Journal of Educational Research and Evaluation
Volume 8, Issue 4, 2024, pp. 796-805
P-ISSN: 2597-422x E-ISSN: 2549-2675
Open Access: https://doi.org/10.23887/jere.v8i4.80112

Experimental Methods Improve Learning Outcomes on Human Respiratory System Material in Fifth Grade Elementary School Students

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ARTICLE INFO

Article history:
Received June 09, 2024
Accepted October 22, 2024
Available online November 25, 2024

Kata Kunci :
Keefektifan, Metode Eksperimen, Hasil Belajar IPAS.

Keywords:
Effectiveness, Experimental Method, IPAS Learning Outcomes.

ABSTRAK

Siswa yang merasa bosan dalam kegiatan pembelajaran IPAS berdampak pada hasil belajar siswa yang rendah. Penelitian ini bertujuan untuk menganalisis pengaruh serta keefektifan metode eksperimen terhadap hasil belajar IPAS materi sistem pernapasan di kelas V Sekolah Dasar. Penelitian ini menggunakan metode eksperimen dengan pendekatan kuantitatif. Bentuk desain penelitian ini adalah Nonequivalent Control Group Design. Populasi dalam penelitian ini adalah seluruh siswa kelas V SD yang berjumlah 121 siswa. Teknik pengambilan sampel pada penelitian ini menggunakan Cluster Sampling. Sampel dalam penelitian ini adalah 50 siswa sebagai kelas eksperimen, dan 50 siswa sebagai kelas kontrol, sisanya 21 siswa sebagai kelas uji. Metode yang digunakan dalam mengumpulkan data yaitu tes, observasi, wawancara, dokumentasi, dan catatan lapangan. Instrumen yang digunakan untuk mengumpulkan data yaitu lembar kuesioner dan soal tes. Teknik analisis data yang digunakan dalam penelitian ini yaitu analisis statitsik inferensial. Hasil Penelitian yaitu hasil uji-t menunjukan Metode eksperimen memiliki pengaruh serta efektif digunakan dalam meningkatkan hasil belajar IPAS siswa kelas V pada materi sistem pernapasan manusia. Hasil uji n-gain menunjukan peningkatan pemahaman IPAS pada kelompok kontrol termasuk pada kategori sedang, dan peningkatan pemahaman IPAS pada kelompok eksperimen termasuk pada kategori tinggi. Disimpulkan bahwa metode eksperimen dapat mningkatkan hasil belajar IPAS materi sistem pernapasan di kelas V Sekolah Dasar.

ABSTRACT

Students who feel bored in science and science learning activities impact low student learning outcomes. This research aims to analyze the influence and effectiveness of experimental methods on science and science learning outcomes regarding the respiratory system in class V elementary school. This research uses an experimental method with a quantitative approach. The design form of this research is a Nonequivalent Control Group Design. The population in this study was all fifth-grade elementary school students, totaling 121 students. The sampling technique used in this research was cluster sampling. The sample in this study was 50 students in the experimental class, 50 in the control class, and the remaining 21 in the test class. The methods used to collect data are tests, observation, interviews, documentation, and field notes. The instruments used to collect data were questionnaire sheets and test questions. The data analysis technique used in this research is inferential statistical analysis. The research results, namely the results of the t-test, show that the experimental method has an influence and is effectively used in improving the science and science learning outcomes of class V students on the human respiratory system. The results of the n-gain test showed an increase in understanding of IPAS in the control group, including in the medium category, and an increase in understanding of IPAS in the experimental group, including in the high category. It was concluded that the experimental method could improve science and science learning outcomes regarding the respiratory system in class V elementary school.

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1. INTRODUCTION

Education is an absolute human need to support the achievement of life goals. The purpose of the life in question is so that students can explore and develop their potential and benefit themselves and the surrounding environment (Amaliyah & Rahmat, 2021; Rozalena & Kristiawan, 2017). With education, humans can develop their mindsets, attitudes, and skills. Education can improve human competence in facing changes in the era of globalization (Amaliyah & Rahmat, 2021; Kurniawan, 2018; Rahmi et al., 2021; Rozalena & Kristiawan, 2017). To realize student character development, the quality of education in elementary schools needs to be improved (Ernawati & Rahmawati, 2022; Lestari et al., 2021; Permatasari et al., 2021). Several components are needed to achieve educational goals. Teachers are a critical component in supporting education. Teachers are the controllers of education for students; teachers can be considered drivers responsible for the smooth running of the educational journey (Putri et al., 2020; Simanjuntak et al., 2020). This can be seen from the significant role of teachers in preparing learning and implementing learning in class based on well-structured learning materials. The teacher's role as a facilitator is that the teacher must provide the facilities that students need in learning, such as pedagogy, student psychology (in terms of problems faced by students, both internal and external) and student cognition (in critical reasoning or understanding material quickly) (Aditama et al., 2022; Handayani & Amirullah, 2019; Wijiutami et al., 2020). Teachers are also adaptability is a key requirement curriculum that applies in the world of education in Indonesia. The current curriculum is the Merdeka Curriculum. The independent curriculum is a curriculum that gives freedom to schools and the components in it, namely teachers and students, to innovate and channel their creativity in learning according to the needs and level of student development Teachers educate students through a planned learning process, so the human growth and development process in school must be distinct from the learning process carried out by educators for students. Learning is an interaction between educators and students to acquire knowledge, attitudes and skills from educators (Agustina et al., 2022; Iswara et al., 2022; Welerubun et al., 2022). Learning is an essential component of education because the quality of learning will influence the quality of education (Aruan et al., 2022; Bukhori et al., 2022; Puspitasari & Ahmadi, 2024).

In elementary school, students will study various subjects, one of which is science, which in the current independent curriculum is combined with social studies subjects to become science. Combining science and social studies subjects aims to give students a more comprehensive perspective in understanding the surrounding environment (Aini et al., 2024; Marwa, 2023). Science learning can maximise students' scientific potential (Khaeriyah, 2018; Thalib et al., 2020). Natural Sciences learning can foster students' curiosity about events that occur in the surrounding natural environment (Aini et al., 2024; Dewi & Suniasih, 2023). The critical role of Natural Sciences (IPA) in the progress of a country, so it needs to be introduced, taught and developed as early as possible among the younger generation, especially among elementary school and MI students who tend to have a higher curiosity (Hasanah, Suryana, et al., 2023; Rosihah & Pamungkas, 2018). Science learning in elementary schools must be taught because there is much to learn about the surrounding natural environment. Besides that, science learning also allows students to experiment and try new things according to the theory they are studying.

The low science learning outcomes in Indonesia are caused by learning environmental factors and how science is taught, which is classified as rote learning (Tiyas et al., 2020; Yani & Widiyatmoko, 2023). Previous research findings state that science learning requires experiments that involve students practising directly with the help of appropriate learning media so that students can have an overview of theories whose abstract form becomes concrete (Candra Dewi & Negara, 2021; Jannah & Atmojo, 2022; Supriyani et al., 2021). Based on interviews with several fifth-grade elementary school teachers, some information was obtained regarding problems often encountered in the learning process, especially science and science. Namely, students are having difficulty focusing or concentrating on learning. This is influenced by several factors, including students not liking the learning material discussed or learning feeling boring for students. The characteristics of elementary school children who like to play make them often act cold when learning, so the material taught by the teacher is not conveyed well to students; besides that, the condition of the classroom environment also greatly influences students' learning concentration. The environment is an important aspect in supporting education as a source of learning to gain new knowledge. Learning environments that are not conducive, such as crowded, noisy and dirty can make students uncomfortable in participating in learning, making it difficult for students to focus and difficult to concentrate in receiving material taught by the teacher. Students also often have difficulty understanding the material taught by the teacher, when the child is focused it does not mean that the child really understands the material presented by the teacher. Difficulty understanding this material can occur because the learning method or model used by the teacher is not appropriate. Learning methods commonly used in Indonesia generally still use conventional methods (Hasriadi, 2022; Octaviani et al., 2020).

According to the results of interviews with fifth grade teachers of SD Negeri Gugus Pangeran Diponegoro, the learning methods that teachers often use are only lecture and discussion methods. Teachers only emphasize the concepts in the book, the delivery of material rarely involves understanding through concrete objects in the environment around the child. Actually, teachers also want to make innovative learning, but due to limited school facilities in the form of teaching aids and learning media, teachers can only do makeshift learning. Meanwhile, according to several teachers of Pangeran Diponegoro Primary School, students are very interested in learning IPAS when they do experiments or experiments directly, students look more enthusiastic about learning and understand more about the material being studied. Based on the above problems, it is necessary to have a more effective learning method, so that students have no difficulty in understanding and remembering the IPAS learning material. By creating an interesting and fun learning atmosphere using the right learning method, it will foster student learning motivation so that the material taught will be easily accepted and understood. The method is a way of delivering a material by paying attention to the applicable curriculum (Ramdani et al., 2023; Solikah, 2020). A suitable learning method used to improve student concentration and understanding is the experimental method. Previous research findings state that experimental methods allow students to learn through direct experience, develop scientific attitudes, and improve learning outcomes (Hasanah, Batubatara, et al., 2023; Rati & Dewi, 2017). Other research also reveals that experimental methods can increase students' activeness in learning, impacting a pleasant learning atmosphere (Hasibuan & Suryana, 2021; Subekti & Ariswan, 2016). A learning environment that is not conducive, such as being busy, noisy and dirty, can make students uncomfortable in participating in learning, so students have difficulty focusing and have difficulty concentrating in receiving the material taught by the teacher (Arianti, 2017; Naibaho, 2023). Creating an exciting and enjoyable learning atmosphere with appropriate learning methods will foster students' learning motivation so that the material taught will be readily accepted and understood. However, there has yet to be a study regarding the application of experimental methods to the learning outcomes of class V IPAS students on the Human Respiratory System material. Based on this, this research aims to analyze the effect of experimental methods on the learning outcomes of class V IPAS students on the Human Respiratory System material.

2. METHODS

This research uses an experimental method with a quantitative approach. The experimental research method is a research method carried out through an experiment that is used to determine the effect of an independent variable (which is treated) on the dependent variable (which is the result) under controlled conditions. It uses experimental research methods, consciously creating a situation and examining its consequences. In other words, this research was conducted to explore the cause-and-effect relationship between two factors. The quantitative approach itself is an approach that uses data in the form of numbers to analyze data. This approach is carried out systematically and accurately because it uses data in the form of numbers which are analyzed statistically (Moleong, 2019; Sugiyono, 2019). The form of this research design is a Nonequivalent Control Group Design, which is used to determine the effect of a treatment on the sample. It determines the effect of an experiment or treatment on the researcher's desired subject characteristics. This research was conducted in class V of the Elementary School in Pangeran Gugus Diponegoro, Blora Regency, Central Java, which consists of four elementary schools, namely: SD Negeri 1 Mendenrejo, SD Negeri 2 Mendenrejo, SD Negeri 3 Mendenrejo, and SD Negeri 4 Mendenrejo. The population in this study was all 121 grade V students at Pangeran Diponegoro Elementary School. The sampling technique in this research used Cluster Sampling. Cluster sampling or area sampling is used to determine samples if the object to be studied or data source is very broad. The sample in this study was 50 students as the experimental class, and 50 students as the control class, the remaining 21 students as the test class. In this research, the experimental group received special treatment using experimental methods during learning, while the control group did not receive special treatment. The methods used to collect data are tests, observation, interviews, documentation and field notes. The test method is used to measure student learning outcomes in the cognitive domain in the science and science lesson content. The observation method was used to obtain initial information regarding the use of learning models and media used in schools. The interview method is used to identify problems, then formulate the problem so that it will make it easier for researchers to determine the appropriate learning model to be applied in the experimental class. The documentation method is in the form of student learning outcomes and learning tools. Apart from that, there is complementary documentation in the form of photos and videos during learning. This field note method is used by researchers to strengthen data in research reporting. The instruments used to collect data were questionnaire sheets and test questions. The instrument grid is presented in Table 1.

Table 1. Research Instrument Grid

No	Question Indicator	Cognitive Domain
1	Presented with questions, students can understand the meaning of the respiratory system	C2
2	Given an image, students can analyze the function of the respiratory organs	C4
3	Given a question, students can determine the name of the respiratory organ based on its characteristics/location	C4
4	When presented with questions, students are able to explain the importance of maintaining healthy respiratory organs	C4
5	Given the names of respiratory organs, students can analyze the flow of air in	C4
6	Given a question, students can match the 5 respiratory organs and their functions correctly	C4
7	Presented with questions, students can differentiate the mechanisms of inspiration and expiration	C4
8	Presented with questions, students can differentiate the mechanisms of chest breathing and abdominal breathing.	C4
9	Presented with questions, students can analyze disorders of the human respiratory system, efforts to prevent and overcome them	C4
10	Presented with questions, students can sequence the experimental steps correctly	C3
11	Presented with questions, students can name tools and materials for respiratory system experimental activities	C2
12	Presented with pictures of the results of experiments on simple human breathing apparatus, students can conclude the results correctly	C5
13	Presented with questions, students can analyze the factors that influence lung capacity	C4

The data analysis technique used in this research is inferential statistical analysis. The initial data analysis test used in this research aims to determine whether the data variance from the pretest results is normally distributed and homogeneous or vice versa. The prerequisite tests used by researchers in this research are the normality test and homogeneity test. In this final data analysis test, descriptive analysis of student learning activities was used, the average difference test (t test), and the average increase in learning outcomes test (N-Gain test).

3. RESULT AND DISCUSSION

Results

The Data analysis test results

Before conducting data analysis using parametric statistics, it's important to carry out a normality test on the learning outcomes. The purpose of this test is to determine whether the data is normally distributed, which is necessary for statistical analysis. Normality and Homogeneity Test showed in Table 2.

Table 2. Normality & Homogeneity Test

Group		Significant Value KS-20 Normality Test	Homogeneity
Control	Pretest	0.061	0.954
	Posttest	0.068	
Experiment	Pretest	0.069	
	Posttest	0.094	

The pretest and posttest data in the control group had sig values. 0.061 and 0.068 or greater than 0.05. The pretest and postest data have sig values. 0.069 and 0.094 or greater than 0.05. So it can be concluded that the pretest and postest data are normal. Control and experimental group pretest data have a sig value of 0.954 or greater than 0.05, so the data is homogeneous and can be tested further. T-test of Mean Equality & Difference showed in Table 3.

Table 3. T-test of Mean Equality & Difference

Control and Experiment Group	Sig Value	Description
Pretest	0.982	> 0.05
Posttest	0.000	< 0.05

The pretest data of the control and experimental groups have a sig value of 0.982 or greater than 0.05, so the pretest data of the control and experimental groups do not have an average difference, so the data have the same average initial data. The posttest data of the control and experimental groups have a sig value of 0.000 or less than 0.05, so the posttest data of the control and experimental groups have an average difference. Pretest and Posttest Data showed in Table 4.

Table 4. Pretest and Posttest Data

Results	Control		Experiment	
	Pretest	Posttest	Pretest	Posttest
Average	42.7	67.7	41.5	88.8
S. Deviation	4.77	5.09	4.80	5.98

The pretest and postest scores of the control group were 42.7 and 67.7. The pretest and postest scores of the experimental group were 41.5 and 88.8. These results show that the results of the experimental group are higher than those of the control group. The description of each criterion is showed in Table 5. N-Gain Improvement Test Results showed in Table 6.

Table 5. Frequency Distribution

No.	Score Interval	Category	Control Group		Experiment Group	
			Frequency	Percentage	Frequency	Percentage
1	76-100	Very Good	2	4%	50	100%
2	51-75	Good	48	96%	0	0%
3	26-50	Simply	0	0%	0	0%
4	0-25	Less	0	0%	0	0%
Total			**50**	**100%**	**50**	**100%**

Table 6. N-Gain Improvement Test Results

	Average		Gain	N-Gain	Criteria
	Pretest	Posttest			
Control Group	42.65	67.74	25.08	0.44	Medium
Experiment Group	41.54	88.78	47.24	0.81	High

It is known that the posttest data in the control group has an average of 67.74 with details of two students in the very good category and 48 students in the good category. Posttest data in the experimental group had an average of 88.78 with details of all students in the excellent category. The N-gain in the control and experimental group tests was 0.44 and 0.81. These results mean that the increase in understanding of IPAS in the control group is in the medium category, and the increase in understanding of IPAS in the experimental group is in the high category.

Discussion

The data analysis results show differences in science learning outcomes between the experimental class and the control class after being treated with the application of the experimental method in learning science. The following factors cause this. First, applying experimental methods can improve students' learning outcomes in Natural Sciences and Social Sciences. Science and science learning, especially at the primary level, such as elementary school, requires the right approach to ensure students' good understanding of concepts (Fanani et al., 2022; Surya et al., 2023). Science and science learning should be student-centred so that students are more active in participating in learning (Dinda Sartika et al., 2023; Failasufah & Setyasto, 2023; Wijayanti & Ekantini, 2023). The experimental method has been recognized as effective in improving learning outcomes and students' interest in science (Adnyani et al., 2017; Khaeriyah,

2018). In the context of this research, the experimental method was applied to strengthen fifth-grade students' understanding of the Respiratory System material. The experimental method offers more active and fun learning for students. The experimental method makes it easier for students to understand the material provided (Juraini et al., 2017; Ratunguri, 2016). The experimental method is a practicum-based learning method.

Second, applying experimental methods can make it easier for students to learn Natural Sciences and Social Sciences. Experimental methods can direct students to prove the truth of their studied theory (Hasibuan & Suryana, 2021; Ma'viyah, 2021). By involving students in practical activities and direct observation, this method allows them to theoretically understand concepts that may be difficult to understand (Iswatun et al., 2017; Khaeriyah, 2018). Learning about the respiratory system, students can carry out simple experiments such as observing air flow through a model lung or breathing experiments. The experimental method also allows students to interact directly with learning material. The experimental method can make students happy and enthusiastic about participating in learning (Sakliressy et al., 2021; Sari et al., 2023). Students can see, feel and observe phenomena relevant to the studied topic. This helps students develop a more profound and conceptual understanding of the respiratory system, compared to learning approaches based on theory and verbal explanations. Besides improving conceptual understanding, experimental methods also develop students' science process skills. Experiments are designed to test hypotheses derived from a theory (Sakliressy et al., 2021; Sari et al., 2023; Zabrodina et al., 2015). This experimental method can have a scientific impact, making students less likely to believe something before proving it for themselves. Students learn to think critically and scientifically by formulating hypotheses, designing experiments, collecting data, analyzing results, and drawing conclusions (Mulyono, 2018; Sari et al., 2023). These skills are essential to equip students with relevant high-level thinking skills in facing future challenges.

Third, the application of experimental methods can create a pleasant learning atmosphere. In implementing the experimental method, animated learning media is also used to make the student learning atmosphere enjoyable. The use of animated videos and PowerPoint presentations in learning is beneficial because it can help visualize complex concepts, increase student interest and motivation, and convey information more effectively (Afrilia et al., 2022; Arditya Isti et al., 2020; Prasetya et al., 2021). In the context of experimental methods, animated videos can be used to display experimental procedures and steps that may be difficult to carry out in class, while PowerPoint provides an organized structure for documenting results and analysis (Candra Dewi & Negara, 2021; Putri & Imaniyati, 2017). The combination of these two tools not only makes learning more interactive and immersive and helps students understand and remember the material better and develop critical and analytical thinking skills in conducting experiments. The findings show that videos and animations significantly impact critical thinking skills (Ekaputra et al., 2021; Yuniarni et al., 2020). Additionally, it was observed that animated videos in presentations can help students understand experiments and facilitate science learning more efficiently. Previous research findings state that the experimental method helps students learn because it can significantly increase student activity (Khaeriyah, 2018; Simanjuntak et al., 2020) . Other research also reveals that the experimental method allows students to find answers to problems by carrying out experimental activities, thereby training critical and innovative thinking skills (Jayanti et al., 2017; Rismaningsih, 2016). It was concluded that using the experimental method, students were more active in the learning process, thereby creating an active learning situation and developing physical, mental, intellectual and emotional thinking abilities. The limitation of this research is that this research only examines the application of experimental methods in science learning to student learning outcomes. The research impliesresearch implies that the experimental method provides learning conditions that can optimally develop thinking abilities and creativity so that students can develop their concepts in their cognitive structure.

4. CONCLUSION

The results of the data analysis show that there are differences in science learning outcomes between the experimental class and the control class. The results of the N-gain test also show that the increase in understanding of IPAS in the control group is in the medium category, and the increase in understanding of IPAS in the experimental group is in the high category. It was concluded that the experimental method had an influence and was effectively used in improving the learning outcomes of class V students on the human respiratory system material. Teachers can consider using experimental methods in designing and implementing effective learning strategies. By providing opportunities for students to carry out experiments and other practical activities, teachers can improve the quality of science learning in the classroom and stimulate students' interest and motivation towards science.

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