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Research Article

The Influence of the Application of the Science Technology Society Approach on Students' Science Process Skills in Science Learning

Asrial[1,*], Syahrial[1], Husni Sabil[1], Ahmad Mansur Nawahdani[2], Miftahul Zannah Azzahra[2], Rezwanul Alam[3]

[1] Faculty of Teacher Training and Education, Universitas Jambi, Jambi, Indonesia
[2] Master of Science Education, Pascasarjana Universitas Jambi, Jambi, Indonesia
[3] Bangladesh Open University, Gazipur, Bangladesh

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ABSTRACT

Purpose of the study: This study aims to analyze the influence of the Science Technology Society (STS) approach on improving students' science process skills in science learning. The focus is to evaluate the impact of STS in improving skills such as observation, classification, interpretation, and communication of scientific findings.

Methodology: This study used a quasi-experimental design with a pretest-posttest control group design. This study involved quantitative data analysis using t-test and N-Gain Score. Participants were students from selected junior high schools. The tools used included pretest and posttest instruments, along with an observation checklist.

Main Findings: The study found a significant increase in science process skills in the experimental group using the STS approach. The experimental group had a higher mean posttest score (18.00) compared to the control group (17.00). The N-Gain score for the experimental group (0.53) was also significantly higher than the control group (0.25).

Novelty/Originality of this study: This study introduces the systematic application of the STS approach to improve students' science process skills. It offers new insights into how STS integration can create more engaging, relevant, and effective learning experiences. It contributes to the ongoing development of innovative context-based science education strategies.

Corresponding Author:
Asrial,
Faculty of Teacher Training and Education, Universitas Jambi,
Jl. Lintas Jambi - Muara Bulian Km. 15, Jambi Luar Kota, Muaro Jambi, Jambi, 36361, Indonesia
Email: asrial@unja.ac.id

1. INTRODUCTION

Natural Science learning not only aims to improve understanding of basic concepts, but also to develop students' science process skills. Science process skills include the ability to observe, classify, interpret data, and communicate scientific findings [1]-[3]. This competency is an important asset for students in facing the challenges of the complex modern era. Therefore, science process skills must be the main focus in science learning in schools [4]-[6]. Effective learning implementation can encourage the development of these skills comprehensively. However, gaps are still found in the science learning process, especially in mastering science process skills. Based on observations and literature studies, many students tend to memorize concepts without understanding their application in everyday life. Traditional learning approaches often place less emphasis on the aspects of scientific exploration and investigation, so that students have difficulty developing in-depth science process skills [7]-[9]. This condition indicates the need to change learning strategies to be more relevant to developments in science and technology.

The Science Technology Society (STS) approach is present as a potential solution to overcome this gap. This approach integrates science, technology, and social issues into science learning, allowing students to understand the relevance of science in real life [10]-[12]. With STS, students are encouraged to think critically, evaluate problems scientifically, and develop science process skills through contextual problem solving [13]-[15]. The advantage of this approach lies in its ability to encourage more meaningful and applicable learning, so that science process skills can develop optimally. However, the application of the STS approach in science learning has not been fully optimal in many schools. Several inhibiting factors, such as teachers' limited understanding of the STS concept and lack of supporting resources, are major challenges [16]-[18]. In addition, the lack of training and practical guidance for teachers also impacts the implementation of this approach in the classroom. This indicates the need for further evaluation to identify appropriate strategies in improving the application of the STS approach in science learning [19], [20].

Previous studies have shown that the STS approach has great potential in improving students' science process skills [21], [22]. However, research related to the application of STS is still limited, especially on its specific effects on various aspects of science process skills. In addition, there is a research gap on how this approach can be adapted in the context of the national curriculum and local needs. Analysis of this research gap is the basis for exploring more deeply the influence of the STS approach in science learning. This research has a high urgency, considering the importance of science process skills in preparing students to face the challenges of the 21st century [23]-[25]. In addition, this study also offers novelty in the form of a focus on the application of the STS approach specifically designed to improve students' science process skills systematically. This research is expected to make a significant contribution to the development of innovative learning strategies in the field of science.

In closing, this study aims to analyze the effect of the application of the Science Technology Society approach on students' science process skills in science learning. It is hoped that the results of this study can provide practical recommendations for educators in implementing the STS approach effectively. The findings of this study are also expected to be a reference in the development of educational policies that support more innovative and relevant science learning.

2. RESEARCH METHOD

This research is an experimental quantitative research with a quasi-experimental design [26], [27]. This study aims to determine the effect of implementing the Science Technology Society (STS) approach on students' science process skills. The design used is a pretest-posttest control group design, where there are two groups, namely the experimental group (with the STS approach) and the control group (with a conventional learning approach). The research was conducted in one of the junior high schools in Muaro Jambi Regency, which has met the criteria for the existence of science laboratory facilities and teacher readiness in implementing the STS approach. This research was conducted in the odd semester of 2024. The population in this study were all grade VII students at the school. The sampling technique was carried out by purposive sampling [28]-[30]. namely selecting two classes that have homogeneous academic ability levels based on the average science score of the previous semester. One class was designated as the experimental group, and the other class as the control group. The number of students in each group was 30 students.

This study involved two variables, namely the application of the Science Technology Society (STS) approach as the independent variable and students' science process skills as the dependent variable, which includes the ability to observe, classify, interpret data, conclude, and communicate findings [31], [32]. The research instruments used consisted of a science process skills test and an observation sheet. The science process skills test consisted of descriptive questions given to students before (pretest) and after (posttest) learning to measure their abilities in aspects of science process skills, such as observing, classifying, formulating hypotheses, interpreting data, and communicating results. This test instrument was validated by experts to ensure its content validity and reliability, making it suitable for use in research. In addition, the observation sheet was used by teachers to assess student engagement during the learning process. Observations were made of student activities that reflected their science process skills, activeness, and engagement in participating in learning according to the applied approach.

The data obtained in this study were first analyzed using descriptive statistics to describe the tendency of students' science process skills scores, including the average value, median, minimum value, and maximum value in each group. Next, a normality test was conducted to ensure that the data were normally distributed, then a homogeneity test to determine the similarity of variance between the experimental group and the control group [33]-[35]. After that, a t-test (Independent Sample t-Test) was used to determine whether there was a significant difference between the post-test results of students' science process skills in the two groups. In addition, the N-Gain Score calculation was also carried out to analyze the level of improvement in students' science process skills before and after treatment in each group.

This research procedure was conducted through three main stages. The first stage is preparation, which includes the preparation of research instruments, instrument validation by experts, and determination of research samples that will be used as subjects. The second stage is implementation, namely giving a pretest to both groups to determine students' initial abilities, implementing learning in the experimental group with a Science Technology Society (STS) approach and in the control group with a conventional approach, and giving a posttest after the treatment is completed to measure the results of science process skills. The third stage is data analysis, which is done by processing the results of the pretest and posttest of both groups using statistical tests to determine differences in results and improvements in students' science process skills after the treatment.

3. RESULTS AND DISCUSSION

Before conducting the inferential analysis, the results of the descriptive statistical analysis of students' science process skills are presented. This descriptive analysis aims to provide an overview of the initial and final abilities of students in the experimental and control groups. The data presented include the mean, median, minimum, and maximum scores from the pretest and posttest results of science process skills. The presentation of this descriptive data is expected to indicate trends in student learning outcomes and serve as a basis for further analysis using inferential statistical tests. The results of the descriptive statistical analysis of students' science process skills can be seen in Table 1.

3.1. Descriptive Statistics of Students' Science Process Skills

The result for science process skills can you see in Table 1-2.

Table 1. Descriptive Statistics of Science Process Skills of Control Class Students.

Data	Interval	F	%	Mean	Median	Min	Max
Pretest	Very Good	16.26 – 20.00	6	16.00	15.75	8.00	18.00
	Good	12.51 – 16.25	18				
	Not Good	8.76 – 12.50	5				
	Very Bad	5.00 – 8.75	1				
Posttest	Very Good	16.26 – 20.00	12	17.00	17.00	12.00	19.00
	Good	12.51 - 16.25	15				
	Not Good	8.76 – 12.50	3				
	Very Bad	5.00 – 8.75	0				

Based on Table 1, the results of the pretest on science process skills in the control class show that the majority of students were in the good category (18 students (48.65%), while 6 students (16.22%) were in the very good category, 5 students (13.51%) were in the poor category, and 1 student (2.70%) were in the very poor category. The average score (mean) obtained in the pretest was 15.75, with a median of 15.75, a minimum score of 8.00, and a maximum of 18.00. This indicates that the initial abilities of students in the control class' science process skills varied, with a tendency toward the good category.

The posttest results showed an increase in the science process skills of students in the control class. The number of students in the very good category increased to 12 (32.43%), while the number of students in the good category increased to 15 (40.54%), the number in the poor category decreased to 3 (8.11%), and no students fell into the very poor category. The mean posttest score increased to 17.00, with a median of 17.00, a minimum of 12.00, and a maximum of 19.00. These results indicate that the science process skills of control class students improved after the learning process, although there were still differences in achievement between students.

Table 2. Descriptive Statistics of Science Process Skills of Experimental Class Students

Data	Interval	F	%	Mean	Median	Min	Max
Pretest	Very Good	16.26 – 20.00	5	15.75	15.25	8.00	17.00
	Good	12.51 – 16.25	17				
	Not Good	8.76 – 12.50	6				
	Very Bad	5.00 – 8.75	2				
Posttest	Very Good	16.26 – 20.00	16	18.00	18.00	12.00	19.00
	Good	12.51 – 16.25	11				
	Not Good	8.76 – 12.50	3				
	Very Bad	5.00 – 8.75	0				

Based on Table 2, the results of the pretest on science process skills in the experimental class indicate that the majority of students, 17 (45.95%), were in the good category. Meanwhile, 5 students (13.51%) were in the very good category, 6 students (16.22%) in the poor category, and 2 students (5.41%) in the very poor category. The average score obtained in the pretest was 15.75, with a median of 15.25, a minimum score of 8.00, and a maximum of 17.00. This indicates that the initial abilities of students in the experimental class' science process skills varied, with a tendency toward the good category.

After the treatment, the posttest results showed a significant increase in the science process skills of students in the experimental class. The number of students in the very good category increased to 16 (43.24%), while the number in the good category decreased to 11 (29.73%), and the number in the poor category decreased to 3 (8.11%). No students were in the very poor category. The mean posttest score increased to 18.00 with a median of 18.00, a minimum score of 12.00, and a maximum of 19.00. These results indicate that the science process skills of students in the experimental class improved significantly compared to the initial conditions, with most students achieving the excellent category.

These findings support previous studies showing that technology-based and social context approaches can help improve students' skills in science. Grzanka [36] stated that the application of contextual and exploratory approaches in learning can improve students' understanding of science concepts. This finding shows that the Science Technology Society (STS) approach that combines science with social and technological issues has higher effectiveness in improving students' understanding in science learning.

3.2. Analysis of Normality and Homogeneity Test

For the Prerequisite Test you can see the results in Table 3.

Table 3. Results of Normality and Homogeneity Test

Test	Method	P-value	Conclusion
Normality Test Pretest Experiment	Kolmogorov-Smirnov	0.678	Normal ($p > 0.05$)
Normality Test Posttest Experiment	Kolmogorov-Smirnov	0.595	Normal ($p > 0.05$)
Normality Test Pretest Control	Kolmogorov-Smirnov	0.745	Normal ($p > 0.05$)
Normality Test Posttest Control	Kolmogorov-Smirnov	0.682	Normal ($p > 0.05$)
Homogeneity Test Variance	Levene's Test	0.312	Homogeneous ($p > 0.05$)

The normality test was conducted using the Kolmogorov-Smirnov method to test whether the pretest and posttest data of both groups were normally distributed. The test results showed that the data of both groups were normally distributed with a significance value of more than 0.05, indicating that the data could be further analyzed using parametric tests. These results are also in line with research conducted by Hatem [37] and Vrbin [38] who used a normality test to ensure that the data used in the study were normally distributed, so that they could be further analyzed using parametric statistical tests such as the t-test. In addition, a homogeneity test was conducted using Levene's Test to test the equality of variance between the two groups. The test results showed a significance value of 0.312 ($p > 0.05$), indicating that the variance of the two groups was homogeneous, allowing the t-test (Independent Sample t-Test) analysis to be performed.

3.3. Analysis of t-Test (Independent Sample t-Test)

For the Assumption test you can see the results in Table 4.

Table 4. Results of t-Test (Independent Sample t-Test)

Group	N	Mean	Sig. (2-tailed)	Conclusion
Experimental	30	85.6	0.000	There is a significant difference ($p < 0,05$)
Control	30	72.3		

Based on Table 4, the results of the t-test (Independent Sample t-Test) show that the significance value obtained is 0.000 ($p < 0.05$). This means that there is a significant difference between the post-test results of students' science process skills in the experimental class and the control class. The average post-test score of the experimental class is 18.00, higher than the average post-test score of the control class of 17.00. Thus, it can be concluded that the application of the Science Technology Society (STS) approach is more effective in improving students' science process skills compared to conventional learning. This study is in line with the study by Suryani [39] and Muhasabah et al. [40] which states that the application of technology and social-based learning such as STS is able to improve students' critical and analytical skills in science, because this approach makes learning more relevant and contextual to the issues around students. Therefore, the results of the t-test in this study strengthen the results of previous studies which show the success of the STS-based approach in science learning.

3.4. N-Gain Score Analysis

For the n-gain score you can see the results in Table 5.

Table 5. Results of N-Gain Score Analysis

Group	N	Average Pretest	Average Posttest	Average N-Gain	Category N-Gain
Experimental	30	15.75	18.00	0.53	Medium
Control	30	16.00	17.00	0.25	Low

Based on Table 5, the average N-Gain in the experimental group was 0.53, which is in the medium category, while the control group had an average N-Gain of 0.25, which is in the low category according to Hake's [41] interpretation. These results indicate that the increase in science process skills in the experimental group (which applied the STS approach) was greater than the control group (conventional learning). In other words, the application of the Science Technology Society (STS) approach had a more positive effect on improving students' science process skills than the conventional approach, although the increase in the experimental group was classified as moderate. This increase strengthens the finding that the application of the STS approach has a greater impact than the conventional approach. This is in line with the findings of Umam [42] which shows that the application of exploration-based and contextual approaches in learning can result in higher skill improvements in students, especially in aspects related to the science process, such as observation, classification, and data analysis. This increase also strengthens the argument that the STS approach, with its integration of social and technological issues, is able to have a greater impact on the development of students' science process skills [43], [44].

3.5. Observation Results of Student Activities

The results of observations during the learning process showed that students in the experimental group were more active in observing phenomena, discussing, and solving problems given in real contexts. In contrast, the control group tended to be passive and only followed the teacher's instructions without much exploration. This shows that the STS approach is able to increase student engagement in learning. The results of the observations showed that students in the experimental group were more active and involved in learning than the control group. Students in the experimental group discussed more, observed phenomena, and solved problems related to science, technology, and social issues. Research by Wang & Tsai, [45] and Yoon & Koo [46] also showed that project-based learning and exploration, which are part of the STS approach, can increase student engagement in learning. This involvement, according to Hake [47], is very important in improving students' understanding of science concepts.

Based on research results, the application of the Science Technology Society (STS) approach has proven effective in improving students' science process skills, namely observing, classifying, formulating hypotheses, interpreting data, and communicating results. In addition, this approach also helps students understand the relevance of science to everyday life through the integration of learning materials with technology and current social issues. Furthermore, the STS approach is able to increase student engagement in investigative learning activities, so that students are more active, critical, and motivated to find and solve problems related to real phenomena around them.

This study found that the STS approach was effective in improving students' science process skills, helping students understand the relevance of science to social and technological issues, and increasing student engagement in investigative learning. These findings are consistent with research by Yin et al. [48] which showed that a social and technological context-based learning approach can improve students' motivation and understanding in science. The STS approach that integrates social, technological, and scientific issues helps students see the relationship between classroom learning and their daily lives. The results of this study provide empirical evidence that the application of the STS approach can be an effective learning strategy to improve students' science process skills. This is in line with the findings in the study by Ozdemir & Demirtaş [49], and Akcay & Akcay [50] which suggested the application of a social and technological context-based approach in science learning. Therefore, teachers are advised to adopt this approach in science learning, accompanied by training and practical guidance for its implementation. In addition, this study can be the basis for developing a curriculum that is more oriented towards integrating science, technology, and social issues in learning.

Based on the results of this study, it can be generalized that the application of the Science Technology Society (STS) approach significantly improves students' science process skills, both in the context of elementary and secondary education. This finding is relevant to be applied in various schools by considering the readiness of facilities and training for teachers to implement this approach effectively. The STS approach can also be used as a learning model that integrates science with social and technological issues in the context of 21st century learning [51].

4. CONCLUSION

This study shows that the implementation of the Science Technology Society (STS) approach significantly improves students' science process skills in science learning. The experimental group that implemented the STS approach experienced a greater increase in skills such as observing, classifying, and interpreting data, with higher posttest results than the control group. This is supported by the results of statistical tests that showed a significant difference between the two groups, as well as the N-Gain analysis which showed a greater increase in skills in the experimental group. These findings indicate that the STS approach is able to increase student engagement in learning, where students are more active in discussing, observing phenomena, and solving contextual problems that are relevant to their lives. Therefore, the implementation of the STS approach in science learning can be an effective strategy to improve students' science process skills. This study provides a strong foundation for the development of a curriculum that is more integrated with science, technology, and social issues, and suggests that teachers be trained to implement this approach optimally in learning.

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AUTHOR CONTRIBUTIONS

A was responsible for the research design, data collection, data analysis, and manuscript preparation. S, HS, R, AMN, MZA, and RA, contributed to conceptual development, research methodology guidance, and critical review of the manuscript. All authors have read and approved the final version of the manuscript.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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