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The Influence of Science, Technology and Society Learning Models on Value-Natured Energy Concepts on Student Learning Outcomes

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ABSTRACT
Science education plays a vital role in the development of science and technology, especially in an era that demands the integration of science, technology, and society. The Science, Technology, and Society (STM) learning model provides a holistic approach to teaching energy concepts by connecting scientific knowledge with social contexts and value considerations. This study aims to examine the effect of the STM learning model on students' learning outcomes related to value-based energy concepts. The research employed a quasi-experimental design using a one-group pretest posttest method. The STM learning model was applied by linking energy topics with real-life issues and societal values. Data were collected through learning outcome tests and student response questionnaires. The results indicate that students responded positively to the implementation of the STM model, with 40% of students showing the highest level of positive response. However, student interest in conventional physics learning activities remained the lowest response indicator.The findings suggest that integrating societal and value aspects into energy instruction can enhance student engagement and conceptual understanding. The STM learning model helps bridge theoretical knowledge with its relevance to daily life. To further improve student interest, the use of varied instructional strategies such as discussions and field observations is recommended to create a more meaningful learning environment.

Keywords: *Learning Model, Learning Outcomes, Value Nature Energy Concept*

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INTRODUCTION

Science education has become very important in the development of science and technology. In the modern era, integration between science, technology and society is very necessary. Learning models that are oriented towards the relationship between science, technology and society, such as the Science, Technology and Society (STM) learning model, have emerged as a holistic approach in presenting energy concepts. In this approach, energy is not only seen from the technical aspect, but also from its impact on society and the values contained therein. In this way, students can understand energy as part of everyday life and contribute to the development of technology that is more beneficial to society (Ayu Made et al., 2017; Lestari et al., 2017; Mustofa, 2022).

The Science-Technology-Society (STS) learning approach and its variants, such as Science-Environment-Technology-Society (SETS) and Socio-Scientific Issues (SSI), have proven to be effective in improving student learning outcomes, particularly in energy-related topics that incorporate social, environmental, and moral values. These models not only enhance students' cognitive understanding but also foster scientific literacy, critical thinking, and awareness of the ethical and social implications of science and technology (Huda, Setiawan, & Haerussaleh, 2024; Muhasabah, Supeno, & Yusmar, 2023).

Huda et al. (2024) reported that blended learning using the STS approach significantly improved students' learning independence, which positively affected their understanding of energy concepts. Likewise, Muhasabah et al. (2023) developed an STS-based e-module that successfully enhanced students' critical thinking skills, with a medium N-Gain score and highly positive student responses (83%).

Fitri and Asrizal (2023) integrated SSI-based approaches into a learning module on energy sources, which effectively enhanced 21st-century skills and raised students' awareness of the environmental and social impacts of energy use. Furthermore, STS learning is shown to cultivate ethical awareness and responsibility in students regarding real-life science issues (Rahmi Fartiwi, Adlim, & Nurmaliah, 2019).

Additionally, Eso, Putri, and Jamun (2022) emphasized that the SETS model implemented in biotechnology topics improved students' scientific literacy, which is a key indicator of value-oriented learning outcomes. Thus, integrating STS, SETS, or SSI-based approaches in energy learning plays a vital role in achieving value-natured learning outcomes, encompassing cognitive, affective, and moral dimensions.

At the top of this inverted pyramid are the expected learning outcomes from the integration of the three Science, Technology and Society (STM) learning models. These learning outcomes include a deep understanding of energy concepts, critical thinking skills in analyzing the implications of technology on society, as well as awareness of the ethical and moral values related to energy use. In this way, students can have a broader and deeper understanding of energy, as well as the skills to analyze its implications for society and related values. The layer below the science learning model is the community science technology learning model (STM). This model is the basis for understanding energy concepts scientifically. The STM model emphasizes not only conceptual understanding, but also practical exploration through experimentation and observation, providing

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a strong foundation for students to develop analytical thinking and practical skills. (Fitria et al., 2022; Lestari et al., 2017).

At the center of this inverted pyramid is a technology learning model, which brings energy concepts into an applicable context. Students not only learn how energy is used in technology, but also understand its impact on the environment and society more broadly. This model encourages students to think systematically about sustainable and environmentally friendly energy solutions (Ummayah, 2019).

At the bottom layer is the societal learning model, which leads to the understanding that the concept of energy is not isolated from social reality. Students are guided to consider the social implications of energy use, including equitable distribution, accessibility, and collective responsibility to the environment. Thus, values such as justice, sustainability and social responsibility are introduced as an integral part of learning about energy (Rahma, 2022).

By strengthening the integration between Science, Technology and Society (STM) learning models, it is hoped that students will be able to produce a more comprehensive understanding of energy concepts that are not only technical, but also deeper into the values held by society. In this context, learning outcomes include not only mastery of material, but also the application of values that promote sustainable and responsible energy use.

METHODS

This research aims to determine the influence of student learning outcomes through science, technology and society learning models on value-nuanced energy concepts. The research used a quasi-experimental method. In this research, the samples that have been taken are grouped into one group. The experimental group was given treatment using a science, technology and society learning model on value-nuanced energy concepts. The research design used in this study was one group pre-posttest. The population is all members of a human group who live together in one place and are planned to be the target for conclusions at the end of the research. The sample is the total population selected for the data source. One of the conditions that must be met is that the sample must be taken from an accessible population of two classes.

The sampling technique used in this research is the Purposive Sampling technique. Sampling using the Purposive Sampling technique is a technique carried out with the aim of determining classes that have been determined in accordance with the procedures chosen in the research design. Data collection techniques are ways of obtaining data. Method
data collection with tests and non-tests.

RESULTS

1. Experimental Physics Learning Results (Pretest)

To describe students' initial physics learning outcomes before the implementation of the STM learning model, a pretest was administered to the experimental group. The distribution of students' scores is presented in Table 1.

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Table 1. Physics Learning Results Table (Pre test) Experiment

Interval class	*f*	Middle value (xi)	Real limits	*f*(%)
35-41	3	38	34.5 - 41.5	10
42-48	5	45	41.5 – 48.5	16.67
49-55	9	52	48.5 – 55.5	30
56-62	7	59	55.5 – 62.5	23.33
63-69	3	66	62.5 – 69.5	10
70-76	3	73	69.5 – 76.5	10
Amount	**30**			**100**

As shown in Table 1, the pretest scores of 30 students were distributed across six score intervals. The highest frequency was found in the 49–55 interval (30%), indicating that most students had a moderate level of initial understanding. The mean pretest score was 54.50 with a standard deviation of 9.98, suggesting that students' prior knowledge of energy concepts varied and had not yet reached an optimal level.

2. Experimental Physics Learning Results (Posttest)

After the STM learning model was implemented, a posttest was conducted to measure students' physics learning outcomes. The distribution of posttest scores for the experimental group is presented in Table 2.

Table 2. Physics Learning Results Table (Post test) Experiment

Interval class	*f*	Middle value (xi)	Real limits	*f*(%)
50 – 55	2	52	49.5 – 55.5	6.67
56 – 61	4	58	55.5 – 61.5	13.33
62 – 67	4	64	61.5 – 67.5	13.33
68 – 73	6	70	67.5 – 73.5	20
74 – 79	6	76	73.5 – 79.5	20
80 – 85	8	82	89.5 – 95.5	26.67
Amount	**30**			**100**

Table 2 shows that students' posttest scores shifted toward higher score intervals compared to the pretest results. The highest percentage of students (26.67%) was found in the 80–85 interval. The mean posttest score increased to 70.8 with a standard deviation of 9.65, indicating an improvement in students' achievement and a more consistent level of understanding.

3. Recapitulation of Learning Outcome Data

To provide a clearer comparison between students' learning outcomes before and after the implementation of the STM learning model, a recapitulation of pretest and posttest data is presented in Table 3.

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Table 3. Learning Results Data Recapitulation Table

The calculation results	Experiment	
	Pretest	Posttest
X	54.50	70.8
elementary school	9.98	9.65

Based on Table 3, there was a noticeable increase in the average score from 54.50 in the pretest to 70.8 in the posttest. In addition, the standard deviation decreased from 9.98 to 9.65, indicating that students' learning outcomes became more homogeneous after the intervention.

4. Experimental Group t test results

To determine whether the difference between pretest and posttest scores was statistically significant, a t-test analysis was conducted. The results of the t-test are presented in Table 4.

Table 4. Experimental Group t Test Results

Data	Pre-test	Post test
Standard deviation	9.98	9.65
t count	4.55	12.45
t table	2.00	2.00
Conclusion	Different	Different

As shown in Table 4, the calculated t-values for both the pretest (4.55) and posttest (12.45) exceeded the t-table value of 2.00. This indicates a significant difference between students' learning outcomes before and after the application of the STM learning model.

5. Questionnaire Data Analysis

To find out whether students showed a good response to STM learning, a questionnaire was created with a liker scale from 1 to 5. After the results were collected, the data was converted into a descriptive table, which can be found in the attachment.

In terms of student responses to the value-nuanced energy concept taught using the STM model, most respondents received a score of 40%. This shows that the highest indicator is related to students' responses to STM learning about value-nuanced energy concepts, and the lowest indicator shows students' interest in physical lessons. This shows that students responded well when the STM model was applied to the value-nuanced idea of energy.

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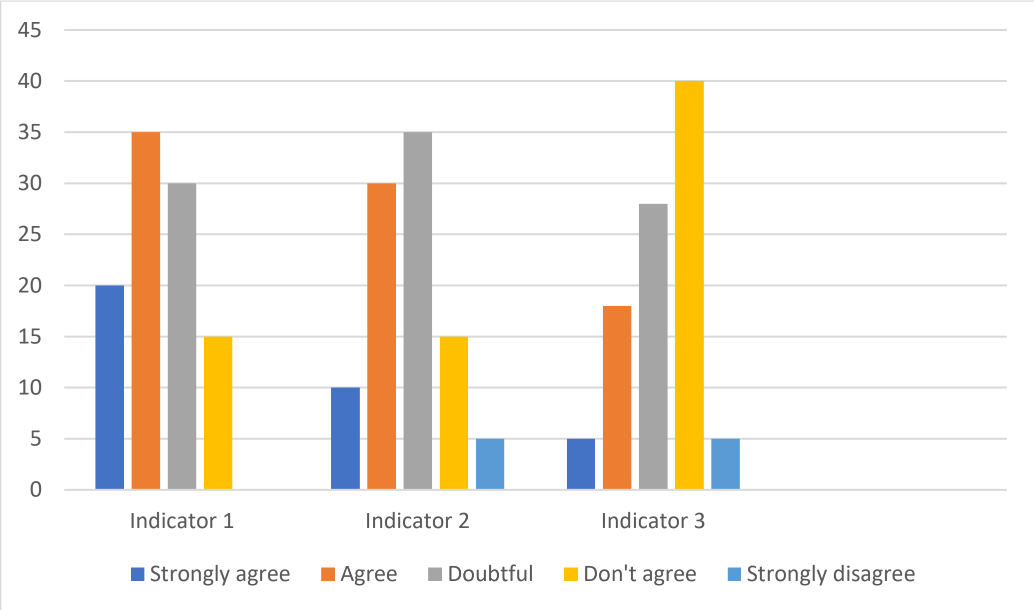

Figure 1. Student Questionnaire Results

The questionnaire results show that the highest indicator, with a percentage of 40%, was related to students' responses to learning value-nuanced energy concepts using the STM model. Although students' interest in physics lessons was the lowest indicator, overall responses indicate that students reacted positively to the application of the STM learning model.

DISCUSSION

Learning is a process that involves direct experience and activities aimed at changing a person's behavior. To learn, a person must actively participate in activities that allow them to have direct experiences and discover knowledge they already know. Hands-on experience is key to gaining relevant and valuable knowledge.

This research focuses on the role of students in identifying problems faced by society due to the development of information and communication technology (science and technology). Therefore, this research aims to increase students' understanding of the concept of energy and its relationship with values related to the development of science and technology. Based on statistical data analysis, this research found that the Science, Technology and Mathematics (STM) learning model has a strong relationship with related concepts (Al-Masyhud, 2016). Before using the structured inquiry learning method, the teacher carries out a pre-test to determine the student's level of knowledge. Pretests are used in the learning process to measure students' abilities before learning begins and to find out whether students have sufficient knowledge to understand the material that will be discussed. Thus, this pretest allows teachers to find out the level of students' knowledge before learning begins and to find out whether students have a sufficient knowledge base to understand the material that will be discussed. After the exam, the teacher can find out whether students have sufficient knowledge to understand the material to be discussed. Students have a strong curiosity about the topic to be discussed and are ready to start learning more effectively and efficiently by using this perception (Hidayat et al., 2019).

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This apperception aims to arouse students' interest in the material that will be discussed and to prepare students to understand the material that will be discussed. In this way, students have a strong sense of curiosity about the material to be discussed and are ready to start learning more effectively and efficiently. After the preliminary activities, the core learning activities are carried out. The teacher divides students into six small groups, each consisting of five students. Then, the teacher distributes equipment and worksheets to each group, and each group carries out experiments according to the tasks on the worksheet. With the teacher's guidance, each group talks about the results of their experiments and fills in their worksheets. Students make conclusions from the material they have studied with the help of the teacher in this lesson closing activity. Students have the opportunity to ask questions about material that is unclear to understand during this activity. On the other hand, teachers help unite students' thinking framework by explaining important aspects. This activity was carried out over three meetings and tested afterwards to find out to what extent students could understand what they had learned.

Before learning using the STM model begins, students are given the opportunity to determine energy problems in their environment. During learning, students are given greater freedom to participate in any activity. The results of the written test at the beginning of learning, which was followed by a test of the equality of two pretest averages, showed that the physics learning outcomes of students in the two research groups did not show significant differences in their understanding of energy concepts. The use of the value-nuanced STM model shows that students' understanding of energy concepts is the same in both research groups. However, students' physical learning outcomes can be improved by adding religious, intellectual, and practical values to the energy concept. The results show that the STM learning model places students as active learning subjects. The posttest results from both experimental groups showed quite high average scores, and the students' physical learning outcomes changed. From the results of the questionnaire given at the end of the lesson, overall students showed a high response to STM learning on value-nuanced energy concepts. This is in line with research conducted by Umm Hafidah, which shows that the STM learning model for environmental pollution concepts with value nuances can improve student learning outcomes (Hadawiyah et al., 2019).

In teaching energy concepts with religious values using the STM model, students who received the highest scores were in the strongly agree category, which covers 40%. This shows that the second indicator shows students' responses to STM learning about value-nuanced energy concepts, and the first indicator shows students' interest in STM learning about value-nuanced energy concepts. This shows that the average student considers that learning physics with value nuances is very important to learn with the aim of increasing faith, intelligence and scientific literacy in students' lives. By using the STM model, students can demonstrate and investigate energy problems that exist in society. During the learning process using the STM model, students carry out various activities, such as raising problems about energy changes and energy sources related to daily life, speaking to find the source of the problem, responding to problems, making active observations in groups, actively drawing up conclusions and communicate their conclusions. In addition, students talk about the results achieved by each group in the learning process.

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CONCLUSIONS

Based on the research data analysis and hypothesis testing carried out, it can be concluded that there is a significant influence of the science, technology and society learning model on the value-nuanced energy concept on the physics learning outcomes of class VII students in junior high schools. Student learning outcomes after learning with the science technology and society model reached an average of 70.8 in the good category. The response of students who were taught using the science, technology and society learning model to the value-nuanced energy concept was classified as very positive. Learning will be more interesting if it is presented using a variety of methods, so it is best to use a variety of appropriate methods, for example variations between discussion methods and field observation methods.

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