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Improving Students' Science Problem Solving Ability through the Implementation of Problem Based Learning Models Assisted by Animation Media

Faisal Salim[1]*, Agung Purwanto[2], Ika Lestari[3]
[1,2] Pendidikan Dasar, Universitas Negeri Jakarta, Jakarta, Indonesia

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ABSTRAK

Kemampuan siswa dalam memecahkan masalah IPA yang rendah disebabkan oleh kurangnya efektivitas penggunaan model dan media pembelajaran. Penelitian ini bertujuan untuk menganalisis pengaruh model problem-based learning berbantuan media animasi terhadap kemampuan pemecahan masalah IPA siswa Kelas IV SD. Metode penelitian yang digunakan adalah eksperimen dengan menggunakan desain posttest-only control. Sampel yang diambil menggunakan teknik simple cluster random sampling berjumlah 30 siswa dalam kelompok eksperimen dan 30 siswa dalam kelompok kontrol. Teknik analisis data yang digunakan meliputi statistik deskriptif dan statistik inferensial dengan pengujian hipotesis menggunakan uji-t. Hasil penelitian menunjukkan bahwa rata-rata nilai pada kelompok eksperimen adalah 82,4, sedangkan pada kelompok kontrol adalah 59,1. Hasil uji hipotesis menunjukkan bahwa nilai Sig. (2-tailed) adalah 0,000 < 0,05 atau lebih kecil dari (α=0,05), menandakan adanya perbedaan signifikan dalam kemampuan pemecahan masalah IPA antara siswa pada kelompok eksperimen dan kelompok kontrol. Berdasarkan hasil penelitian, dapat disimpulkan bahwa model problem-based learning berbantuan media animasi memiliki pengaruh signifikan terhadap kemampuan pemecahan masalah IPA siswa Kelas IV sekolah dasar. Dengan adanya hasil penelitian ini, diharapkan guru dapat mengintegrasikan model problem-based learning dan media animasi dalam proses pembelajaran untuk meningkatkan kemampuan pemecahan masalah IPA siswa di sekolah dasar.

ABSTRACT

The low ability of students to solve science problems is caused by the lack of effectiveness in the use of learning models and media. This study aims to analyze the effect of problem-based learning models assisted by animation media on the ability to solve science problems for grade IV elementary school students. The research method used was an experiment using a posttest-only control design. The samples taken using the simple cluster random sampling technique amounted to 30 students in the experimental group and 30 students in the control group. Data analysis techniques used includes descriptive statistics and inferential statistics by testing hypotheses using t-tests. The results showed that the average score in the experimental group was 82.4, while in the control group was 59.1. The results of the hypothesis test showed that the value of Sig. (2-tailed) was 0.000 < 0.05 or less than (α=0.05), indicating a significant difference in science problem-solving ability between students in the experimental group and the control group. Based on the results of the study, it can be concluded that the problem-based learning model assisted by animation media has a significant influence on the science problem-solving ability of grade IV elementary school students. With the results of this research, it is hoped that teachers can integrate problem-based learning models and animation media in the learning process to improve students' science problem-solving abilities in elementary schools.

1. INTRODUCTION

Natural Sciences have an important role in the education system because it not only provides an understanding of natural phenomena, but also trains students to develop critical and analytical thinking skills. Science presents a variety of life materials that give students the opportunity to observe, measure, and analyze surrounding natural phenomena, thus enabling them to understand the basic principles of science (Utami & Amaliyah, 2022; Widyaningrum et al., 2022). In addition, science is not only a systematic means of natural exploration, but also a discovery process that actively involves students in learning (Kurniawan et al., 2019; Tanti et al., 2021). Science learning also trains learners in formulating and solving problems systematically, key skills to face daily challenges and preparation for 21st century learning (Ghafar, 2020; Ichsan et al., 2023; Suendarti & Virgana, 2022). With a 21st century learning approach that emphasizes critical, collaborative, and analytical thinking, science learning provides a solid foundation for the development of those skills, preparing future generations to be more competent and adaptive in the face of evolving changes and challenges.

*Corresponding author.
E-mail addresses: faisal30052000@gmail.com (Faisal Salim)

The ability to solve problems is an important key for students in facing the learning challenges of the 21st century era. The emphasis on 21st century learning abilities, often described as the 4Cs, includes critical and creative thinking skills, problem solving, collaboration, and communication (Salfina et al., 2021; Valtonen et al., 2021). In this context, the world of education, including elementary schools, is faced with the demand to prepare students with 21st century skills so that they become innovative individuals who are able to compete on the global stage, and have the ability to change the world and behavior, as well as improve their coping and problem-solving skills and the ability to think and analyze problems to find solutions (Mulhayatiah et al., 2019; Savitri et al., 2021). Therefore, developing problem-solving ability early on in primary school is an important investment step in building students' skills for future success. Problem-solving ability is an active process of thinking that involves cognitive-behavioral measures, such as identifying problems, changing strategies, finding alternative approaches, and implementing appropriate solutions to achieve desired goals (Çiftci & Bildiren, 2020; M Leasa et al., 2021). As a higher-order thinking skills activity, problem-solving abilities involve various intellectual aspects of individuals, requiring the use of memory, perception, reasoning, conceptualization, language, emotions, motivation, confidence, and the ability to control situations effectively (Handayani et al., 2022; Hobri et al., 2020). Thus, problem-solving ability is a complex and integrated process, utilizing various intellectual aspects and cognitive-behavioral strategies to identify, understand, and find solutions to problems encountered in everyday life.

The steps in the problem-solving process, as described by Polya, including problem understanding, solution planning, plan implementation, and answer rechecking, require complex and critical thinking processes (Son & Fatimah, 2020; Suarsana et al., 2019; Sudarsono et al., 2022). This process is not only important in science learning, but also forms very essential thinking skills, including analytical and creative abilities. The importance of critical and creative thinking skills as an integral part in the development of intellectual abilities has been affirmed by several studies. Several studies have shown that problem-solving ability is a very significant component in the development of learners, such as critical, creative thinking skills, and the ability to apply scientific thinking (Ceylan, 2022; Marleny Leasa et al., 2021; Muzana et al., 2021). In addition, continuous practice in problem solving has proven to be an effective approach in improving the intellectual abilities of learners. By engaging consistently in the problem-solving process, learners not only gain practical experience in handling complex situations, but also develop critical skills such as analytical, creativity, and logical abilities (Nugraheni & Marsigit, 2021; Suarsana et al., 2019). Thus, problem-solving ability plays a very important role in the development of learners. Understanding and applying problem-solving concepts is an important foundation in education to prepare learners to face challenges in a changing world.

Students' problem-solving ability still has not reached the expected level, especially based on observations in elementary schools in Depok City, showing that students' problem-solving abilities in science subjects are still low. This is in line with the results of research that highlights the low problem-solving ability of students in Indonesia, including in terms of identifying, understanding, formulating problems, finding solutions, and drawing conclusions (Fauzia & Kelana, 2020; Made et al., 2022). In addition, the interview results show that the learning model applied is still not optimal because it still relies on conventional approaches centered on the role of teachers, and the use of learning media is less varied, especially limited to the use of books. This condition not only impacts students' ability to solve problems but also causes low learning outcomes. Other studies have also confirmed that the learning approach in science subjects in elementary schools is still limited to traditional methods, resulting in a lack of student involvement and low problem-solving abilities (Made et al., 2022; Rochman et al., 2019).

Based on these problems, it is important for teachers to have skills in applying learning models that stimulate active student participation and choose media that are effective, interesting, and in accordance with student characteristics. The process of developing problem-solving abilities can be done through learning steps that encourage students to think critically and find solutions to the problems faced, with the aim of increasing their capacity to solve problems (Sari & Fathoni, 2022). One learning model that has proven effective in improving students' problem-solving abilities is problem-based learning (PBL) because it is specifically designed to help students solve problems (Binasdevi et al., 2022; Melawati et al., 2022; Simanjuntak et al., 2021). By using this approach, students are encouraged to develop critical thinking skills in facing the challenges given in the learning process. Therefore, the PBL model is considered an appropriate solution because it helps students relate learning to real-world situations that can be applied in practical learning experiences (Hidayati & Wagiran, 2020; Valdez & Bungihan, 2019).

The PBL model displays great potential in stimulating the development of critical thinking and problem-solving abilities in authentic learning contexts, which in turn can result in optimal learning achievement. Research findings support the effectiveness of PBL in improving students' problem-solving abilities (Arini et al., 2019; Chamidy et al., 2020; Jabarullah & Iqbal Hussain, 2019). Models are more effective than conventional models, providing a positive and significant impact on students' critical thinking skills (Ahdhianto et al., 2020; Darmawati & Mustadi, 2023; Lubis et al., 2019). PBL also affects the science learning outcomes of elementary school students. In addition to having an impact on science learning outcomes, the PBL Model shows higher effectiveness than conventional learning models in improving learning outcomes in other subjects, such as social studies, and student mathematics (Chang et al., 2020; Fatayan et al., 2022; Mustofa & Hidayah, 2020). Thus, it can be concluded that problem-based learning models not only provide benefits in the development of critical thinking and problem-solving skills, but also contribute to improved learning outcomes in various subjects.

In addition to applying the PBL model, improving the quality of science learning to be more effective requires learning media such as animation media (Eleaser et al., 2023; Widyaningrum et al., 2022). Animation media is a form of audio-visual media that involves a series of moving images and is equipped with sound elements, aims to arouse their interest in the subject matter, increase teaching efficiency, and facilitate students in learning (Putra & Sujana, 2021; Utami & Amaliyah, 2022). The application of problem-based learning supported by animation media can provide various benefits for students, including increasing learning motivation, intensity of learning activities, and problem-solving skills (Said et al., 2019; Simanjuntak et al., 2021). In addition, the collaboration of the PBL model with animation media has an impact on improving students' problem-solving abilities and science learning outcomes, because the learning model involves students in solving everyday problems that demand an active role, so as to improve their cognitive abilities in solving problems (Darmawati & Mustadi, 2023; Hidayati & Wagiran, 2020). Based on some of the results of this research, it can be said that animated video media or PBL models are very feasible to be developed to support the success of the learning process. Therefore, the combination of PBL models and animation media can have a positive impact on students in the learning process (Astuti et al., 2020; Mustofa & Hidayah, 2020; Rahmah & Aznam, 2023).

This research is very important for several fundamental reasons. First, by introducing a Problem-based learning (PBL) model supported by animation media, this research has great potential to significantly improve science learning conditions in elementary schools. This approach can not only increase students' interest and motivation towards science, but also open up opportunities for a deeper understanding of complex scientific concepts. Second, the study aims to improve learners' problem-solving abilities, an important skill needed in everyday life and in the future. Finally, this research will provide a solid foundation for the development of more effective learning strategies in the future. Based on the background of this problem, the purpose of this study was to analyze the effect of the problem-based learning model assisted by animation media on the science problem-solving ability of grade IV elementary school students. The novelty of this study is focus on solving ability using problem based learning assisted by animation media.

2. METHOD

This research applies an experimental method, which is a technique that can be accounted for to explore the impact or influence of independent variables (treatment) on the dependent variable, taking into account other factors that can affect the results of the study (Creswell, 2021; Djaali, 2020). The design used is posttest-only control design. This design involves the formation of two groups randomly, namely the experimental group (receiving treatment) and the control group (without previous treatment), which then both groups are given postes to observe whether there are significant differences between the two. In the experimental group, students were treated with a problem-based learning model assisted by animation media, while the control group used an expository model. The problem-based learning model assisted by animation media is an independent variable that plays a role in influencing, while the ability to solve science problems is the dependent variable that is influenced.

The population in this research was all students in Cimanggis District, Depok City. Population is the entire general area consisting of objects or subjects with certain qualities and characteristics set by the researcher to be studied, where all members of the group of humans, animals, events, or objects live together in one place, being the target of conclusions generated in a study or analysis. In this research, several populations that are considered representative of the entire population are taken as samples. Sample determination is carried out using a simple cluster random sampling technique, which is a technique for selecting samples from clusters selected simultaneously, with a note that clusters in the population must be homogeneous. Based on this technique, the school that became the sample or object of research was grade IV students of SD Negeri Mekarsari 5 Depok City consisting of two classes, namely the experimental class with a total of 30 students and the control class with a total of 30 students. The following is presented the research design scheme in Figure 1.

Figure 1. Research Design Scheme

The instrument used in data collection in this research is a description test of science problem-solving ability. Testing the validity of IPA problem-solving ability instruments involves testing content validity and construct validity. Content validity is an evaluation of instruments carried out by experts in relevant fields such as science lecturers without the need for statistical analysis and involves examining the grid to ensure that the instrument used covers all aspects of the material that should be measured, while construct validity involves assessment by experts and can be strengthened by field trials to evaluate the extent to which test items are able to accurately measure what is actually intended, according to certain constructs or concepts that have been explained in conceptual definitions. Before use, the test instrument is assessed by experts such as science lecturers who have been appointed in this study, and then the instrument is tested on samples from which they are taken. After the instrument trial data was collected, statistical analysis was carried out with Pearson Product Moment Validity and Cronbach Alpha Reliability. Based on instrument trials, valid and reliable results are obtained for all items.

The preparation of this problem-solving ability test instrument is based on indicators of science problem-solving ability that have been made by researchers, namely: (1) understanding the problem; (2) plan a solution; and (3) Implement a problem-solving plan. The subject matter of science in this study is "Changes in Energy Form" in Grade IV elementary schools. Furthermore, a matrix of relationships between problem-based learning models with indicators of problem-solving ability will be presented, as well as problem-solving ability activities in the learning process. Relationship matrix of PBL models, problem-solving capabilities and learning activities is show in Table 1.

Table 1. Relationship Matrix of PBL Models, Problem-Solving Capabilities and Learning Activities

Stages of the PBL model	Science Problem-Solving Ability Indicator	Learning Activity
Phase 1: Orienting students towards problems	-	Presenting problems through animation media as initial analysis
Phase 2: Organizing learners to learn	-	Group and prepare students to solve problems
Phase 3: Guiding individual and group investigations	1. Understand the problem 2. Plan a solution 3. Implement a problem-solving plan	Guiding learners in solving problems which include: 1. Mention causation 2. Determine how to solve the problem 3. Solution implementation
Phase 4: Develop and present results	1. Understand the problem 2. Plan a solution 3. Implement a problem-solving plan	Directing students to present findings carried out in groups
Phase 5: Analyze and evaluate the problem-solving process	1. Understand the problem 2. Plan a solution 3. Implement a problem-solving plan	Review the problem-solving process and conduct Q&A as an evaluation of learning

The data analysis process is carried out using descriptive statistical analysis and inferential statistics, with t-tests used to test research hypotheses. Before testing a hypothesis, a classical assumption test is performed as a prerequisite to ensure that the data meet the requirements of hypothesis testing. The classical assumption test involves two stages, namely the normality test and the data homogeneity test. A normality test is performed to check whether the data is normally distributed or not. While the homogeneity test is used to check the homogeneity of variance between groups of data to be compare. This is important because the t-test requires the assumption that the data are normally distributed and have homogeneity of variance in order for the analysis results to be reliable. Thus, this stage ensures that statistical analysis is carried out according to appropriate methods and provides valid and reliable results.

3. RESULT AND DISCUSSION

Result

Descriptive analysis is a statistical approach used to describe and present a clear summary of data. The goal is to provide a comprehensive picture of students' ability to solve science problems in this study, without making conclusions or generalizations that are too deep. The results of descriptive analysis of posttest data, which include the average value, standard deviation, maximum value, and minimum science problem solving ability of students in this study in this study in this study in this study are presented in Table 2.

Table 2. Descriptive Analysis Results

Statistics	Experimental Class	Control Class
Mean	82.4033	59.0867
Minimum	66.60	40.00
Maximum	96.60	80.00
Std. Deviation	6.83835	10.15873

Based on Table 2, it can be known that N or the total population of both classes is 60 students, the minimum score for the control class is 40 points, while the minimum score for the experimental class is 66.6 points. It can be seen that the maximum value of the control class is 80 points, while the maximum value of the experimental class is 96.6 points. From these data, it can be seen that the average value of the experimental class using the problem-based learning model assisted by animation media is 82.4033 while the average value of the control class using the expository model is 59.0867. From this average, it is known that experimental classes that use problem-based learning models assisted by animation media are higher than experimental classes that use expository models.

Before the hypothesis test is carried out, the first step that needs to be done is an assumption test or analysis prerequisite test. This test includes the data normality test and the variance homogeneity test, which aims to assess whether the data to be analyzed has a homogeneous normal distribution and variance. The normality test is carried out using the Kolmogorov-Smirnov test, in which the significance value of the test is observed. The acceptance criterion for normality is that if the significance value of the calculation result is greater than the alpha value ($\alpha = 0.05$), then the data distribution is considered normal. Conversely, if the significance value is less than $\alpha = 0.05$, then the distribution is considered abnormal. The normality test results of the two groups, namely the experimental group and the control group, can be seen in Table 3.

Table 3. Normality Test Results

Statistics		Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Science Problem-Solving Abilities	Experimental Class	0.135	30	0.169	0.960	30	0.312
	Control Class	0.114	30	0.200	0.970	30	0.537

Based on Table 3, it can be known the value (sig.) of the experimental class and the value (sig.) of the control class that has a value higher than 0.05. The experimental class obtained a significance value of $0.169 > 0.05$ and the control class with a significance value of $0.200 > 0.05$. Results from both classes showed that the data were normally distributed. After the normality test is met, the next step is to perform a variance homogeneity test. A variance homogeneity test is performed to evaluate whether the variance between the two groups is homogeneous or not. The commonly used level of significance in this case is $\alpha = 0.05$. If the value (sig.) of the variance homogeneity test is greater than $\alpha = 0.05$, then the data is considered homogeneous. Conversely, if the value (sig.) < 0.05, then the data is considered inhomogeneous.

The results of the variance homogeneity test will provide important information in determining the appropriate statistical methods to use in future analyses. Therefore, the results of this variance homogeneity test will greatly affect the interpretation and conclusion of the research conducted. Information regarding the results of the variance homogeneity test will be described in more detail in Table 4.

Table 4. Homogeneity Test Results

Statistics		Levene Statistic	df1	df2	Sig.
Science Problem-Solving Abilities	Based on Mean	3.807	1	58	0.056
	Based on Median	3.322	1	58	0.074
	Based on Median and with adjusted df	3.322	1	49.439	0.074
	Based on trimmed mean	3.876	1	58	0.054

Based on the data in Table 4, it is concluded that the significance value (sig) in the column "Based on Mean" is 0.056, exceeding the predetermined alpha value (α) by 0.05. Thus, the data can be interpreted to satisfy the assumption of homogeneity of variance. With the fulfillment of both prerequisite tests, namely the normality test and the variance homogeneity test, the next step is to test the hypothesis using the t-test. This testing process was performed using SPSS statistical software version 27 for Windows, which is listed in Table 5.

Table 5. T-Test Results

Statistics Parameters		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Science Problem-Solving Abilities	Equal variances assumed	10.429	58	0.000	23.31667	2.23579	18.84124	27.79209

Based on Table 5 which shows the results of the t-test calculation, there are conditions in decision making, namely if the value of sig. (2-tailed) is smaller than the value (α=0.05) then H_0 and H_1 are accepted. Conducting an independent sample test serves to test the hypothesis to determine the average difference in experimental classes with treatment using problem-based learning models assisted by animation media and control groups using expository models. The results showed that Table 5 had a smaller significance value, namely: 0.000 < 0.05. This value can be interpreted that there is a significant average difference in students' science problem-solving ability in the experimental class and the control class.

Discussion

Based on the results of data analysis, it is known that there are significant differences in the ability to solve science problems of students taught with the problem-based learning (PBL) model assisted by animation media with students taught with expository models. This is due to the student-centered nature of PBL, which is designed around real-world problems, thus encouraging students to build a deeper understanding of science concepts contextually through a series of constructive questions that they must resolve (Ananda et al., 2022; Fauzia & Kelana, 2020; Nugraheni & Marsigit, 2021). The problem-based learning model encourages students to actively solve problems related to real-world situations, which ultimately can improve their problem-solving abilities and this model also provides clear focus and direction in achieving learning objectives through active involvement of students in discussions during the learning process (John et al., 2020; Rahmah & Aznam, 2023). Based on the problems given, students work together in groups to solve these problems by constructing the knowledge they already have with relevant new knowledge, so that with this PBL model students are directly involved in learning activities so that the knowledge gained can be digested properly (Astuti et al., 2020; Fatayan et al., 2022; Utaminingsih et al., 2022).

Applied problem-based learning has five stages, one of which is the investigation stage carried out independently or in groups is the core of the PBL model because this phase includes the process of understanding problems, planning solutions, and implementing problem-solving solutions so that problem-solving skills can be developed and trained (Salfina et al., 2021; Sari & Fathoni, 2022). This shows that the applied PBL model has a real impact in improving students' science problem-solving abilities. This finding is in line with previous research showing that students who follow learning with problem-based learning models experience better improved problem-solving abilities than those who follow conventional learning models (Jabarullah & Iqbal Hussain, 2019; Valdez & Bungihan, 2019). In addition, PBL models have been shown to have a significant effect on students' problem-solving abilities (Ahdhianto et al., 2020; Son & Fatimah, 2020).

The integration of problem-based learning models with animation media also contributes to improving students' science problem-solving abilities. The application of problem-based learning assisted by teaching aids or learning media such as animation media can foster student learning motivation, learning activities, and problem-solving abilities (Alexander et al., 2020; Said et al., 2019). If the media is in accordance with the characteristics of elementary school students such as music, images, sounds, and other supporting components, it can support more comfortable learning conditions and atmosphere, motivate students in learning, and improve student absorption and memory (Maranatha & Putri, 2021; Sukarini & Manuaba, 2021). Therefore, collaboration between PBL models and animation media has an effect on improving students' science problem-solving abilities, because it is caused by students' involvement in solving everyday problems that demand their active role, thus encouraging an increase in their cognitive abilities in solving problems.

Several previous studies have also shown that PBL models not only improve students' problem-solving abilities, but also students' critical thinking skills (Darmawati & Mustadi, 2023; Lubis et al., 2019). When teachers present problems, students' passion for finding solutions is sparked, and when they are involved in the problem-solving process, they actively contribute to finding solutions. This awareness gives encouragement to students to improve their critical thinking skills. With continuous practice in solving problems, students indirectly improve their critical thinking skills in taking concrete steps in solving the challenges faced. Thus, problem-solving abilities are closely related to critical thinking skills. In addition, previous research has also shown that problem-based learning contributes to improving students' science learning outcomes (Permatasari et al., 2019; Suendarti & Virgana, 2022). Based on this, the PBL model assisted by animation media has many benefits, especially it can improve students' science problem-solving abilities.

A limitation of this study is that it was carried out in only one school and only in grade IV, so the generalization of the findings may be limited to this group only. This is because the conditions and characteristics of the school may not accurately represent all schools in different regions or neighbourhoods despite random sample selection in a homogeneous population. The implication of this study is that the use of problem-based learning models assisted by animation media can significantly improve the science problem-solving ability of grade IV elementary school students. These findings suggest that learning approaches that involve interactivity and deep experiential learning may provide greater benefits than more traditional expository models. This research can be used as a reference so that elementary schools consider adopting a problem-based learning model assisted by animation media as part of their learning strategy in science subjects. Teachers may also consider the use of animated media as an effective learning tool to increase student engagement and facilitate a deeper understanding of scientific concepts. In addition, further research can be conducted to explore the effects of using this learning model at different levels of education.

4. CONCLUSION

The results showed that there was a significant difference in the science problem-solving ability of grade IV elementary school students who were taught using a problem-based learning model assisted by animation media and students who used an expository model. Based on the results of the study, it can be concluded that there is a significant influence of the problem-based learning model assisted by animation media on the science problem solving ability of grade IV elementary school students. Therefore, teachers can use problem-based learning models assisted by animation media that can improve students' science problem-solving abilities by presenting interesting problems to students.

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