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Analysis of Students' Problem-Solving Abilities in Learning with an Ethnoscience-Based Socio-Scientific Issues (SSI) Approach

Sri Jumini [1*], P Parmin[2], Anissa Valenia Samputri[3], Hamzah[4]

[1,3] Physics Education, Faculty of Tarbiyah and Teacher Training, Universitas Sains Al-Qur'an
Jln. KH. Hasyim As'ari, Km. 03, Kalibeber, Mojotengah, Wonosobo
[2] Natural Sciences Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang
Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229
[4]Madrasah Aliyah Negeri 2 Wonosobo
Jln. Dieng No.Km. 05, Krasak, Kec. Mojotengah, Kabupaten Wonosobo, Jawa Tengah 56351

e-mail: [1*]srijumini@unsiq.ac.id, , [2]parmin@mail.unnes.ac.id, [3]ansvln51@gmail.com, [4]abyfadhil@gmail.com
*** Corresponding Author**

Abstract

Ethnoscience-based learning is limited to constructing community knowledge into scientific knowledge, it needs to be directed at solving problems that occur in local potential/culture. The research aims to analyze students' problem-solving abilities in learning using the Ethnoscience Based Socio Scientific Issues (SSI) Approach. The research uses a quantitative approach, true experimental method, and pretest-posttest control group design type. The research sample was taken using the simple random sampling method. Problem-solving ability is measured using description questions and analyzed using a percentage scale. To see the difference in problem-solving abilities between the experimental class and the control class, the t-test was used and to see how big the difference was, the Gain test was used. The research results showed that 81% of students' problem-solving abilities were in the good category. The results of the t-test show that there is a difference in problem-solving abilities between classes that apply the ethnoscience-based Socio Scientific Issues (SSI) approach and those that do not, as indicated by the t_{count} of 7.396 which is greater than the t_{table} of 2.045. The difference in students' problem-solving abilities is 0.74 in the high category. The impact of being trained in the stages of problem-solving on each topic of local problems, students have good problem-solving abilities.
Keywords: Science; Socio Scientific Issues, Ethnoscience; Problem-solving skill.

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INTRODUCTION

The very rapid development of science and technology in the 21st century cannot be separated from the development of scientific knowledge. Discoveries in the field of science are the main basis for technological development (Jumini, Madnasri, et al., 2022; Subiantoro, 2017). The problems that arise are increasingly complex, so they require individuals who not only have knowledge, but also skills in solving problems. However, science learning so far seems theoretical, mathematical, and far from real life (Jumini, Hidayah, et al., 2022; Priscylio & Anwar, 2019). Learning must be directed at forming skills in facing the challenges of the 21st century. Science learning, whatever the approach, cannot be separated from the spirit of science learning itself, namely scientific products, processes, and attitudes.

Science learning departs from facts that occur in nature/society and is processed through inquiry/discovery to produce principles, laws, and theories as well as practicing scientific attitudes such as (1) curious attitude, (2) critical attitude, and (3) open attitude., (4) objective attitude, (5) willingness to respect other people's work, (6) courageous attitude to defend the truth, and (7) futuristic (Jumini, 2016; Suryantari et al., 2019). Much of science learning is still not contextual, so students are less able to apply science to the context of everyday life (Nikmatur Rohmaya, 2022). The inability to connect scientific concepts with everyday life has an impact on the inability to analyze and find solutions to social problems that occur in society.

The problems that occur in society are increasingly complex along with the development of science and technology. This requires that learning not only be able to make students understand scientific concepts, but also students are better able to understand the problems and issues that occur in society, especially those around them, and are able to make decisions to provide solutions to problems. Learning must be directed at analyzing local problems around students both through culture and existing local potential. Culture-based science learning (ethnoscience) directs students to transform original community knowledge into scientific knowledge (Parmin et al., 2017). Ethnoscience is the process of combining indigenous science with scientific science. Ethnosaics is an approach to creating a learning environment and creating learning experiences that combine culture in the learning process (Sudarmin et al., 2018, 2020).

Pembelajaran sains berbasis budaya lokal dapat mengarahkan siswa untuk mengamati dan mengeskplorasi budaya-budaya dan potensi lokal ke dalam pembelajaran, sehingga akan melatih dan merangsang kemampuan bernalar dan berfikir kritisnya (Tresnawati, 2018). Budaya lokal ini dapat berupa pengetahuan lokal, keterampilan lokal, kecerdasan lokal, sumber daya lokal, proses sosial lokal, norma-etika lokal, dan adat istiadat lokal (Parmin & Fibriana, 2019). Pembelajaran yang mengintegrasikan budaya dan potensi lokal akan lebih membantu peserta didik dalam memahami konsep yang sedang dipelajari, karena nyata terjadi di sekitar siswa. Rekontrusi pengetahuan masyarakat ke dalam pengetahuan ilmiah membuat nalar siswa berkembang, sehingga mampu menganalisis isu-isu, permasalahan sosial, fakta-fakta dan fenomena (sosio-saintifik issue) yang terjadi di sekitarnya.

Socio-Scientific Issues (SSI) is an approach that uses social life problems which are conceptually closely related to science (Utomo et al., 2020). SSI helps students improve their reasoning and argumentation skills by providing different perspectives. The SSI approach uses argumentative thinking, formal debate, and informal discussion as important elements in training students to use information in a consistent framework individually and in groups. SSI trains students to reason and think critically so that they can understand problems well and use the knowledge they have to solve problems that occur around students. SSI is recognized as a good context for developing students' competencies in facing the challenges of the 21st century (I Made Tri Pramana Putra, 2022). SSIs are problems related to science and technology, authentic and unstructured problems that are often controversial and involve many stakeholders with different perspectives. SSI represents important social issues and problems that are conceptually related to science. The solution to a problem must pay attention to moral, political, social, and economic issues. In this way, students' problem-solving abilities can be trained in learning.

The ability to solve problems is a basic ability to deal with life's problems. The ability to solve problems is a process of continuous learning and improvement, and trains students to understand the relationship between knowledge and problems and experience the benefits of learning. The problem-solving stages begin with identifying the problem, analyzing possible causes, identifying solutions, selecting solutions, implementing solutions, and evaluating (Pradani & Nafi'an, 2019; Rosita & Yuliawati, 2016). The ability to solve problems has an important advantage when individuals are faced with situations that require problem-solving, selecting the best solution considering various factors, and taking appropriate action. This ability is an intellectual process that is realized through actions, results and responses that are based on knowledge. Students discover a close relationship between mastery of knowledge and problem-solving abilities, which in turn improves their understanding, skills, and attitudes. It is important to remember that problem-solving ability is a cognitive-based process that requires appropriate pedagogy for its development.

Science learning that uses an ethnoscience-based SSI approach is still rarely carried out. Literature studies on ethnoscience learning have recently begun to be widely carried out, however, the learning has only been limited to constructing community knowledge into scientific knowledge (Falah et al., 2024; Kinslow et al., 2019; Sudarmin et al., 2014). The resulting construction is still rarely used to analyze problems that occur around students, so it still seems theoretical and not yet applicable. On the other hand, there are many problems related to local culture, especially in Wonosobo. Local culture includes the hot air balloon festival, Sikidang crater, global warming, the color lake whose color is starting to fade, gas leaks at the Geothermal Power Plant at PT Geodipa Dieng Wonosobo, Kalianget baths, and so on. There has not been much learning that links the problems that occur in this local culture. Learning that integrates local culture or potential is limited to constructing concepts that exist in local culture.

Science learning with the ethnoscience-based SSI approach trains students' reasoning to use the knowledge they have in analyzing and finding solutions to problems that occur around them (Falah et al., 2024). Therefore, this research aims to find out the extent of students' problem-solving abilities in learning using an ethnoscience-based Socio-Scientific Issue (SSI) approach. The integration of culture and all the problems that occur into learning and the ability to analyze problems in local culture are the main indicators of success in this research. After students are able to analyze concepts in local culture that are integrated into learning, then students are trained to apply the concepts they have learned to analyze and find appropriate solutions to solve the problems discussed in learning. Important research findings to provide an overview of ethnoscience-based science learning in training students' problem-solving abilities.

METHODS

The approach used in this research is quantitative with a type of experiment using the true experiment method (Creswell, 2017; Zulfikar et al., 2024). The experiment was used to determine the effect of the independent variable of learning using the ethnoscience-based Socio Scientific Issues (SSI) approach on the dependent variable of students' problem-solving abilities. The true experiment method was chosen because the research sample was taken randomly from the population of class 11 students at SMA Negeri 1 Wonosobo, totaling 144 students. The sampling technique uses simple random sampling, without paying attention to

strata in the population. Two classes were selected for the research sample, XIC as the experimental class and XIE as the control class, each with 30 students. True experiments are also chosen to control all external variables that can influence the experiment so that the quality of the research implementation can be high (Sugiyono, 2006).

The design used in this True Experiment is a pretest-posttest control group design type, as shown in Table 1. Both classes before and after the treatment were given the same test questions. The experimental class is given learning using an ethnoscience-based Socio Scientific Issues (SSI) approach, while the control class learns as usual using lectures.

Table 1 Research Design

Class	*Pretest*	Perlakuan	*Posttest*
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

Information:
O_1 = Initial abilities of experimental class students
O_3 = Initial abilities of control class students
X_1 = Treatment of learning with an ethnoscience-based SSI approach
X_2 = Conventional method learning treatment
O_2 = Final abilities of experimental class students
O_4 = Final abilities of control class students

The test questions given to measure students' problem-solving abilities consist of 7 descriptive questions which are equipped with scoring guidelines (rubrics). Problem-solving ability uses the Heller model, with indicators 1) identifying problems, 2) planning problem-solving strategies, 3) implementing problem-solving strategies, and 4) evaluating the problem-solving strategies applied (Docktor, 2009; Fitroh et al., 2020; Hidayat et al., 2017). The problem-solving ability test instrument was developed from indicators into learning materials, namely temperature and heat. The instrument was validated internally and externally. Internal validation is carried out with material experts, learning experts, and evaluation experts to see constructs, grammar, and suitability to learning objectives (Jumini et al., 2023). External validation involves testing the test question instrument on students and then analyzing the validity, reliability, level of difficulty, and difference. In this way, a test question instrument for measuring quality problem-solving abilities is obtained.

Analysis of research data was carried out by calculating the total number of student scores and the total score of the problem solving ability test scores. To calculate the percentage of students' problem solving abilities, the following formula can be used.

$$Np = \frac{R}{SM} \times 100\%$$ (Hidayat et al., 2017)

Information :
Np = The percent value sought
R = Raw scores obtained by students
SM = The ideal maximum score of the test in question

After giving a score by looking at the achievement of four aspects of problem-solving ability, then convert the score into percentage form and categorize students' problem-solving ability as in Table 2 below.

Table 2 Interpretation of Problem-Solving Abilities

Presentation of aspect achievements	Categori
76% - 100%	Very good
51% - 75%	good

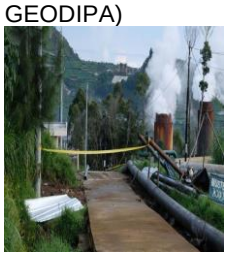
Presentation of aspect achievements	Categori
26% - 50%	Less good
0% - 25%	Not good

Meanwhile, to see the differences in students' problem-solving abilities in the experimental class and the control class, an independent sample t-test analysis was carried out. Then proceed with the Gain test to see how big the difference is.

RESULTS AND DISCUSSION

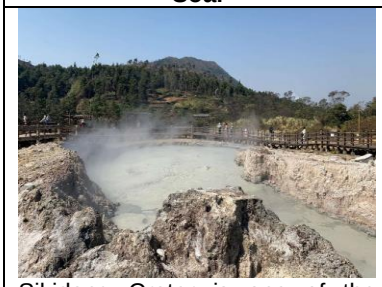
The research began with the preparation of a teaching module that integrated local potential in learning temperature and heat material, along with the problems contained therein. The local potential that is integrated into learning can be seen in Table 3 below.

Table 3. Local Potential in Temperature and Heat Learning

No.	Sub Material	Ethnoscience	Socio Scientific Issues	Analysis
1.	Temperature	balloons at the 2024 homecoming festival 	The balloon failed to fly	Balloons can fly because the air temperature inside the balloon is higher so its density is smaller than the air around the balloon. But because the wind was moving unstable, the balloon could not air properly. Also because the air temperature is too humid because the sun is not bright enough/covered by clouds.
2.	Calor	Kawah Sikidang 	Hot mud exploded and thick white gas or smoke billowed in the air	Kawah Sikidang is an area that has quite high geothermal activity. Inside there is a geothermal source that causes water and mud to boil. Geothermal heat originating from within the earth brings heat energy to the surface, which then causes water and other materials to heat up
3.	Heat of melting	Salt making 	Increasing sea temperatures have resulted in the evaporation of seawater faster than usual, causing the formation of salt crystals that are faster and thicker, making them difficult to separate from the water, making it difficult for farmers to extract salt	In the context of crystal salt formation. If the temperature around the sea water rises and approaches the melting temperature of the salt, then the additional energy absorbed by the sea water can speed up the process of dissolving the salt and forming a saturated solution. When the saturated solution is cooled or exposed to cold temperatures at night, crystallization of salt from the solution can occur more quickly because of the excess energy stored in the solution
4.	Heat Transfer	PLTP Dieng (PT GEODIPA) 	The toxic H2S gas leak at the Dieng PLTP managed by PT Geo Dipa Energi shows that there is a problem with the equipment in the Dieng well pad or generating w	Sulfur particles moving randomly in the gas will interact with each other and with the pipe walls by conduction. Gas flows from hot areas to cold areas and carries heat energy with it by convection. When sulfur gas leaks from a pipe, the gas will have a high temperature, causing the emission of energy in the form of electromagnetic radiation

This teaching module is equipped with Student Worksheets (LKPD) which are used to guide learning to be more focused. Then after learning, a posttest is carried out to measure students' problem-solving abilities. The results of measuring problem-solving abilities in learning were 81% in the very good category. Measuring problem-solving abilities, namely useful description, physics approach, specific application of physics, mathematical procedure, and logical progression (Docktor, 2009). An example of an instrument for measuring problem-solving abilities is in Table 4 below.

Table 4. Example Of An Instrument For Measuring Problem-Solving Abilities

Soal	**Pembahasan**
 Sikidang Crater is one of the famous tourist attractions in Wonosobo. Sikidang Crater has unique characteristics in the form of a geologically active crater-shaped area. In the form of the Sikidang crater, geothermal activity can emit sulfur gas. From the text, how can the concepts of temperature and heat influence the release of sulfur gas bursts?	Stage 1 (**Useful Description**) Mark important information from the reading Stage 2 (**Physical Approach**) Dik. Sikidang Crater is a geothermal activity that can emit Dit sulfur gas. The effect of temperature on the release of sulfur gas Stage 3 (**Specific Application of Physics**) Develop a problem-solving strategy by writing down the knowledge you have • The temperature in the crater is very high which can cause water evaporation Stage 4 (**Mathematical Procedure**) Write down the answer to the problem-solving strategy that has been designed The temperature in the crater is a temperature high enough to evaporate sulfur. High temperatures increase the kinetic energy of sulfur molecules which allows them to move quickly and leave the solid phase to become a gas. The heat generated from geothermal activity below the earth's surface causes the rocks in the crater to heat up. This process produces sufficient thermal energy to heat and convert solid sulfur into gas. The higher the temperature, the faster the rate of sulfur evaporation. Stage 5 (**Logical Progression**) Write conclusions from the problem formulation that has been written. So, the concepts of temperature and heat influence the release of sulfur gas jets in the Sikidang crater by providing the energy needed to melt and evaporate the sulfur.

Next, to see the differences between the experimental class and the control class, a difference test was carried out. Pretest and posttest data on students' physics problem-solving abilities in the experimental class and control class can be seen in Table 5 and Table 6 below.:

Table 5 Pretest Results for Experimental Class and Control Class

Class	Sum	Mean	Maximum Value	Minimum Value
Experiment	722	24,07	59	0
Control	452	15,07	29	0

Table 6 Posttest Results for Experimental Class and Control Class

Class	Sum	Mean	Maximum Value	Minimum Value
Experiment	2399	79,97	98	25
Control	960	32,00	92	0

Based on the results of test data analysis in Table 5, learning using the ethnoscience-based SSI approach in the experimental class has an average posttest score of 79.97 and an average problem-solving ability in the control class of 32.00. So it can be concluded that the average results of problem-solving abilities in the experimental class are greater than the control class. The higher average score obtained by the experimental class after implementing learning using the ethnoscience-based SSI approach is because students have a variety of

thinking skills including observing, reporting, describing, analyzing, classifying, interpreting, drawing conclusions, and making generalizations based on information and processing. Science learning is relevant to students' lives, through ethnoscience-based SSI topics students can improve dialogue arguments through presentation activities, apart from that students can also evaluate scientific information by solving physics problems. This makes learning more meaningful and the learning experience richer and more varied because it is linked to social and cultural issues around students.

The differences in problem solving abilities of the experimental class and the control class were analyzed using the t test. The results of the independent sample t-test calculation for the two groups in terms of differences in students' problem-solving abilities can be seen in Table 7 below.

Table 7 T-Test Results (Independent Sample T-test)

Problem-solving skill	Uji-t		
	t	df	Sig
Equal Variances Assumed	7,396	58	0,000
Equal Variances Not Assumed	7,396	49,095	0,000

The results of the independent sample t-test calculation on students' problem-solving abilities expressed in Equal Variances Assumed have a t_{count} value of 7.396. Based on the ttable value of 0.025, the t value for df = 58 is 2.045. The results show that tcount > t_{table} (7.398 > 2.045) so Ho is rejected. The significance level shows less than 0.05, this means that Ho is rejected and Ha is accepted. This means that there is a difference in the problem-solving abilities of students who use the ethnoscience-based SSI approach and those who do not. Meanwhile, to see the magnitude of the increase in each class, both experimental and control, Gain test analysis was used. The results of the Gain test analysis are shown in Table 8.

Table 8 N-Gain Test for Experimental Class and Control Class

Class	Average N-Gain Score	Category
Experimental Class	0,74	High
Control Class	0,19	Low

Based on the N-Gain test calculations in Table 7, it is known that the increase in problem-solving abilities using the ethnoscience-based SSI approach in the experimental group was at a value of 0.74. Based on the criteria for obtaining the N-Gain Score test, the increase in problem-solving abilities in the experimental class is in the high category (g>0.7). Meanwhile, the problem-solving ability using conventional methods in the control group was at 0.19. Based on the criteria for obtaining the N-Gain Score test, the increase in problem-solving abilities in the control class is in the low category (g < 0.3).

Based on the Gain test, it is known that the average gain for the experimental class is 0.74 with the criteria for obtaining the N-Gain Score test in the high category (g > 0.7). Meanwhile, the problem-solving ability using conventional methods in the control group was at 0.19 and the N-Gain Score test was in the low category (g < 0.3). This value can be said to mean that the average gain test for the experimental class and the control class is different, in the experimental class the average is greater than in the control class. The results of this research are in line with research by Elsa Hanifa, Setiono, and Gina Nuranti (2021) which states that the SSI model which displays social problems influences students' problem-solving skills (Azizah et al., 2022).

The application of the socio-scientific issues (SSI) approach based on ethnoscience is a learning method used to train students in problem-solving. During the learning process, students learn to understand the material using the steps in the ethnoscience-based SSI learning model. 1) starting by presenting a problem for

students to solve; 2) Identifying problems with indicators of problem-solving abilities, in this step students are asked to understand the problem. This stage is the first stage in problem solving so the teacher needs to explain in more detail so that students have strong thinking to find ideas for solving problems. At this stage students can think critically and systematically; 3) Look for alternative problem solutions with problem-solving indicators, at the stage of selecting appropriate physics concepts and principles. In this step students understand the problem and determine which concept is appropriate to the problem presented; 4) Assessing alternative problem solutions, students find whether the physics approach taken in the specific conditions of the given problem is appropriate or not; 5) Answer alternative problems using coherent/appropriate answering procedure indicators. In this step students follow the mathematical rules and procedures that have been prepared precisely; 6) Concluding, students draw logical conclusions from what they answer in other words, namely coherent, focused on the objectives of the problem, and consistent in concluding.

This problem-solving ability is trained repeatedly in science learning with an ethnoscience-based SSI approach. Several problematic topics on local potential such as balloon festivals on temperature; Sikidang crater in hot material; global warming, calorific heat, and boiling heat; Toxic Gas Leak at PLTP Dieng (PT GEODIPA) in heat transfer material is a phenomenon that occurs in the Wonosobo area. This topic is familiar to students because it occurs around students' lives and can be observed directly. This makes the learning process easier because learning is more concrete so students are more interested and easier to think about. Then the measurement of problem-solving abilities follows the Heller model with 5 indicators, namely Useful description (useful description), Physical approach (physics approach), Specific application of physics (specific application of physics approach), Mathematical procedure (mathematical procedure), Logical progression (logical development) (Hidayat et al., 2017). The results of students' problem-solving abilities can be seen in the following graph in Figure 1.

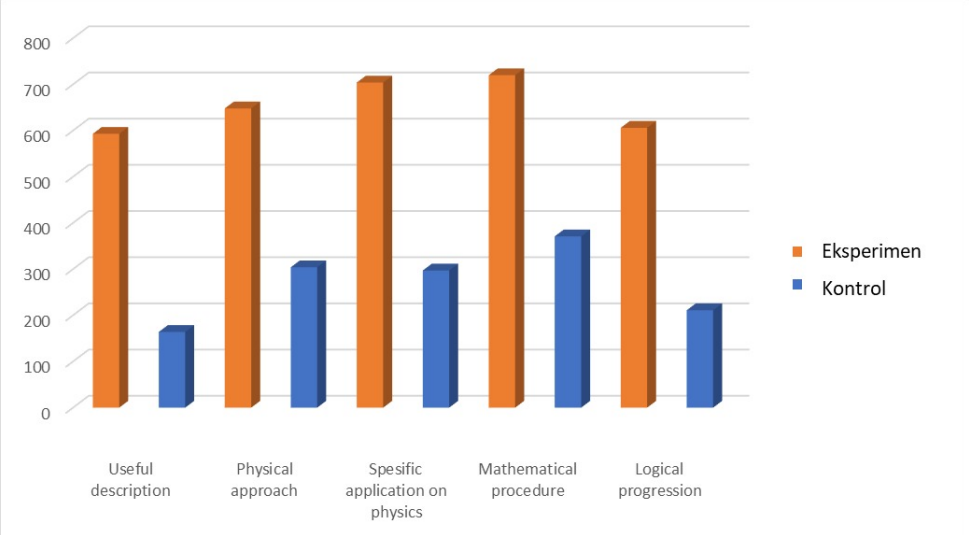


Figure 1 Graph of Students' Problem-Solving Ability

In Figure 1, it appears that problem solving abilities in all categories of the experimental class are higher than those in the experimental class. In the experimental class, learning using the SSI approach trains problem-solving skills presented in each section of ethnoscience in the lesson. The problem-solving skills

that are trained help students to think and then solve problems based on relevant theories and concepts. Problem solving requires students to discover, determine, and solve problems using logic, literary thinking, and creativity. In addition, problem-solving skills require students to connect the knowledge they have to solve or find solutions to the problems they are facing, so that learning is more meaningful.

The ethnoscience-based SSI learning model allows students to improve dialogue arguments through presentation activities, apart from that, students can also evaluate scientific information by solving physics problems, science learning is relevant to students' lives, through ethnoscience-based SSI topics. This makes learning more meaningful and the learning experience richer and more varied because it is linked to social and cultural issues around students. Because the ethnoscience-based SSI approach requires students to study and understand scientific concepts through the cultural context and environment around them. The success of this ethnoscience-based SSI approach is also inseparable from an obstacle, namely that apart from requiring adaptation of the material to the environment and culture, it is also necessary to pay attention to selecting materials that are suitable for implementing this ethnoscience-based SSI approach. If implemented, it is possible to achieve learning objectives that are used optimally and obtain optimal results. The results of this research provide an important contribution to national education that the ethnoscience-based SSI approach is effective in improving students' problem-solving abilities.

CONCLUSION

The application of the Socio-Scientific Issues (SSI) approach based on ethnoscience in learning the subject of temperature and heat applied at SMA Negeri 1 Wonosobo can increase problem-solving abilities by 81% in the very good category. There is a difference in problem-solving abilities in the experimental class and the control class, shown by the results of hypothesis testing using the t-test, t_{count} is 7.396 and the t_{table} is 2.045. There was an increase in students' problem-solving abilities of 0.74 in the high category. The impact of training in the stages of problem-solving on each topic of local problems, students have good problem-solving skills, so learning using socio-scientific issues (SSI) based on ethnoscience in learning can be applied.

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