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The Effectiveness of Project-Based Learning Model Assisted By Design Thinking on Experimenting Skills in Grade IV Science and Technology Learning in Dagangan Sub-District

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ABSTRACT: The purpose of this study was to determine the effectiveness of project-based learning model on experimental skills. The type of research is quantitative. The population was grade VI elementary schools in Dagangan sub-district, Madiun district. The sampling technique used was random sampling. The research sample was SD Negeri Sewulan 02 and SD Negeri Dagangan 02, each with 20 students. The source of data is IPAS learning with material changes in form. Data collection through tests and observations. Data analysis using Paired t-tests and N-gain test for effectiveness test. The results showed that the Paired t-test test for the post-test results of the experimental group obtained data that was significant (2-tailed) less than 0.05 (Sig < 0.05) so it could be interpreted that there was a difference; N-gain effectiveness test = 70.70% with very high criteria; and 83.44% participant activeness with high criteria. In conclusion, the project-based learning model assisted by design thinking is effective in improving students' ability to experiment.

KEYWORDS: Project based learning, design thinking, experimental skills

INTRODUCTION

Project Based Learning (PjBL) is a learning model that allows students to face real situations and solve problems through directed experimental activities. According to (Bytyqi, 2021) Project Based Learning (PjBL) is a systematic teaching method that involves students in learning knowledge and skills through a process of inquiry based on complex and authentic questions with carefully designed tasks and products. Project Based Learning (PjBL) is a form of constructivism and collaborative learning where the learning process is centered on students, which allows students to work together to solve problems, and learn together to build knowledge (Eka Erlinawati & Bektiarso, 2019).

Project Based Learning (PjBL) has several main principles including learner-centered learning, learning can develop learner creativity, creating a challenging and fun classroom learning atmosphere (Ayub et al., 2023). As a learning model, Project Based Learning (PjBL) has several advantages including developing students' creative thinking skills in identifying problems, learning emphasizes processes and skills, fosters independent attitudes in students, encourages active students and encourages collaboration skills between students. Besides having advantages, this learning model also has challenges, namely requiring a long time allocation in the learning process (Yustina et al., 2020a). The weaknesses in this learning model can be minimized or even eliminated by applying the design thinking approach. Design thinking is an experience-based learning process by looking at challenges and problems that may arise to find solutions through planning and control activities (Hölzle & Rhinow, 2019). Design thinking is used to minimize problems by presenting creative and innovative design concepts (Abdurrohman et al., 2021). Design thinking can answer the needs of problems or deficiencies that exist in learning (Kristiani & Sari, 2023).

Project Based Learning (PjBL) assisted by design thinking is the right choice to be applied in IPAS learning in developing experimental skills. Experimentation skills are the skills of students in planning, conducting and analyzing experiments or experiments in a systematic and scientific way. Learning that develops experimental skills emphasizes the process of actively seeking knowledge rather than just listening to the teacher's explanation. Experiential learning applies theoretical and practical knowledge simultaneously. Experimentation skills are an important part of implementing science learning or IPAS (Warsiki, 2018).

Experimentation skills include skills to formulate problems, propose and test hypotheses, design and assemble instruments, collect, process and interpret data and communicate in writing or orally based on empirical evidence obtained from experimental activities (Tyas et al., 2020). In developing experimental skills, different and innovative ideas or new ideas are needed, so that students' ability to think creatively is needed. Creative thinking is one of the important components that students must have in developing experimental skills (Tumurun et al., 2016).

According to (Atiyah & Nuraeni, 2022), creative thinking is the ability to generate new ideas or ideas in producing a way to solve problems. A thought is said to be creative if it meets the indicators in creative thinking which consist of: (1) fluent thinking ability, which is the ability to generate many answers and ideas in solving problems, (2) flexible thinking ability, which is the ability to produce varied questions and answers, (3) original thinking ability, which is the ability to ask questions that are diverse, unique and have novelty, (4) detailed thinking ability, which is the ability to develop ideas by adding or detailing the subject (Kadir et al., 2022).

Students' creative thinking skills in conducting a problem-solving analysis can be developed through the application of Project Based Learning (Putri et al., 2022). Creative thinking skills are an important element in the implementation of Project Based Learning (PjBL) assisted by design thinking to develop experimental skills in the IPAS subject. IPAS is an important subject for students to learn because it aims to develop students' understanding and knowledge of natural phenomena and surrounding life through scientific methods (Rista Aida, 2023).

The objectives of IPAS learning in accordance with the Decree of the Head of the Education Curriculum and Assessment Standards Agency Number 8 of 2022, can be fulfilled if in the learning process the teacher is able to develop students' experimental skills. The development of experimental skills can be through the application of learning models and strategies that make students actively involved. The application of various models and strategies will make IPAS learning meaningful for students. Meaningful learning will make it easier for students to understand the subject matter instead of just memorizing. Meaningful learning will make IPAS learning achieve the expected goals. IPAS learning will achieve the expected goals, if: (1) the learning is learner-centered, that is, learning that provides relevant and interesting learning experiences for learners, (2) learning that encourages learners to think critically and analytically in solving problems, (3) learning that provides opportunities for learners to conduct experiments and design scientific research, (4) learning that utilizes technology, (5) learning that provides opportunities for learners to innovate and develop new ideas, (6) learning that facilitates learners in group activities, projects and discussions to develop collaboration skills, (7) learning that is oriented towards results and processes, and (8) learning that encourages learners to have responsibility and train independent attitudes. Such learning can be realized through experimental activities.

The above statement is an ideal condition in the IPAS learning process in elementary schools. However, the reality in the field shows that IPAS learning so far has not developed experimental skills even though it has carried out experimental activities in the learning process. The lack of development of experimental skills is due to limitations in preparing adequate experimental equipment, experiments carried out are not good in design, experimental activities are more demonstrative and do not provide opportunities for students to design their own experiments, do not optimize students' activities in discussion and analysis, experiments are not applied in the real world. These conditions will cause limited conceptual understanding of the material learned, the difficulty of students in connecting theory with concepts that exist in the real world, students cannot develop their creative thinking skills, and interest in learning decreases.

One of the solutions in overcoming these problems in IPAS learning is the application of Project Based Learning (PjBL) assisted by design thinking. Project Based Learning (PjBL) is a learning model that prioritizes learning through projects or project-based tasks. In Project Based Learning (PjBL), students will be actively involved in planning, designing, and implementing projects related to IPAS learning. Through this learning model, learners can develop creative thinking skills, collaboration, and practical application of scientific concepts. Project Based Learning (PjBL), can also increase motivation and interest in learning (Zaeriyah, 2022). Design thinking is a learning approach designed to answer the problems and challenges faced in the learning process (Ilham et al., 2021).

Based on the description above, researchers can formulate research problems as follows: how is the effectiveness of the Project Based Learning learning model assisted by Design Thinking on experimental skills in grade IV IPAS learning in Dagangan sub-district? The purpose of this study was to determine the level of effectiveness of the Project Based Learning learning model assisted by Design Thinking on experimental skills in learning IPAS grade IV in Dagangan sub-district.

RESEARCH METHODS

This type of research is quantitative with an experimental approach. Ibrahim, at all, (2018: 55) explains that experimental research is a type of research that analyzes several variables, more than two, by giving treatment to the independent variable and then measuring the dependent variable. The independent variable in this study is the project-based learning model assisted by design thinking and the dependent variable is experimental skills. The design in this research is quasi-experimental. Dantes (2017) states that quasi-experimental is often called a pseudo-experiment whose design is a nonequivalent control group design. The quasi-experimental research in this study used two groups, namely: experimental group and control group. The experimental group received treatment by applying the project-based learning model with the help of design thinking. While the control group implemented conventional learning.

The population was fourth grade students in Dagangan sub-district, Madiun district, East Java. Sampling using random sampling which is then determined based on the lottery number to select two elementary schools. The control group was SD Negeri Sewulan 02 and the experimental group was SD Negeri Dagangan 02, each of which had 20 students. The sampling technique used in this study was saturated sampling. (Hardani, et all, 2020: 369) explains that saturated sampling is a way of selecting samples by including all members in the population.

The data source in this study is learning Natural and Social Sciences (IPAS), while the data are tests, interviews, and observations. Data collection techniques using tests, observations, and documentation in the form of test instruments with IPAS material and observation sheets. The IPAS test instrument has been tested for validity, reliability, difficulty level, and distinguishing power. The observation sheet has been analyzed by IPAS material expert lecturers, language expert lecturers, and education science expert lecturers from Sebelas March University, Surakarta, Indonesia. The observation sheet was used to measure the level of student activeness, with indicators: courage to ask questions; answering questions from the teacher or other students; speed of working on problems; and teamwork. The criteria for the level of student activeness is adjusted to the following criteria:

Table 1. Learner Activity Leve

achievements	Criteria
75% - 100%	Tall
51% - 74%	currently
25% - 50%	Low
0% - 24%	Very Low

Source: Arikunto (2017: 130)

At the initial stage of data processing, the incoming data is tested for normality, homogeneity test to determine that the sample comes from a normal population and the two groups are comparable data groups (homogeneous). Normality test, Homogeneity test, and Paired sample t-test, in this study, researchers used the help of the SPSS version 26 program. Meanwhile, to measure the effectiveness of the project-based learning model assisted by design thinking, researchers used the normalized N-gain test (Hake, 1999: 1) with the formula:

$$N - gain = \frac{S_1 - S_2}{S_{\max ideal} - S_2}$$

Description:

S_1 = post-test score

S_2 = pre-test score

S_maxideal = ideal maximum score that can be obtained by students

Conclusions were drawn using criteria based on Table 2. following

Table 2. N-gain grouping criteria

$N - gain$	Criteria
$N - gain \geq 0{,}7$	Tall
$0{,}3 \leq N - gain < 0{,}7$	Currently
$N - gain < 0{,}3$	Low

Source: Hake (1999: 1)

To evaluate the significant effectiveness of the treatment given, the requirement that must be met by the N-gain is at least 0.3 as listed in Table 2.

RESULTS AND DISCUSSION

Results

The research was conducted in Dagangan sub-district, Madiun district at Sewulan 02 State Elementary School as the control group and Dagangan 02 State Elementary School as the experimental group. Each group will be given a pre-test before treatment and a post-test after treatment. The observation sheet was used during the learning process to see the level of student activeness.

Data analysis of the pre-test results of the two groups was intended to determine the ability of experimental skills in IPAS learning with material on changes in the form of objects. The data on the test results of the control and experimental groups are presented in the table as follows:

Table 3. Descriptive Statistics of Pre-Test Results

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Control Group	20	60.00	78.00	67.4000	5.00946
Experimental Group	20	61.00	77.00	67.4000	4.86015
Valid N (listwise)	20				

The results of table 3. Obtained data that the minimum scores for the control and experimental groups were 60.00 and 61.00, respectively. The maximum values for the control and experimental classes were 78.00 and 77.00 respectively. The mean of the control and experimental groups is the same, namely 67.40, with the standard deviation of the control and experimental groups being 5.01 and 4.86.

Data analysis of the post-test results of the two groups is intended to determine the ability of the experimental group after the treatment of PBL learning model assisted by design thinking and conventional learning for the control class in IPAS learning with material changes in the form of objects. The data on the post-test results of the control and experimental groups are presented in the table as follows:

Table 4. Descriptive Statistics of Post-Test Results

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Control Group	20	70.00	80.00	75.7500	4.06364
Experimental Group	20	78.00	92.00	84.6000	5.39395
Valid N (listwise)	20				

The results of table 4. Obtained data that the minimum scores for the control and experimental groups were 70.00 and 78.00, respectively. The maximum values for the control and experimental classes were 80.00 and 92.00 respectively. The mean of the control and experimental groups were 75.75 and 84.60 respectively, with the standard deviation of the control and experimental groups being 4.06 and 5.39.

Observations were made by researchers 4 times during the IPAS learning process with material on changes in the form of objects. The results of observations of student activeness obtained the following data:

Table 5. Student Activity

Group	Predicate			Percentage	Criteria
	Low	Medium	High		
Control	-	20	-	60.63%	Medium
Eksperimental		4	16	83.44%	High

Data is analyzed for prerequisite tests which include normality and homogeneity tests. Gunawan (2020: 52) explains that the normality test is used to know that the data and population used in research are normally distributed so that they are included in parametric statistics. Enterprise (2018: 53) explains that decision making is considered from Significance (sig)> 0.05 then the data is normally distributed, whereas if the value at Significance (sig) <0.05 then the data is not normally distributed.

Table 6. Normality Test Results

Test of Normality

	HASIL BELAJAR	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
MARK	Control group pre-test	.132	20	.001	.751	20	.203
	Control group post-test	.252	20	.002	.797	20	.331
	Experimental group pre-test	.183	20	.003	.837	20	.216
	Experimental group post-test	.253	20	.002	.832	20	.413

The results of the calculation of SPSS version 26, normality test with Shapiro-Wilk (because the data is less than 100) obtained data that the significant results of the learning test both control and experimental groups above 0.05 (Sig> 0.05). This can be interpreted that the learning outcomes are normal data.

The pre-test test results of the control group and the experimental group were then tested for homogeneity. Gunawan (2020: 53) explains that the homogeneity test is a test to determine that the variants of the research population are homogeneous or heterogeneous. If the value at significance (Sig) > 0.05 so that the variants of two or more data groups are said to be homogeneous.

Table 7. Homogeneity Test Results

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
LEARNING OUTCOMES	Based on Mean	4.723	1	38	.536
	Based on Median	4.369	1	38	.543
	Based on Median and with adjusted df	4.369	1	37.703	.543
	Based on trimmed mean	4.727	1	38	.536

The results of the SPSS version 26 calculation, the Homogeneity test obtained data that the significant results of the Post-test learning test results of the control and experimental groups were above 0.05 (Sig> 0.05). It can be interpreted that the Post-test learning outcomes of the two groups are homogeneous.

The learning outcomes of the control and experimental groups need to be seen the average difference with the Paired sample t-test test. Using the Paired sample t-test test because the amount of data is less than 100 (the data is small). The description of the average difference for the experimental group is presented in table 8 below:

Table 8. Experiment Mean Difference Data

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Experimental group pre-test	67.40	20	4.860	1.087
	Experimental group post-test	84.60	20	5.394	1.206

The mean difference for the control group is presented in table 9 below:

Table 9: Control Mean Difference Data

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Control group pre-test	67.40	20	5.009	1.120
	Control group post-test	75.75	20	4.064	.909

The average increase of the experimental group and control group was 17.20 and 8.35, respectively.

The data from the Paired Sample t-test test results are as follows:

Table 10. Paired Sample T-Test Test

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pre-test Eksperimen - Post_test Eksperimen	-17.200	4.753	1.063	-19.424	-14.976	-16.184	19	.000

The results of the Paired Sample T-Test test found that the significant (2-tailed) is less than 0.05 (Sig < 0.05), so it can be interpreted that there is a difference or in other words, the average difference in the experimental group is significant increase.

The results of the N-gain calculation, as follows:

S1 = 1809; S2 = 1348; SIdeal = 2000

$$\text{N-gain}=\frac{1809-1348}{2000-1348}$$

N-gain=0.7070

The results of the N-gain calculation obtained 0.7070 or 70.70% with very high criteria.

DISCUSSION

The application of the PjBL learning model assisted by design thinking in IPAS lessons with material changes in form is effective for improving students' ability to experiment. This is evident from the increase in the average learning outcomes of the experimental group which is 17.20 compared to the control group which rose 8.35. The PjBL learning model assisted by design thinking is effective in improving students' ability to experiment as evidenced by the N-gain reaching 70.70% with very high criteria. This is also evidenced by the score of students' activeness during learning obtained 83.44% with high criteria.

The activeness of students shows that students have the ability to build their knowledge through activity. This is because students are directly related to what to do and what to think. The statement is explained by Huriah (2018: 43) PjBL is a learning model that provides space for students to communicate problems through problems that exist in a real-life environment by doing activities and experiments.

The PjBL learning model has learning steps that direct learners to continue to actively build their knowledge. The steps of the PjBL model provide space for students to continue to be active. The PjBL learning steps in this study are in line with Rahmawati (2018) who states that the steps of Project Based Learning (PjBL) are: (1) determine the fundamental question / Start With the Essential Question (2) design a project plan / Design a Plan for the Project, (3) develop a schedule / Create a Schedule, (4) monitor students and the progress of the project / Monitor the Students and the Progress of the Project, (5) test the results / Assess the Outcome, (6) evaluate the experience / Evaluate the Experience. This step has activated students as evidenced by the results of observations of student activeness. The observation results get a score of 83.44% with high criteria. This is also supported by Sani (2021: 264) who states that carrying out repeated trials, formulating processes and discussing results are stages of the project-based learning model.

The increase in the effectiveness of the PjBL learning model in improving the ability to experiment, by obtaining an N-gain score of 70.70% and very high criteria, proves that Project Based Learning (PjBL) is able to activate students to carry out experiments. Adinugraha (2018) explains that PjBL has advantages to make participants actively build knowledge, these advantages are: (1) encouraging students to be creative and independent in producing work or products; (2) giving students experience to build their own knowledge; (3) improving students' ability to communicate with other friends; (4) improving the ability to solve problems; and (5) improving students' science process skills which include: asking questions, formulating hypotheses, observation activities, planning experiments, and communicating the results.

So, PjBL assisted by design thinking has been proven effective in improving students' ability in experimental skills in grade IV elementary schools in Dagangan sub-district, Madiun district.

CONCLUSION

The project-based learning (PjBL) learning model assisted by design thinking has been able to improve the ability of students to experiment. This is indicated by the observation results which state that students are active in PjBL assisted by design thinking by obtaining 83.44% with high criteria. In addition, PjBL assisted by design thinking is also effective in developing students in improving their ability to experiment by 70.70% with very high criteria.

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