This characteristic encourages students to develop critical thinking and problem-solving skills, while simultaneously building new understanding through an active and meaningful learning process (Yuli Puji Lestari, 2018). According to Rambe et al (2022)



The Problem-Based Learning (PBL) model is an innovative approach that engages students in addressing real-life problems as a starting point for the learning process. Through problem-solving, students are encouraged to actively engage in learning, creating a more meaningful learning experience.

In problem-based learning, students encounter problems as part of the learning process itself. Learning is directed toward finding solutions or relevant information based on facts related to the issues that arise. To achieve this, students need to systematically go through several stages to understand the problem and formulate an appropriate solution (Irawati, 2020).

The steps in the Problem-Based Learning (PBL) model consist of five main stages, each of which can be applied in real-life elementary school settings. The first stage is orienting students to the problem. At this stage, the teacher begins the lesson by asking a provocative question, such as, “What do you know about light and its properties?” The question is then developed with the students into a main question, namely, “How can we prove that light has certain properties, such as traveling in a straight line, being reflected, refracted, and passing through transparent objects?” This question is the focus of the project that students will complete in groups.

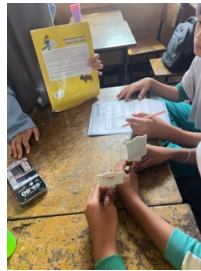
The second stage is organizing learning activities. Students are divided into five groups, each discussing one property of light. The teacher provides a Student Worksheet (LKPD) to help students design a project relevant to their topic. Each group discusses and determines what project they will create to demonstrate the property of light, then records the results of their discussion in the LKPD.

The third stage, guiding independent or group investigations, involves directing students to develop work steps and dividing tasks among group members. The teacher helps develop a project schedule and sets deadlines. Throughout the activity, the teacher facilitates the learning process by monitoring, asking prompting questions, and assisting with any technical difficulties. Students begin working on the project according to the plan and document their progress.

The fourth stage is developing and presenting the results. Each group tests their project through simple experiments and records their observations. The project results are then presented to the class. This presentation not only demonstrates students' understanding of the material but also builds their communication skills and confidence. The teacher provides feedback on the groups' work and the results presented.



**Figure 1.** Light Travels in a Straight Line



**Figure 2.** Light can be reflected



**Figure 3.** Light can penetrate transparent objects



**Figure 4.** Light can be desomposed



**Figure 5.** Light can be refracted

The fifth stage, analyzing and evaluating the problem-solving process, is carried out through collaborative reflection. The teacher invites students to evaluate the process they have gone through, such as what they learned from the project and how the group collaboration went. This evaluation provides an opportunity for students to recognize the development of their thinking and develop a sense of responsibility and collaboration in completing assignments.

**b. Evaluation Value**

Evaluation is a crucial element that is integral to the entire learning process and cannot be separated from teaching activities. The implementation of evaluation in educational activities plays a crucial role because it serves as a measuring tool to determine the extent to



which students have mastered the material presented. Through evaluation, the achievement of learning objectives can be seen more clearly and convincingly (L, 2019).

To evaluate students' understanding of the concept of light and its properties, assessment is conducted through experimental results presented by each group and through post-test questions given after the learning activity has taken place. Because no pre-test was conducted in this process, student success is assessed based on the achievement of the established Minimum Completion Criteria (KKM). The KKM serves as the primary reference for assessing students' understanding of the material. Students who achieve a score above or equal to the KKM are considered to have completed the course, while those below it require further guidance.

In addition to the cognitive scores from the post-test, skills and attitudes were also assessed through observations during the experiment and during group presentations. The presentation process was a crucial opportunity to assess students' ability to convey observations, explain concepts, and actively interact with the teacher and their peers. This evaluation reflected a holistic approach to assessing learning outcomes, encompassing not only knowledge but also students' scientific skills and attitudes.

During the learning activities conducted, the author obtained post-test data, completed individually by 20 students. This post-test aimed to measure the students' understanding of the concept of light and its properties after completing the learning series. The following table shows the students' names and their scores:

**Table 1.** Individual student assessment

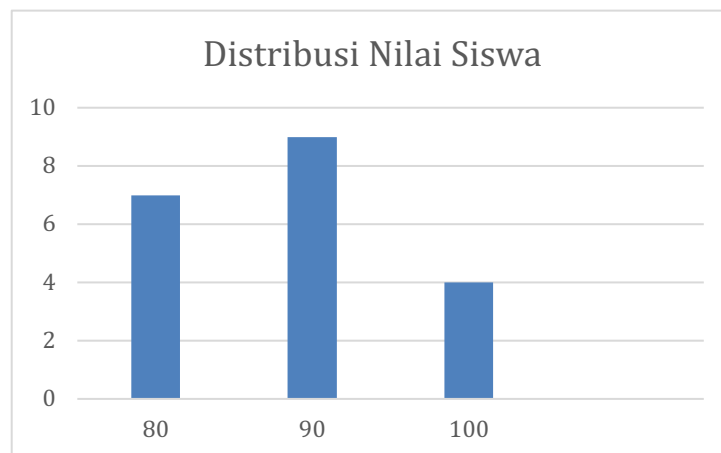
NO	STUDENT NAME	KKM	VALUE	INFORMATION
1.	AA	75	80	Passed
2.	AC	75	80	Passed
3.	ASJ	75	90	Passed
4.	BP	75	80	Passed
5.	CAR	75	90	Passed
6.	FI	75	100	Passed
7.	GI	75	80	Passed
8.	HD	75	90	Passed
9.	IP	75	90	Passed
10.	LS	75	80	Passed
11.	MF	75	100	Passed
12.	NKF	75	90	Passed
13.	PS	75	90	Passed
14.	RAF	75	80	Passed
15.	RAA	75	100	Passed



16.	RM	75	100	Passed
17.	SG	75	90	Passed
18.	SAI	75	90	Passed
19.	VJ	75	80	Passed
20.	ZH	75	90	Passed

Based on the data in the table above, it is known that all students successfully achieved scores above the established Minimum Completion Criteria (KKM), which is 75. This indicates that overall, students have understood the material well and the learning provided can be said to be effective. To provide a clearer picture of the distribution of student scores and how they compare to the KKM score, the following is a visual graph of the data:

**Chart 1.** Distribution of student grades



The graph above shows that most students achieved fairly high scores, with some even achieving the maximum score. This reflects that the majority of students not only met the minimum standard but also demonstrated excellent mastery of the material.

### 3.2 Discussion

#### a. How PBL is Overall

Learning with the Problem Based Learning (PBL) approach applied in this activity was quite effective and in accordance with the stages that had been designed.(Khakim et al., 2022). The students successfully executed each stage, from formulating the problem, developing a plan, conducting the experiment, to presenting the results. This activity demonstrated that students were actively involved in the learning process, not only receiving information but also seeking solutions to the problems they faced.

According to Jumadi (2018) The Problem-Based Learning (PBL) model is characterized by the use of real-life problems directly related to students' daily lives. This problem-solving process encourages students to actively participate in learning and broadens their understanding. In its implementation, PBL demands teacher creativity due to the wide variety of learning resources used. Furthermore, this model creates a comfortable and enjoyable



learning environment and fosters students' creative thinking skills through problem-solving activities.

In the context of science learning in elementary schools, the application of PBL has proven effective in improving student learning outcomes. For example, research by Ariyani & Kristin (2021) showed that the use of PBL in social studies learning in elementary schools can significantly improve student engagement and learning outcomes.

Observations during the lesson revealed that PBL encouraged students to think critically, collaborate, and solve problems both independently and in groups. Each group demonstrated high enthusiasm in designing experiments and discussing the results. Furthermore, students demonstrated improved communication skills when presenting their experimental results to the class.

Despite some challenges, such as limited equipment and limited time, the PBL model was overall successful in creating meaningful learning. The teacher played an active role as a facilitator, assisting students when they encountered difficulties without taking over their learning process. This success was also reflected in the students' post-test results, which showed a good level of understanding of the concept of light and its properties.

**b. The Relationship between PBL and Practical Work Regarding Understanding the Concept of Light and Its Properties**

The application of the Problem-Based Learning (PBL) model to the concept of light and its properties has proven highly relevant and positively impacted student understanding. The practicums conducted by each group serve as the primary medium for implementing PBL, where students learn not only through theory but also through direct exploration of the concepts being studied.

The Problem-Based Learning model itself is a learning approach that focuses on real-world problems as the core of the learning process. Through this approach, students are conditioned to think critically in finding solutions to problems presented by the teacher. Thus, students acquire not only conceptual knowledge but also essential skills such as problem-solving, collaboration, and communication (Megalia et al., 2024).

Through the PBL stages, students are invited to discover for themselves the relationship between theory and practice (Rika Widianita, 2023). For example, to prove that light travels in a straight line, a group of students conducted a simple experiment using a flashlight and a hollow object. This activity not only answered the initial question they had formulated but also encouraged students to draw conclusions from their own observations.

The integrated lab activities within the PBL process provide meaningful learning experiences. Students learn to observe, measure, document, and present their work. This is highly effective in helping students understand the properties of light, such as reflection, refraction, and the ability of light to penetrate transparent objects, as they experience and observe these phenomena firsthand.

**c. Supporting Research**

Several studies support the effectiveness of this approach in applying the Problem-Based Learning (PBL) model to science instruction, particularly on the properties of light. One such study by Nur Raida (2021) demonstrated that the use of PBL can improve students' knowledge because this model presents problems relevant to students' real-life situations, thus making them more engaged and easier to solve.

Other research by Laili (2022) analyzed elementary school students' generic science skills on the properties of light. The results showed that the PBL model had an effect on students' generic science skills, as well as on their retention after learning.

In addition, research by Husnaeni et al (2018) Research at SDI Garaupa demonstrated that applying the experimental method can improve science learning outcomes for the



properties of light. Through this approach, students are more active in the learning process and are able to better understand the concepts.

The findings of this study are in line with the results obtained in the learning that has been carried out, where students showed an increase in understanding of the concept of light and its properties through a PBL approach integrated with practical work.

#### d. Recommendations for Using PBL for Light and Its Properties

Based on experience applying the Problem-Based Learning (PBL) model to the topic of light and its properties, this approach is highly recommended for use in science instruction in elementary schools. One reason is that PBL provides space for students to explore concepts independently through direct experience through experiments. In practice, students appear more enthusiastic when they are directly involved in proving that light can be reflected, refracted, pass through transparent objects, and travel in a straight line.

By positioning students as active participants, teachers can more easily build constructive understanding. Furthermore, PBL helps train students to think critically, work collaboratively in groups, and convey ideas confidently during presentations. This aligns with the characteristics of 21st-century learning, which emphasizes the 4Cs (critical thinking, collaboration, communication, and creativity) (Nurhayati et al., 2024).

However, the implementation of PBL also needs to be adapted to classroom conditions. Teachers must prepare a thorough plan, including providing safe and simple experimental tools and materials, and developing clear and focused worksheets. Learning time must also be structured so that each group has the opportunity to complete the experiment and reflect effectively.

#### 4. Conclusion

This study successfully demonstrated that the use of simple experiments in learning the concept of light and its properties significantly improved elementary school students' understanding. The Problem-Based Learning (PBL) method applied not only facilitated cognitive mastery of the material but also trained students' critical thinking, collaboration, and communication skills. The quantitative evaluation results showed that all students achieved scores above the Minimum Completion Criteria (KKM), indicating an adequate level of understanding. Scientifically, a learning approach that integrates experiments and problem-solving provides a positive contribution to the science learning process, especially for abstract materials such as light. This active and contextual learning experience supports the development of students' comprehensive competencies and encourages the formation of scientific attitudes. For future research, it is recommended that a larger number of participants and a wider variety of evaluation methods be used, including more in-depth measurement of skills and attitudes. Furthermore, the development of more innovative learning media could be a focus to make learning about light concepts more engaging and effective.

#### Thank you Note

The authors would like to express their deepest gratitude to all students who willingly participated actively in this learning activity, ensuring the smooth running of this research. We also extend our gratitude to the elementary school teachers who took the time and granted permission to conduct the learning activities and collect data. We also extend our special appreciation to the lecturers who provided guidance, support, and direction throughout the process of compiling this article. The support of all parties was crucial to the smooth running and success of this research.

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## JURNAL Pendidikan Dasar dan Keguruan

Volume 10, No. 2, 2025

P-ISSN: 2527-578X

E-ISSN: 2715-2818

Homepage: <https://journal.uiad.ac.id/index.php/JPDK/index>

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