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Optimizing Science Process Skills through Multiple Representation

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A B S T R A K

Penelitian ini dilatarbelakangi oleh rendahnya keterampilan proses sains siswa pada mata pelajaran IPA, yang disebabkan oleh metode mengajar konvensional yang fokus pada hafalan, variasi model pembelajaran yang terbatas dan minimalnya keterlibatan siswa. Tujuan penelitian ini yaitu menganalisis pengaruh model pembelajaran multipel representasi terhadap peningkatan keterampilan proses sains pada siswa sekolah dasar. Metode yang digunakan dalam penelitian ini yaitu metode penelitian kuantitatif jenis penelitian eksperimen. Dalam penelitian ini menggunakan desain Nonquivalent Control Group Design. Populasi yang digunakan dalam penelitian ini adalah seluruh siswa kelas V SD. Teknik yang digunakan dalam mengambil sampel penelitian yaitu menggunakan teknik Purposive Sampling. Sampel pada penelitian ini adalah peserta didik kelas VA dan VB yang berjumlah 54 siswa. Metode pengumpulan data menggunakan teknik tes dan dokumentasi. Instrumen yang digunakan dalam mengumpulkan data yaitu lembar soal tes. Teknik analisis data penelitian ini menggunakan analisis statistik inferensial. Hasil penelitian menunjukkan perbedaan signifikan dalam keterampilan proses sains antara kelas eksperimen dan kelas kontrol, serta disparitas nyata dalam peningkatan keterampilan yang mendukung representasi model pembelajaran multipel representasi. Sehingga dapat disimpulkan bahwa, model pembelajaran multipel representasi dapat meningkatkan keterampilan proses sains pada siswa sekolah dasar. Penelitian ini diharapkan dapat membantu meningkatkan kualitas pengajaran IPA dan keterampilan sains siswa di sekolah dasar.

A B S T R A C T

This research is motivated by students' low science process skills in science subjects, which is caused by conventional teaching methods focusing on memorization, limited variations in learning models and minimal student involvement. This study aims to analyze the effect of the multiple representation learning model on improving science process skills in elementary school students. The method used in this research is the quantitative research method of experimental research type, using a nonquivalent control group design. The population used in this study were all fifth-grade elementary school students. The technique used in taking research samples is the Purposive Sampling technique. The sample in this study comprised students from the VA and VB classes, totalling 54. Data collection methods using test techniques and documentation. The instrument used in collecting data is a test question sheet. The data analysis technique used inferential statistical analysis. The results showed significant differences in science process skills between experimental and control classes and real disparities in improving skills that support the representation of multiple-representation learning models. So, the multiple representation learning model can improve science process skills in elementary school students. This research is expected to help improve the quality of science teaching and students' science skills in elementary schools.

1. INTRODUCTION

Educating or guiding students toward self-maturation is another definition of learning. This view places great emphasis on the maturation process, meaning that teaching in the form of delivering material does not necessarily mean the transmission of content (transfer of knowledge) but rather how to transmit and adopt the desired values to mature students. The role of teachers and students in the learning process is an essential determining element in general education (Alifiyarti et al., 2023; Anderson & Taner, 2023;

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Otyola et al., 2022). Students must have science process skills (KPS) to overcome various scientific challenges during scientific investigation activities (Lestari & Diana, 2018; Salam & Miriam, 2017; Sumarti et al., 2018).Science Process Skills are all the mental, physical, and social talents necessary to learn, develop, and apply scientific concepts, principles, laws, and theories (Fitria, 2020; Jannah & Shofiyah, 2023; Samijo & Romadona, 2023). Process skills in the context of natural science (science): Students can learn about concepts and principles if they have basic skills, especially scientific processes. Skills needed to use science (Fanani et al., 2022; Riswakhyuningsih, 2022). Observing, categorizing, communicating, measuring, recognizing and using space/time correlations, drawing conclusions, defining operational definitions, searching for hypotheses, controlling variables, interpreting data, and experimenting are just some of the skills needed in the field of science (Gizaw & Sota, 2023; Hasanah et al., 2023; Nuha et al., 2023). Science process skills are needed to acquire, develop, and apply scientific concepts, principles, laws, and theories. Students are required to cover several indicators that must be achieved, including observing, classifying, interpreting, hypothesizing, interpreting data, planning experiments, drawing conclusions, and communicating them in science lesson content (Diella & Ardiansyah, 2019; Sumarti et al., 2018; Wahyudi & Lestari, 2019). By involving cognitive or intellectual skills, students are expected to be able to sharpen their mastery of the concepts they have in learning.

However, previous research findings reveal that many students have difficulty learning science (Aiman & Ahmad, 2020; Lusidawaty et al., 2020; Sari et al., 2020). Other research also shows that the low science process in students is caused by poor learning activities taking place in class, which has an impact on students' low abilities (Fathurohman et al., 2023; Wicaksono et al., 2020; Yusmar & Fadilah, 2023). Based on interviews with fifth-grade students at SD Negeri 1 Awirarangan, science learning was identified as something of concern because this learning requires memorizing the basics of science and learning new material. Understanding science subjects is only provided in class by copying existing textbooks, without additional efforts to understand student learning. Students also have difficulty understanding science lessons because classroom learning resources are rarely used when learning science. Using media during the learning process is very important so students can easily absorb the information (Ariyani & Ganing, 2021; Fuadi et al., 2021; Maharuli & Zulherman, 2021). Students who do not understand, master, or even have a low level of science process skills in science material will be affected because they only receive information from the teacher and books as a learning resource. In the end, they are incapable of learning. To solve the problems they encounter (Biswal Biswajit Behera, 2023; Wangi & Agung, 2021).

The data analysis found that the results of science process skills in science subjects for class V students at SD Negeri 1 Awirarangan still needed to be higher. Based on the data, 13 students, or 48%, achieved the observation indicator, while 14 students, or 52%, did not. For the classification indicator, 33% of 9 students have achieved it, while 67% of 18 students still need to. For the interpreting indicator, 12 students achieved it with a percentage of 44%, while 15 students did not achieve it with a percentage of 56%. For the indicator of applying the concept, 8 students achieved it with a percentage of 30%, while 19 students did not with a percentage of 70%. For the communication indicator, 11 students achieved it with a percentage of 41%, while 16 students did not achieve it with a percentage of 59 %. Based on the empirical data collected by researchers, it can be seen from students who still need to meet the indicators that students' science process skills still need to be higher. Specifically, when science content is consistently low, this will impact science process skill outcomes if not acted upon.

Solutions to improve science process skills by implementing learning activities and innovative learning models. One of the learning models used is the use of the Multiple Representation Learning Model, which can be used to improve science process skills in elementary school science content (Aldeaij, 2023; Astalini et al., 2023; Wang, 2023). The multiple-representation learning model is a model that represents concepts that have been learned through various methods and various actions and expressions (Haris et al., 2021; Lestari et al., 2020). Using multiple representations in learning will help students form mental models to approach external reality. Learning with multiple representations can build procedural and conceptual knowledge if, in learning, there is an exciting visualization of concepts at the (sub) microscopic level. There are procedures for transforming from the macroscopic to the symbolic level and the (sub) microscopic level or vice versa (Iqbal et al., 2020; Lestari et al., 2020). This learning model provides opportunities for students to understand and actively participate in learning concepts from environmental phenomena under teacher guidance, which will make learning more meaningful (Aldeaij, 2023; Wang, 2023). Students can actively participate in learning by exploring information or using their imagination to find solutions to problems using various representation models. Students can also make scientific discoveries directly during learning, including observing, classifying, interpreting, applying concepts, and communicating. This can improve students' ability to learn science concepts (Gopinathan et al., 2022; Martens et al., 2019; Siahaan et al., 2021). The following list includes several purposes for using multiple representations during learning. First, to increase students' cognitive capacity to understand scientific concepts. Second, depending on the subject being studied, it requires students to present the ideas they learn in various ways, such as through oral/text, graphs, diagrams, and pictures (Aldeaij, 2023; Bakri & Muliyati, 2018; Haili et al., 2017; Nielsen et al., 2022; Wang, 2023). The novelty of this research is that this research investigates multiple representation learning models to improve science process skills. Based on this, this research aims to identify multiple representation learning models to improve science process skills in elementary school students.

2. METHOD

The method used in this research is a quantitative, experimental research type. This research uses a Nonquivalent Control Group Design (Hapsari et al., 2020; Rochimah, 2016). This design is the same as the pretest-posttest control group design, and only the experimental and control groups are not selected randomly. This research design was carried out on two sample groups (two classes), namely the experimental class and the control class. This experimental class is a class that is given treatment, namely using a multiple representation learning model. In contrast, the control class is a class that is not given special treatment, and this control class uses a discovery learning model. The tests were carried out twice: the pretest and the posttest. In this research, the experimental and control classes will be given two tests: a test carried out before learning (pretest) and a test carried out after learning (posttest). These two classes will receive the same treatment in terms of material and learning objectives.

The research location is SD Negeri 1 Awirarangan. The population used in this research was all fifth-grade students at SD Negeri 1 Awirarangan. The technique used in taking research samples is the Purposive Sampling technique. Purposive sampling is a technique that does not allow any element or member of the population to be selected as a sample. The sample in this study consisted of 54 students from classes VA and VB, with 27 students from class VA as the experimental class group and 28 students from class VB as the control class. The data collection method uses test and documentation techniques. Tests are an evaluation tool used to measure the extent to which teaching objectives have been achieved (Hapsari et al., 2020; Rochimah, 2016). A good test must meet the following requirements: it must be efficient, standardized, have norms, be objective, valid, and reliable. To obtain a test that meets these requirements, the test that has been created needs to be analyzed. Test analysis starts when the test is designed, where the test must be based on the syllabus/SAP of each subject. First, create a blueprint, then arrange the questions according to the rules of question construction based on the type of question desired. This research documentation method uses documents in the form of photos, drawings, and data regarding student activities in the learning process at SD Negeri 1 Awirarangan. The instrument used to collect data was the test question sheet. The test instrument grid is presented in Table 1.

Table 1. Test Question Instrument Grid

No	Basic Competency	Indicator Science Process Skills	Question Indicators	Cognitive Domain
1	3.8 Analyze the water cycle and its impact on events on earth and the survival of living things	Observing	Observe the process water cycle	C1, C4
2.		Classifying	Grouping water cycle and hydrological cycle types	C4,C6
3.		Interpreting	Interpret the factors thaT influence the process water cycle	C5
4.		Applying concept	Apply the concept of conceptualizing the water cycle process and Impact on events on earth.	C2, C3,C4
5		Communicating	Summarize/conclude the water cycle process on earth	C5

Data analysis techniques are a way of processing data so that information from research that has been conducted previously can be presented (Gebre, 2018; Hapsari et al., 2020; Rochimah, 2016). This research data analysis technique uses inferential statistical analysis. The normality test is used to calculate the pretest and posttest scores of the two groups to determine whether the data is usually distributed. The homogeneity test considers two sources of error that arise in the planned test. This hypothesis test uses a similarity test of two means to test the similarity between two data means, in this case, between the experimental group data and the control group data, with the formulation of a hypothesis. The n-gain test is used to compare compare the pretest and posttest scores in the experimental and control classes. This research will use the n-gain test to provide a general picture of whether or not there has been an increase in students' science process skills after receiving treatment. The increase in science process skills is between students who are given treatment using multiple representation models and students who are given treatment that does not use multiple models.

3. RESULT AND DISCUSSION

Result

The data used consists of a pretest carried out before learning begins and a posttest carried out after learning using the multiple representation model. The aim of these two tests is to determine the extent of the influence of the dual representation model on improving science process skills. The pretest scores for the experimental class and control class are presented in Table 2.

Table 2. Pretest Scores for Experimental Class and Control Class

Class	N	Lowest Score	Highest Score	Total Score	Average	Standard Deviation
Experiment	27	25	65	1.235	45.25	12.17
Control	28	20	60	1.115	39.82	11.93

Based on Table 2, it can be seen that the control class consisted of 28 respondents, with a total score of 1,115, the lowest score was 20, the highest score was 60, the average score was 39.82, and the standard deviation was 11.93. Meanwhile, in the experimental class which used the dual representation model, there were 27 respondents, with a total score of 1,235, the lowest score was 25, the highest score was 65, the average score was 45.25, and the standard deviation was 12.17. The posttest scores for the experimental class and control class are presented in Table 3.

Table 3. Posttest Scores for Experimental Class and Control Class

Class	N	Lowest Score	Highest Score	Total Score	Average	Standard Deviation
Experiment	27	55	95	2.060	76.29	12.32
Control	28	40	80	1.679	59.64	11.53

Based on Table 3, the control class posttest results amounted to 28 respondents, with the lowest score of 40, the highest score of 80, total score of 1.670, average score of 59.64, and standard deviation of 11.53. Meanwhile, in the experimental class with 27 respondents, the lowest score was 55, the highest score was 95, the total score was 2,060, with an average score of 76.29 and a standard deviation of 12.31. This normality test was carried out to find out whether the pretest data from the experimental class and control class were normally distributed or not. This test is carried out using the Chi Square formula (X_2). The results of data analysis show that the results of the pretest normality test in the experimental class obtained an X_{2count} value of 5.8506 with a confidence level of 95% and with db 3. Thus obtaining X_{2table}. namely 7.8147. Thus it can be concluded that the pretest normality test in this experimental class has a normal distribution. The results of the pretest normality test in the control class obtained an X_{2count} value of 4.7301 with a confidence level of 95% and with db 3. Thus obtaining X_{2table}. namely 7.8147. Thus, it can be concluded that the pretest normality test in the control class is normally distributed. The results of the pretest normality test for the experimental and control classes are presented in Table 4.

Table 4. Pretest Normality Test Results for Experimental and Control Classes

Statistics	Experimental Class	Control Class
	Pretest	Prestest
Average	45.11	39.5
SD	12.17	11.93
X^2 count	5.8506	4.7301
X^2 table	7.8147	7.8147
Detail	Normal	Normal

The results of the posttest normality test in the experimental class obtained an X2count value of 3.168 with a confidence level of 95% and with a db of 3, thus obtaining X2table. namely 7.8147. Thus it can be concluded that the posttest normality test in this control class is normally distributed, because $X_{2count} < X_{2table}$. The results of the posttest normality test in the control class obtained an X2count value of 4.9135 with a confidence level of 95% and with db 3, thus obtaining X_{2table}. namely 7.8147. Thus it can be concluded that the posttest normality test in this experimental class is normally distributed. Posttest Normality Test Results for Experimental and Control Classes are presented in Table 5.

Table 5. Results of the Posttest Normality Test for the Experimental and Control Classes

Statistics	Experimental Class	Control Class
	Posttest	*Posttest*
Average	76.40	59.53
SD	12.32	11.53
X^2 count	3.168	4.9135
X^2 table	7.8147	7.8147
Detail	Normal	Normal

Homogeneity testing aims to state or test whether the two group data have homogeneous variances or not. The results of this homogeneity test use the F-test formula. The results of data analysis show that the pretest homogeneity test obtained results namely F_{count}, namely 1.0415 and F_{table}, namely 4.023. So it can be concluded that the data results are homogeneous. Based on the results of the pretest homogeneity test, the results obtained were $F_{count,}$ namely 1.1419 and F_{table}, namely 4.033. So it can be concluded that the data results are homogeneous. This hypothesis testing was carried out after obtaining previous data. After ensuring that the posttest data in the experimental class and control class were normally distributed and homogeneous, testing was carried out using the t-test formula to answer the hypothesis: "There are differences in science process skills between students in the experimental class. using a dual representation model and the control class using the Discovery Learning model." The t test results are shown in Table 6.

Table 6. Hypothesis Test Results in the Experimental Class and Control Class

Class	Average	Standard Deviation	Number of Students	t *Value*	t *table*
Eksperiment	76.29	151.94	27	5.170	2.006
Control	59.64	133.05	28		

Based on Table 6, the t test results for the posttest show a calculated t value of 5.170 and a t table value of 2.006. Therefore, it can be concluded that Ho is accepted. This means that there are differences in the science process skills of students in the experimental class which uses the multiple representation model compared to students in the control class who use the Discovery Learning model after being given treatment.

Discussion

The data analysis results show differences and improvements (acquisitions) in students' science process skills between classes that received treatment using the multi-representation model and classes that received treatment that did not use the multi-representation model. This is due to the following factors. First, the multiple-representation learning model can make it easier for students to learn science. This multiple representation model can improve students' science process skills in the learning process; students can observe learning videos, discuss and exchange opinions with other students, and communicate or conclude from learning results (Iqbal et al., 2020; Yunitasari et al., 2019). This means students' science process skills can be seen during the learning process. This model involves presenting material in various ways, such as verbal, visual, verbal, and symbolic, using tools such as instructional videos, PowerPoint presentations, 3D media, worksheets, and textbooks (Gondo & Mbaiwa, 2022; Husna et al., 2022; Yunitasari et al., 2019). This model also functions as a complement, interpretation, and deepening of the material. With the multiple representation models, students can learn independently, express opinions, and understand, and pay attention to the material presented in various ways. This is in line with the theory which states that there is a social system related to the roles of students and teachers in implementing the dual representation model, where teachers act as facilitators, moderators and consultants (Haris et al., 2021; Yuanita & Ibrahim, 2015; Yunitasari et al., 2019). Second, the multiple-representation learning models can increase student learning activity. Learning models with multiple representations can build procedural and conceptual knowledge if interesting visualizations are used in learning for concepts at the (sub) microscopic level, and there are procedures for transforming from the macroscopic to the symbolic level and the (sub) microscopic level or vice versa. This causes student activity to increase (Dwi Sari & Setiawan, 2020; Sugrah, 2020; Wali et al., 2020). Multiple representations have the primary function, namely as a complement; they complement multiple representations, presenting fairly complete information in clarifying concepts or problems (Iqbal et al., 2020; Yunitasari et al., 2019). Multiple representations help create more understanding when students combine representation forms to identify and solve problems. Both teachers and students are actively involved (Lasari et al., 2021; Widyaningrum, 2023; Zahranie et al., 2020). Students in the learning process can actively explore information or use their imagination to determine solutions to problems. Third, the multiple-representation learning model can create a pleasant learning atmosphere. The learning process can be carried out in groups or individually. The teacher plays the mediator (mediator) and provider (facilitator) in learning activities. Apart from that, teachers in learning activities guide students with difficulty solving problems. This makes learning activities enjoyable because teachers help and facilitate students' learning (Brandmiller et al., 2020; Trust & Pektas, 2018). This is supported by previous research findings, which state that the multiple representation model is a fun learning model for students so that students easily understand the material presented by the teacher (Lestari et al., 2020; Yunitasari et al., 2019). The multiple representation model can create a learning environment rich in individual and collaborative learning activities. In educational activities, students learn by using all their five senses. As a result, using multiple-representation learning models can help students become more proficient in scientific methods (Syahmel & Jumadi, 2019; Yuanita & Ibrahim, 2015). Multiple representation models have three main uses: as a complement, a barrier to interpretation, and a tool to improve understanding. Previous findings also reveal that multiple representations significantly influence mastery of science concepts and science process skills (Haili et al., 2017; Syahmel & Jumadi, 2019). The advantage of the multiple representation model is that it can encourage or motivate students to improve their imagination and understanding abilities. Multiple representation models can be combined with ICT, and teachers will use various types of media. The limitation of this research is that the population used in this research is only class V students at SD Negeri 1 Awirarangan. It is hoped that other research can use a wider population. This research implies that applying the multiple representation learning model can improve science process abilities in elementary school students.

4. CONCLUSION

Based on the data analysis, it was found that differences in the science process skills of experimental class students who used the multiple representation model compared to the control class who used the Discovery Learning model were observed after the treatment. There was an increase in the science process skills of experimental class students who used the multiple representation model compared to the control class who used the Discovery Learning model after being given treatment. It was concluded that the multiple representation model can improve elementary school students' science process skills.

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