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THE INFLUENCE OF STEAM-BASED PROJECT MODEL ON FIFTH GRADE ELEMENTARY STUDENTS' SCIENCE PROCESS SKILLS

Trivena[1*], Reni Lolotandung[2]
[1,2]Universitas Kristen Indonesia Toraja
[1]trivena@ukitoraja.ac.id

Abstrak

This study aims to determine whether the Science Technology Mathematics Art and Technology (STEAM) project-based model influences the Science Process Skills (SPS) of elementary school students. The research method employed is quantitative research with a one-group pretest-posttest design. The population and sample of the study were fifth-grade students from SDN 6 Saluputti, Saluputti District, Tana Toraja, totaling 21 students. The research instruments used were multiple-choice and essay tests developed from science process skill indicators on the topic of heat transfer, teacher and student activity observation sheets, and interview guidelines. The results of the study indicate a significant influence of the STEAM-based project model on the Science Process Skills (SPS) of fifth-grade elementary students with a significance value of 0.001 < 0.05, thus accepting the alternative hypothesis (Ha) and rejecting the null hypothesis (H_0). The data obtained will be analyzed using Paired Sample t-Test.. The N-gain value falls into the moderate category, leading to the conclusion that there is an influence of the STEAM-based project model on the SPS of fifth-grade students at SDN 6 Saluputti. However, further research is still needed on other science topics in elementary school that can be taught using the STEAM project-based approach to enhance students' knowledge and skills in other areas.

Keywords: *STEAM; Scince Process Skills; Natural Science; Elementary School*

Abstrak

Penelitian ini bertujuan untuk mengetahui apakah terdapat pengaruh model proyek berbasi Science Technology Mathematic Art and Technology (STEAM) terhadap Keterampilan Proses Sains (KPS) siswa sekolah dasar. Metode penelitian yang digunakan adalah penelitian kuantitaaif dengan desain penelitian one group pretest-posttest design. Populasi dan sampel dalam penelitian adalah siswa kelas V SDN 6 Saluputti, Kecamatan Saluputti, Tana Toraja yang berjumlah 21 siswa. Instrumen penelitian yang digunakan adalah tes pilihan ganda dan essay yang dikembangkan dari indikator keterampilan proses sains dengan materi perpindahan panas, lembar observasi aktivitas guru dan siswa dan pedoman wawancara. Data dianalisis menggunakan Uji Paired Sample t-Test. Hasil penelitian menunjukkan bahwa terdapat pengaruh yang signifikan model proyek berbasi STEAM terhadap Keterampilan Proses Sains (KPS) siswa kelas V sekolah dasar dengan nilai signifikansi 0,001<0,05 sehingga Ha diterima dan H0 ditolak, dan nilai N-gain berada pada kategori sedang, sehingga dapat disimpulkan bahwa terdapat pengaruh model proyek berbasis STEAM terhadap KPS siswa kelas V SDN 6 Saluputti. Namun, masih diperlukan penelitian lebih lanjut mengenai topik-topik IPA lainnya di sekolah dasar yang dapat diajarkan dengan menggunakan pendekatan proyek berbasis STEAM untuk meningkatkan pengetahuan dan keterampilan siswa dalam bidang lain.

Keywords: STEAM; Keterampilan Proses Sains; IPA; Sekolah Dasar

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Introductions

The essence of Natural Science (IPA) or science extends beyond mere content or products to encompass the scientific process. Hence, the primary aim of science education in schools is not solely focused on understanding scientific concepts, but also on cultivating students' attitudes and skills towards the scientific process (Ekici & Erdem, 2020). The Science Process Skills (SPS) represent transferable intellectual abilities that should be learned for valid induction and deduction using concepts and principles (Tobin & Capie, 1982). In other words, Science Process Skills (SPS) are a set of skills involving one's thinking, reasoning, and actions to achieve specific goals or outcomes effectively and efficiently (Elvanisi et al., 2018).

Basically, Science Process Skills are divided into two parts: basic SPS and advanced or integrated SPS. Basic SPS consists of skills such as observing, measuring, classifying, inferring, communicating, and predicting. On the other hand, advanced or integrated SPS includes skills like operational definition, hypothesis formulation, data interpretation, experimentation, and designing or creating. In the Independent Curriculum for Elementary School (Kurikulum Merdeka), Basic Scientific Process Skills are considered one of the essential elements or competency groups within the Learning Outcomes (Capaian Pembelajaran) of the subjects of Natural Sciences (Ilmu Pengetahuan Alam) and Social Sciences (Ilmu Pengetahuan Sosial) (Nurani et al., 2022). As one of the elements within the learning outcomes, basic science process skills differ from derived understanding of natural sciences that are translated into learning objectives, but are integrated within the learning process. This integration is expected to enable students to experience reinvention or discover new things while learning scientific concepts or materials (Abrahamson & Kapur, 2018).

Based on initial observations at SDN 6 Saluputti, it appears that the understanding and ability of teachers to formulate learning outcomes within the natural sciences and social science teaching module are lacking. The learning outcomes developed by teachers has not been adjusted to match the characteristics of the content and the elements to be achieved, particularly in integrating SPS into the learning outcomes. Additionally, interviews with one teacher indicated that the teaching module used is still an initial prototype developed by the Curriculum Development Team of the Directorate of Elementary Schools, without being tailored to the needs of students or the characteristics of the science content itself, mainly because teachers still do not fully understand how teaching modules should be structured. Therefore, there is a need for a strategy or approach to facilitate teachers' understanding of science content and SPS, enabling integration into learning outcomes and objectives in science education, specifically for Grade 5. This lack of integration is likely impacting students' SPS development at the elementary level, where students are less active in observing, questioning, or answering given questions. Several relevant studies also show that science education in elementary schools particularly emphasizes the application of science concepts to students. However, teachers still face difficulties in developing students' science process skills (Elfeky et al., 2020; Yildiz & Guler Yildiz, 2021).

Learning based on Science, Technology, Engineering, Arts, and Mathematics (STEAM) is an educational approach that emphasizes the integration of different fields of knowledge, such as science, technology, engineering, arts, and mathematics, to enhance a more holistic and creative understanding in the teaching and learning process (Hadinugrahaningsih et al., 2017). The STEAM approach can enhance creative skills such as problem-solving, critical thinking, and collaboration by providing opportunities to develop creative projects that integrate various STEAM elements (Quigley et al., 2017). Furthermore, students working in groups or

teams can promote collaboration and communication, which are crucial skills in the real world. STEAM also enables teachers to become more flexible in their teaching approaches and encourages creativity in lesson design (Jamil et al., 2017). This allows for a more adaptive approach to students' needs. STEAM-based learning emphasizes the practical application of academic concepts in real-world situations, helping students see the relevance of what they have learned in everyday life (Wang et al., 2011). STEAM learning also supports 21st-century learning associated with the challenges and demands of modern times, fostering skills such as collaboration, problem-solving, critical thinking, communication, technological literacy, and information processing (Rahmawati et al., 2019). In science education, students not only learn to understand concepts but also need to master scientific process skills and apply them through project-based approaches (Andersson & Gullberg, 2014). By implementing STEAM-based projects, teachers can integrate Scientific Process Skills (SPS) into science education effectively. This approach encourages collaboration, communication, and other skills like problem-solving that involve basic SPS such as; 1) Observing; 2) Questioning and Predicting; 3) Planning and Conducting Investigations;4) Analyzing; 5) Communicating Results. Through STEAM projects, students engage in activities that naturally incorporate these skills, fostering a deeper understanding of scientific processes while promoting collaboration and communication among peers (Herro & Quigley, 2017).

One of the previous studies that investigated students' Science Process Skills (SPS) was conducted by Rusmiyati and Yulianto. Their research demonstrated a significant improvement in the SPS of Grade XI high school students through the implementation of Problem-Based Learning (PBL) model (Rusmiyati & Yulianto, 2009). Furthermore, previous research conducted on STEM approaches in elementary schools indicated that fifth-grade students showed a high level of interest in STEM learning, particularly in science and mathematics, when teachers integrated these subjects into project-based learning (Trivena et al., 2018; Trivena & Langi', 2021). Several other relevant studies have explored the implementation of project-based learning (PBL) or STEAM-integrated PBL models, but there is currently no research that specifically applies these models to enhance students' SPS, especially at the elementary school level and within science education that follows the Independent Curriculum (Kurikulum Merdeka). This highlights a potential area for future research to investigate the effectiveness of STEAM-integrated PBL in improving SPS among elementary school students, particularly in the context of science education aligned with the Independent Curriculum. Such research could provide valuable insights into innovative teaching approaches that enhance students' scientific skills and understanding (Annisa et al., 2019; Nisfa et al., 2022; Safriana et al., 2022). Therefore, the researcher is interested in conducting this study with the aim of examining the impact of a STEAM-based project model on improving students' Scientific Process Skills (SPS) in Grade 5 science (IPA) education.

Research Method

The type of research used in this study is a quantitative approach with a pre-experimental method. This research involves one independent variable, which is the STEAM-based project model (X), and one dependent variable (Y), which is students' scientific process skills. The research design is a one-group pretest-posttest design, using a single group sample that receives learning with the STEAM-based project model without a control group, thus testing the research data by comparing pretest and posttest scores.

Table 1. One Group Pretest and Postest Design

Class	Pretest	Perlakuan	Posttest
Experiment	O_1	X	O_2

Description:
O_1 = pretest SPS
O_2 = posttest SPS
X = Treatment (STEAM-based project)

The selection of both Grade 5 classes at SDN 6 Saluputti as the research sample was conducted using a non-probability sampling technique by taking the entire population of Grade 5 students at SDN 6 Saluputti. The treatment that will be applied to the experimental class involves implementing the STEAM-based project model in science learning, consisting of five stages: observation, questioning, data collection, classification, and communication, integrating elements of Science, Technology, Engineering, Arts, and Mathematics (STEAM) into the learning process (Haifaturrahmah et al., 2020).

The instruments used in this study consist of student SPS tests in the form of essay and multiple-choice questions developed from five basic SPS indicators: observing, questioning or predicting, collecting data or conducting investigations, analyzing, drawing conclusions, and communicating (Fatmawati et al., 2022). Additionally, observation sheets are used to measure the implementation of the STEAM-based project model, and interview guidelines are used to gather student and teacher opinions related to the learning process. Before being used on the sample, the instruments undergo various tests including validity testing, reliability testing, assessment of item difficulty, and item discrimination. To determine whether the STEAM-based project model has an effect on SPS, prerequisite tests (normality test and homogeneity test) and hypothesis testing are conducted. Furthermore, an analysis is performed to assess the quality of the improvement in students' SPS using the normalized gain (N-gain) formula:

$$N - gain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$

The categories of N-gain values obtained from the formula can be found in Table 2 (19) as follows:

Table 2. N-Gain Category

Persentage (%)	Category
0.7 < g < 1	High
0.3 < g < 0.7	Moderate
< g < 0.3	Low
g = 0.00	No Improvement

Source: (Astuti et al., 2020; Sudjana, 2010)

Result and Discuss

Based on the data processing results of pretest (before treatment) and posttest (after treatment) scores of Grade 5 students at SDN 6 Saluputti on the topic of Heat Transfer, the data obtained are presented in Table 3 as follows:

Table 3. Pretest-posttest Scores for students' SPS

	Men	Standard Deviation	Maximum	Minimum
Pretest	70.24	8.62	83	52
Posttest	79.81	7.94	92	60

Table 3 shows that the average pretest score before applying the STEAM project-based model was 62.3, ranging between a maximum score of 75 and a minimum score of 50, with a standard deviation of 7.94. On the other hand, the average posttest score after applying the STEAM project-based model was 83.75, ranging between a maximum score of 92 and a minimum score of 50. The difference between the average pretest and posttest scores is 21.45. This indicates an improvement in students' SPS scores after implementing the STEAM project-based model.

Hypothesis testing in this study was conducted using a Paired Sample T-test to determine whether there is an effect of the STEAM project-based model on the Scientific Process Skills (SPS) of Grade 5 students at SDN 6 Saluputti, with the assistance of SPSS Version 26. Below are the results of the Paired Sample T-test::

Table 4. Hasil Uji *Paired Sample T-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	sebelum treatment - sesudah treatment	-9.57143	10.85620	2.36902	-14.51311	-4.62974	-4.040	20	.001

Based on the results of the paired sample T-test above, the obtained p-value (2-tailed) is 0.001. According to the decision-making principle in the paired sample T-test, where the p-value (2-tailed) < 0.05 or 0.001 < 0.05, we reject the null hypothesis (H_0) and accept the alternative hypothesis (Ha). Therefore, it can be concluded that there is a significant difference between the pretest and posttest results, indicating an effect of the STEAM project-based model on the Science Process Skills (SPS) of Grade 5 students at SDN 6 Saluputti on the topic of heat transfer.

The students' SPS data is also translated into gain scores to assess the improvement in SPS before and after implementing the STEAM project-based model. To calculate the gain score, we subtract the pretest score from the posttest score.

Based on Table 2 for N-Gain categories, with a value of (g = 0.32 \), the SPS is categorized as "moderate." Therefore, from this result, it can be concluded that the student activity in the implementation of the STEAM project-based model is categorized as moderate or acceptable.

Although it falls within the "moderate" category, the analysis of N-gain indicates that the implementation of the STEAM project-based model can indeed enhance students' Science Process Skills (SPS). This is attributed to the collaborative and interactive nature of STEAM project-based learning. The learning environment fosters teamwork and interaction among students, where each student in the group combines various ideas and opinions, engages in discussions, and argues to understand a topic thoroughly and solve problems faced by the group (Suryaningsih & Nisa, 2021). The collaborative aspects of STEAM project-based learning contribute to students' engagement and active participation, allowing them to develop essential skills such as communication, critical thinking, and problem-solving within the context of scientific processes (Wahyuningsih et al., 2020). Despite the "moderate" categorization, the

improvement in SPS underscores the effectiveness of the STEAM approach in promoting holistic learning experiences and skill development among students (Conde et al., 2021).

The STEM-based project model implemented also promotes active learning where students engage directly in experiments and scientific activities, such as making a simple thermos. Through the thermos-making project, which integrates science, mathematics, design, art, and technology, students learn to observe, analyze, and evaluate information, thereby enhancing their scientific process skills including observing, questioning, collecting data, analyzing, and communicating (Trivena & Langi', 2021). By engaging in hands-on activities like creating a thermos, students apply theoretical concepts in a practical context, fostering a deeper understanding of scientific principles and interdisciplinary connections. This project-based approach encourages students to actively participate in the learning process, stimulating critical thinking, problem-solving, and creativity while developing essential scientific process skills essential for scientific inquiry and exploration. Not only that, students also develop critical thinking skills that are crucial for solving scientific problems (Twiningsih & Elisanti, 2021).

Furthermore, through STEAM-based projects involving group work, students learn to collaborate with others. This helps students enhance their social skills and ability to work cooperatively within scientific contexts (Başaran & Bay, 2023).

The STEAM-based project model allows students to explore new ideas and develop creative solutions to specific problems (Erol et al., 2023). This can stimulate creativity among elementary school students in the context of science and technology, providing them with hands-on experiences with scientific concepts (Saddhono et al., 2020). Through the STEAM-based project model, students also learn how scientific theories are applied in real life, making learning more meaningful and engaging. By involving students in interesting and relevant projects, this model can increase elementary school students' interest in science and technology (Amelia & Marini, 2022).

Nevertheless, from the data obtained, it is evident that many students still face difficulties in conducting appropriate investigations and analyzing data. Students still struggle to link the concept of heat transfer with selecting suitable materials for making a thermos that is heat-resistant and incorporates art or design elements. This is consistent with research by Lee and Shin, which indicates that students encounter challenges in applying STEAM projects, particularly in integrating art with science (Lee & Shin, 2014). Addressing these challenges requires continued support and guidance to help students develop a deeper understanding of interdisciplinary connections between science, art, and other disciplines. Effective STEAM education involves scaffolding learning experiences that gradually build students' abilities to synthesize knowledge from diverse areas and apply it creatively to solve real-world problems . By addressing these difficulties through targeted instruction and project design, educators can help students overcome obstacles and fully benefit from STEAM-based learning experiences.

Conclusion

Based on the research findings, it is evident that there is a significant influence of the STEAM project-based model on the Scientific Process Skills (SPS) of Grade 5 elementary school students, with an N-gain falling into the moderate category. This conclusion is supported by the hypothesis testing results showing a significant p-value of $0.001 < 0.05$, leading to the acceptance of the alternative hypothesis (Ha) and rejection of the null hypothesis (H0). Therefore, it can be concluded that the STEAM project-based model has an effect on the SPS of Grade 5 students at SDN 6 Saluputti. However, further research is needed to explore other science topics in

elementary schools that can be taught using the STEAM project-based model. Additionally, research can focus on enhancing students' knowledge and skills in other areas through this approach. This would contribute to a deeper understanding of the effectiveness of STEAM-based learning in elementary education and its broader impact on student learning outcomes.

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