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Research Article

Application of the science model community-based problem solving technology in improving learning outcomes, science process skills, and students scientific attitudes

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ABSTRACT

The STS (science technology and society) learning model teaches students to pay attention to problems that then emerge as other impacts of the use of new technologies in social life. Whereas the Problem Solving learning model teaches students to be trained in problem-solving using creative ways. The purpose of this study was to analyze the effect of the application of STS based problem-solving learning models on the learning outcomes, science process skills, scientific attitude of senior high school 6 Ambon. The research was conducted from January to February 2020. The research design was a quasi-experimental study using a non-equivalent group design. Data were analyzed using descriptive and inferential statistics using the ANCOVA and ANOVA tests. Descriptive statistics are used to explain the range of research data on cognitive learning outcomes, science process skills, and scientific attitudes in the table. ANCOVA test is used to analyze the effect of learning models on cognitive learning outcomes. ANOVA test is used to analyze the effect of learning models on scientific process skills and scientific attitudes. The results showed that the distribution of cognitive learning outcomes, science process skills, and scientific attitudes of students in the experimental class taught using STS based problem solving learning models were better than students taught using conventional learning models (STAD). ANCOVA statistical test shows that the significant value is 0,000 <0.05. This shows that the learning model influences students' cognitive learning outcomes. ANOVA statistical test showed that the significant value was 0,000 <0.05. This shows that the learning model influences the science process skills and scientific attitude. The stages in the STS based problem solving learning models can accommodate cognitive learning outcomes, process skills, and scientific attitudes of senior high school 6 Ambon on Environmental Friendly Technology material.

Keywords: *problem solving, learning outcomes, science process skills, scientific attitudes*

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INTRODUCTION

The learning science, teachers need to apply technology according to the needs of students in the community. In connection with one of the important objectives of learning science, namely the emergence of individuals who are always

responsive to the development of science and technology, as well as sensitive to social issues that arise as a result of these developments. So, one of the learning approaches, namely Science, Technology and Society (STS) needs to be applied in studying science. The (STS) approach in learning can certainly accommodate this important goal, because in this (STS) (science technology and society approach) approach, students are also taught to pay attention to problems that then arise as another impact of the use of new technologies in social life. The impact of the development of science and technology here is not only a negative impact, but also a positive impact. It should be noted that science and technology and society have a reciprocal relationship and influence each other. According to Mansour (2009) (STS) is an interdisciplinary field of study that seeks to explore and understand the many ways modern science and technology shape modern culture, values and institutions on the one hand, and on the other hand how modern values shape science and technology. Kapici et al. (2017) in his research explains that science, technology and society strategies involve students' ideas and include consideration of various points of view, collaborative investigation, and problem solving. In addition to these two explanations, the science curriculum also contains relevant scientific concepts and processes that can be found in everyday life.

In realizing the goals of science education, it is very necessary to enrich knowledge; implementation of constructive learning, collaborative inquiry, problem solving; improvement and innovation of the learning process (Satria, 2018; Kapici et al. 2017). The science, technology and society (STS) approach carries the theory of constructivism, where in this approach students build their own understanding of learning materials. In addition, this STS approach also accommodates a contextual teaching and learning approach, where students are directly invited to understand science according to real conditions that occur in their surrounding environment. Through the STS approach, the environment is not only in the form of a physical environment where students can study abiotic natural phenomena (non-living things) and biotic natural phenomena, but also study their impact on the community environment. Smitha & Aruna (2014) make it clear that STS accepts the responsibility to increase interaction with the community and then has a responsibility to future generations to provide knowledge and technology that have a long-term impact on future generations. Simiti (2017) adds that technology is part of applied science that transforms understanding and discovery of science into applications for society.

Therefore, when practicing the STS approach, teachers must be able to encourage students to design technology that can be applied and beneficial to society. One of the benefits for the people of Maluku today is an electric mosquito repellent. The manufacture of this simple technology is based on the community's need for a mosquito repellent that is easy to use but safe for the environment. Mosquitoes disturb people's lives through epidemics that are transmitted through bites. One solution to prevent mosquito bites is to use electric mosquito repellent. This type of insect repellent does not emit smoke or leave chemical particles on the furniture in the room. One of the materials that can be used in the manufacture of mosquito repellent or natural larvicides is to utilize organic waste in the form of seeds and fruit skins from the genera Lansium, Nephelium and Durio. Organic waste is considered to have a higher level of safety because it is easily biodegradable in nature so that it does not pose a serious residue hazard and is certainly more selective by not poisoning living things and other environments that are not targeted (Kardinan, 2005).

Maluku province is generally a fruit-producing area. In fact, every year there are always fruits of the genus Lansium, Nephelium and Durio abundantly from various villages in Maluku and Ambon city. This has many positive impacts for the community, but on the other hand it also has an unfavorable impact on environmental cleanliness. One of the negative impacts of the presence of seeds and fruit peels in the Ambon city area is the volume of waste that accumulates. This happens because most people, in this case are traders and fruit consumers, just throw away the seeds and skin. If not managed properly, the seed and skin waste will cause problems for the environment, namely making the environment dirty and causing unpleasant odors. To overcome this problem, there is a need for innovation in organic waste management by involving the wider community so that organic waste can be utilized into products of economic value and high volume of organic fruit waste, it is necessary to carry out research activities aimed at increasing added value for durian and langsat skin waste through processing into electric mosquito repellent.

The results of research that has been carried out by Santi (2011) revealed that one of the potentials of durian and langsat skin is the high content of essential oils. Durian peel essential oil contains flavonoid compounds, saponins, and polyphenols which are toxic to pests and mosquitoes so that they can be used as environmentally friendly vegetable pesticides (Asmaliyah et al. 2010). While the research conducted by Mirnawaty et al. (2012) that electric mosquito repellent made from langsat fruit peel extract with several concentrations was able to kill Aedes aegypti mosquitoes and the concentration of langsat peel extract which was most effective in killing Aedes aegypti mosquitoes was 25%. Riyadi et al. (2018) also reported the same results, namely the potential of rambutan seeds as natural larvicides in Aedes aegypti mosquito larvae.

So far, the teaching and learning process that has taken place at Junior high school 6 Ambon has not applied the STS approach in a real way to the community. The STS approach used is still theoretical in the classroom, but has not

been able to create products that are beneficial for the survival of the community. At the same time, durian and langsat are currently abundant in the market. Therefore, the manufacture of electric mosquito repellent products using simple technology is very appropriate. If students have experienced this STS-based learning process, students can have complete science process skills. According to Rauf et al. (2013) teachers must be able to use various learning approaches in order to be able to develop science process skills. These science skills are very important in science learning because they serve as the basis for developing other cognitive abilities such as logical thinking, reasoning, and problem solving skills. In addition, according to Siahaan et al. (2017) science process skills not only focus on the transfer of knowledge, but also emphasize the investigation process to solve problems in real-life situations. As long as students complete the investigation process and develop scientific skills, students have actually taken the steps of the scientific method framed in a problem solving-based STS approach. Because process skills are related to the scientific method, scientific work also contributes to these scientific process skills.

If the use of organic waste from fruit peels into an effective and efficient electric mosquito repellent product is carried out by students, then the next step that can be done is to develop teaching materials based on superior products produced by students. This is related to research innovations that are produced to take advantage of the potential of regional superior products, in an effort to overcome inequality and realize justice and improve the welfare of the community. Based on this, one of the superior products besides being used by the community can also be developed for class VIII students who study the concept of environmentally friendly technology. Based on these explanations, the community science technology approach can be combined with problem solving strategies so as to improve student learning outcomes, science processing skills and students' scientific attitudes in the process of processing organic waste into electric mosquito repellent products in science class students of Junior high school 6 Ambon.

METHODS

This study uses a quasi-experimental type of research because in this study the character, motivation, hobbies, origin of the students cannot be uniformed or conditioned to be the same. The research design used is the non-equivalent group design (Table 1).

Table 1. Research design

E	Y1	X1	Y2
K	Y1	X2	Y2

Information:
E : experimental group
P : control group
Y1 : pretest
Y2 : postest
X1 : acombination of problem solving-based STS models
X2 : conventional learning strategies

Population in this study were all students of class IX Jonior high school 6 Ambon in the 2018/2019 academic year. The sample in this study were students in grades IX_1 and IX_2. One class as a control class while the second class as an experimental class. Class selection is done randomly using lottery. This research used test and non-test instruments. The instruments developed are in the form of test questions and scoring rubrics. Items are prepared referring to competency standards in accordance with the provisions. The items compiled are essay questions that are used to measure problem solving abilities and students' cognitive learning outcomes. The next instrument to be developed is the rubric. The rubric developed in this study is a list of criteria used to measure test results. There are 2 kinds of rubrics developed, namely the science process skills rubric and scientific attitude. The problem solving-based STS learning model is carried out with the following steps: (1) problem identification, (2) choosing factual problems, (3) analyzing solutions to solve problems, (4) finding solution information, (5) implementing solutions , (6) product evaluation. Meanwhile, conventional learning is carried out according to the stages usually carried out by teachers.

Data analysis used inferential statistics, namely ANCOVA and ANOVA tests. ANCOVA test was used to determine the effect of problem solving based STS learning model and conventional learning model on cognitive learning outcomes. The ANOVA test was used to determine the effect of the problem solving-based STS learning model and the conventional learning model on the process skills and scientific attitudes of students. If the criteria for probability or significance value <0.05, it can be said that there is an influence between the independent variables on the dependent variable partially, but if the significance is >0.05, it can be said that there is no significant effect between each

independent variable on the dependent variable. Before the ANCOVA and ANOVA analyzes were carried out, a prerequisite test was performed using the normality and data homogeneity tests. For data analysis, the SPSS program was used.

RESULTS AND DISCUSSION

Student cognitive learning outcomes

Cognitive learning outcomes of students in problem solving-based and conventional STS classes consist of pre-test and post-test (Tables 2 and 3).

Table 2. Cognitive learning outcomes of students in conventional class

Pre-Test			Post-Test		
Interval	**Frekuency**	**Frekuency Relative**	**Interval**	**Frekuency**	**Frekuency Relative**
8-13	1	2.941	40-48	1	2.941
14-19	1	2.941	49-57	2	5.882
20-25	11	32.35	58-66	7	20.59
26-31	18	52.94	67-75	7	20.59
32-37	2	5.882	76-84	11	32.35
38-43	1	2.941	85-93	6	17.65
Total	34	100	Total	34	100

Table 3. Cognitive learning outcomes of students in problem solving-based STS class

free-test			Post-test		
Interval	**Frekuency**	**Frekuency Relative**	**Interval**	**Frekuency**	**Frekuency Relative**
16-22	1	3.125	83-85	1	3.125
23-29	4	12.5	86-88	0	0
30-36	8	25	89-91	0	0
37-43	12	37.5	92-94	3	9.375
44-50	6	18.75	95-97	13	40.625
51-57	1	3.125	98-100	15	46.875
Total	32	100	Total	32	100

Measuring cognitive learning outcomes, students are encouraged to show their best abilities. The results of the descriptive analysis in Table 2 and Table 3 show an increase learning outcomes using both problem solving-based and conventional STS models. This is in accordance with the opinion of Hadijah & Anggereni (2016) that evaluation of learning outcomes is carried out to measure the magnitude of behavioral changes obtained by students in completing learning objectives.

Students' science process skills

The ability of students' science process skills in problem solving and conventional elementary classes was observed during the learning process (Table 4).

Table 4. Students' science process skills in problem solving and conventional STS class

Conventional			Experiment		
Interval	**Frekuency**	**Frekuency Relative**	**Interval**	**Frekuency**	**Frekuency Relative**
58-59	21	61.76	83-84	12	37.5
60-61	0	0	85-86	0	0
62-63	0	0	87-88	0	0
64-65	0	0	89-90	0	0
66-67	13	38.24	92-92	20	62.5
Total	34	100	Total	32	100

Students' science process skills in problem solving and conventional (STAD) based STS classes are carried out during the learning process. Science process skills are a process of carrying out scientific activities related to science to understand phenomena that occur in society (Pardhan, 2000; Rustaman & Nuryani, 2014). The results of the descriptive analysis in Table 3 show that the problem solving-based STS students' science process skills are better than conventional learning (STAD), this happens because the problem solving-based STS learning syntax is able to accommodate students' science process skills.

The effect of learning models on students' cognitive learning outcomes, process skills, and scientific attitudes

Prerequisite Test

Prior to the analysis for testing the hypothesis, the normality and homogeneity of the data were first tested. The normality test of the data used the One Sample Kolmogorov-Smirnov Test, the results showed that the data were normally distributed (Table 6). The homogeneity test of the data used Leven's Test of Quality of Error Variances, the results showed that the data came from a homogeneous population (Table 5).

Table 5. Data normality test

Dependent variable	Kolmogorov Smirnov			Level of confidence	Information
	Statistic	df	Sig.		
Cognitive learning outcomes	1.617		.111		
Science process skills	1.603		.092	α=0.05	Normal
Scientific attitude	1.852		.062		

Table 6. Data homogeneity test

Dependent variable	Levene' Test			Tingkat Kepercayaan	Information
	Statistic	df	Sig.		
Cognitive learning outcomes	2.579		.310		
Science process skills	.015		.904	α=0.05	Homogen
Scientific attitude	2.681		.060		

Hypothesis

The results of ANCOVA and One Way ANOVA tests to determine the effect of problem solving-based STS models and conventional learning models on cognitive learning outcomes, science process skills, and scientific attitudes are shown in Table showed that F value was 44,476 with a significant value of 0.000 <0.05. Based on these results, there is an effect of the learning model on the cognitive learning outcomes of students on environmentally friendly technology materials in class IX science senior high school 6 Ambon. In addition, the results of the LSD test (Table 9) show that there is a notation difference between the conventional learning model (STAD) (notation a) and the problem-solving-based STS learning model (notation b) on the cognitive learning outcomes of senior high school 6 Ambon. This proves that students who are taught using the problem solving-based STS learning model have better cognitive learning outcomes than students who are taught using the conventional model.

Table 7. Hypothesis testing of cognitive learning outcomes for senior high school 6 Ambon

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected model	9721.228[a]	2	4860.614	52.350	.000
Intercept	14693.101	1	14693.101	158.249	.000
pre_test	79.943	1	79.943	.861	.357
model_pembelajaran	4129.503	1	4129.503	44.476	.000
Error	5849.439	63	92.848		
Total	488688.000	66			
Corrected total	15570.667	65			

Table 8. LSD test of cognitive learning outcomes for senior high school 6 Ambon students

Class	Mean	Notation LSD
Control (STAD)	72.9412	a
Experiment (STS-based problem solving)	97.1250	b

The results of the study (Table 7) show that the learning model has an effect on students' cognitive learning outcomes, and the results of the LSD test (Table 8) also show that there is a notation difference between the problem solving-based STS learning model and the STAD model (in the control class) on students' cognitive learning outcomes. Research conducted by Subekti (2017) shows that the application of problem solving learning models in science learning has succeeded in changing teaching activities that are teacher centered to student centered. According to Purwanti & Manurung (2015), problem solving provides experiences for students to solve problems, develop responses, and improve students' thinking process. Akcay & Akcay (2015) explained that learning using the STS model helps students understand science concepts, students have the opportunity to choose real problems for investigative activities, also helps teachers use more explicit teaching methods than traditional learning. According to Nworgu & Yager (2004) the focus of STS learning is that students can construct science concepts, solve common problems in everyday life using technology, and clearly demonstrate new uses for this knowledge.

Based on the findings of this study, it is known that the STS and problem solving learning models have the same focus, namely problem solving and can improve student learning outcomes. Therefore, the problem solving-based STS learning model in this study was also able to improve student learning outcomes compared to the learning model commonly used by teachers (STAD). In addition, the results of the LSD test (Table 9) show that there is a difference in notation between problem solving and conventional STS based learning models. This shows that the problem solving-based STS learning model has the advantage of different learning stages when the STS learning model and problem solving stand alone in the lesson plan. The learning stages in question are identifying problems, choosing factual/real problems, analyzing solutions to solve problems, seeking information to obtain solutions, implementing solutions, and evaluating products.

Through the stages of identifying and selecting problems students are given the experience to study, collect and then select contextual problems related to the concept of environmentally friendly technology. According to Sastiawan et al. (2019) students are able to identify problems because students are given the opportunity to observe directly on learning resources. The stages of analyzing solutions to solve problems help students to understand science concepts to solve problems that have been formulated by students, in addition to science concepts, students also combine science concepts with technology to solve these problems. Agustini et al. (2013) explained through analytical activities helping students to compare results with existing theories to reach the right solution, so that students' mastery of concepts can be achieved at this stage of analysis. Dwipayana (2017) also adds that problem solving skills can provide new experiences for students. Therefore, Problem Solving-based STS learning can provide new experiences for students such as problem identification and problem solving skills so as to improve student learning outcomes compared to conventional learning.

The results of the ANOVA test (Table 10), showed that F value was 719,665 with a significant value of 0.000 <0.05. Based on these results, there is an effect of the learning model on the value of the science process skills of students on Environmentally Friendly Technology in class IX Scinece Senior high school 6 Ambon. In addition, the results of the LSD test (Table 11) show that there is a notation difference between the conventional learning model (STAD) (notation a) and the problem solving-based STS learning model (notation b) on the science process skills of senior high school 6 Ambon students. This proves that students who are taught using the problem solving-based STS learning model have better science process skills scores than students who are taught using the conventional model.

Table 9. Hypothesis of science process skills for senior high school 6 Ambon

Source	sum of squares	df	Square mean	F	Sig.
Between groups	12029.894	1	12029.894	719.665	.000
In Group	1069.821	64	16.716		
Total	13099.715	65			

Table 10. LSD test of science process skills for senior high school 6 Ambon

Class	Mean	Notation LSD
Control (STAD)	61.4735	a
Experiment (STS problem solving)	88.4875	b

The results of the study (Table 9) show that the learning model has an effect on students' science process skills, and the results of the LSD test (Table 10) also show that there is a notation difference between the problem solving-based STS learning model and the STAD model (in the control class) on science process skills. student. Santi's research (2014) reports that science process skills can be improved using the STS learning model. The research of Guritno et al. (2015) reported that problem solving learning can improve student learning outcomes. This is in accordance with the findings in this study that the problem solving-based STS learning model can affect students' science process skills. Indicators that appear when learning using the problem solving-based STS learning model are observation, prediction, classification and communication. Observation indicators appear during the problem identification stage. At this stage the teacher invites students to make observations in the real world of students related to contextual phenomena that occur.

According to Lu et al. (2016), the observation step on process skills is an early stage that can improve science process skills, this is because at the observation stage students can ask questions and formulate hypotheses well. Agustina & Saputra (2016) reported that the calcification stage is one of the advanced stages when students make observations. The classification of the findings of this study is that students can classify problems and solutions according to their type. After that the skills that appear next during the learning process are communication skills. Communication skills are used to present products that have been made by students. According to Lepiyanto (2014) communication activities can be raised in situations of communicating the results of observations, and when explaining the results of observations to other students. According to Osman et al. (2007) the biology learning process can shape students' conscious attitudes towards science and technology as a whole through the right learning process. One of the learning processes applied is the problem solving-based STS learning model.

ANOVA test (Table 12), shows that the F value is 151,811 with a significant value of 0.000 <0.05. Based on these results, there is an effect of the learning model on the scientific attitude of the students of class IX Science senior high school 6 Ambon. In addition, the results of the LSD test (Table 13) show that there is a difference between conventional notation (STAD) (notation a) and problem solving-based STS learning model (notation b) on the scientific attitudes of high school 6 Ambon senior students. This proves that students who are taught using the problem solving-based STS learning model have a better scientific attitude than students who are taught using the conventional model.

Table 11. Hypothesis of scientific attitude of senior high school 6 Ambon students

Source	sum of squares	df	Square mean	F	Sig.
Between groups	7481.077	1	7481.077	151.811	.000
In Group	3153.850	64	49.279		
Total	10634.926	65			

Table 12. LSD test of scientific attitude of senior high school students 6 Ambon

Class	Mean	Notation LSD
Control (STAD)	63.9971	a
experiment (STS Problem solving)	85.3000	b

The results of the study (Table 11) show that the learning model has an effect on students' scientific attitudes, and the results of the LSD test (Table 12) also show that there is a notation difference between the problem solving-based STS learning model and the STAD model (in the control class) on students' scientific attitudes. Mandra's (2012) proves that there are differences in the scientific attitudes of students who are taught using the STS learning model and students who use conventional learning models. Meanwhile, research by Rahmawan et al. (2016) showed that the application of problem solving learning models can increase students' curiosity in learning. Some of these studies show that the STS learning model and problem solving learning model can improve students' scientific attitudes in the learning process.

Therefore, the findings in this study using the problem solving-based STS learning model can affect students' scientific attitudes compared to conventional learning. The scientific attitude in this research consists of indicators of curiosity, critical, perseverance, creative, honest, open-minded, and cooperative. The stages of identifying problems in the problem solving-based STS learning model can foster student curiosity and be critical of the selection of contextual

problems to be solved by students. According to Hunaepi (2016), students' scientific attitudes, especially curiosity, are formed through observations of contextual phenomena based on local wisdom. Meanwhile, Yudhayanti et al. (2015) explained that students who have a high scientific attitude have a positive contribution to curiosity, so they are more active in asking and knowing more than other students. Scientific attitude, perseverance, open-mindedness, honesty and cooperation during learning are needed at the stage of analyzing solutions to solving problems and seeking information. According to Anwar (2009), an open-minded attitude shows that students have a habit of listening to opinions, arguments, and even criticism from other friends. Through an honest, diligent and open-minded attitude, you can cultivate a good cooperative attitude. According to Sukaesih (2011), optimal cooperation between group members in the group provides the opportunity for group members to interact with friends who are more capable. Research by Akpinar et al. (2009) proved that scientific attitudes have an influence on students' views about science and technology.

CONCLUSION

Based on the research that has been done, it can be concluded that the problem solving-based STS model has an effect on improving cognitive learning outcomes, science process skills, and scientific attitudes of students of class IX Science senior high school 6 Ambon. This is related to the learning stages of the problem solving-based STS model, namely identifying problems, choosing factual/real problems, analyzing solutions to solve problems, seeking information to obtain solutions, implementing solutions, and evaluating products.

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