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SCIENCE TEACHING APPROACH ETHNO-SETSaR TO IMPROVE PRE-SERVICE TEACHERS' CREATIVE THINKING AND PROBLEM SOLVING SKILLS

Winarto Winarto[1], Edy Cahyono[1], Woro Sumarni[1], Sulhadi Sulhadi[1], Siti Wahyuni[1], Sarwi Sarwi[2]

[1]Semarang State University(Indonesia)
[2]Universitas Negeri Semarang (Indonesia)

wiwin16@gmail.com, edkim@mail.unnes.ac.id, woro@mail.unnes.ac.id, sulhadipati@mail.unnes.ac.id, wahyuni.smg@mail.unnes.ac.id, sarwi_dosen@mail.unnes.ac.id

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Abstract

Pre-service teachers need creative thinking and problem solving skills to support their teaching quality. The aims of this research: (1) problems in science teaching, creative thinking and problem solving skills of pre-service teachers; (2) improvements of creative thinking and problem solving skills of pre-service teachers through Ethno-SETSaR Science Teaching Approach, and (3) relationship pattern of critical thinking and problem solving skills. The research method applied in this study was sequential exploratory mix method. The research design consisted of five stages: 1) qualitative data gathering; 2) qualitative data analysis; 3) quantitative data gathering; 4) quantitative data analysis and 5) data interpretation. The subjects of this research were 80 pre-service teachers from two universities. The research instruments were essay tests of creative and problem solving skills. The data analysis used was independent T Test. It could be concluded from qualitative study that science teaching practice was still oriented on content knowledge mastery. It did not improve creative thinking and problem solving skills. Science teaching with Ethno-SETSaR approach was applied as foundation to quantitative study. The result of quantitative study was there was difference in creative thinking and problem solving skills of pre-service teachers. The pre-service teachers enrolling science teaching with Ethno-SETSaR approach had higher scores. There was correlation of creative thinking affecting problem solving skills.

Keywords – Ethno-SETSaR, Science teaching, Creative thinking, Problem solving skills.

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1. Introduction

Science teaching has the greatest contribution for the improvement of creative thinking quality (Daud, Turiman, Omar & Osman, 2012). Pre-service teachers needs to be equipped with creative thinking to support their duty and make them able to teach individuals to use creative thinking (Bakir & Oztekin,

2014; Guo, 2014; Chia & Goh, 2016). Teachers having creative thinking skills are connected with their effective teaching practice (Davidovitch & Milgram, 2006; Newton & Newton, 2009), it affects students' creative thinking achievements (Hosseini & Watt, 2010) and improves students' interest to science (Hendrix, Eick & Shannon, 2012). However, teachers with low creativity do not improve students' creative thinking (Al-Abdali & Al-Balushi, 2015), they do not understand creativity dimension (Newton & Newton, 2009), they have difficulty in identifying ways to promote and to assess those skills in the classroom (Bolden, Harries & Newton, 2010), they are not able to facilitate the production of scientific knowledge, its model and it laws (Lotter, Singer & Godley, 2009). Creative thinking skills are supported by the habituation of problem solving thinking.

Chan (2013) states that creative thinking skills are an important matter connected with problem solving skills and creating new idea. Dogru (2008) asserts that to help students to improve problem solving skills is the main target of pre-service science teachers training. The success of students in developing problem solving depends on the skills of the teacher (Adeyemo, Babajide & Amusa, 2013), to improve students' problem solving skills (Mauke & Sadia, 2013), to teach students constructing their knowledge and taking part in knowledge acquisition (Karatas & Baki, 2013), to train students' autonomy (Snyder & Snyder, 2008 in Christiyoda, 2016), and stimulate students to apply their knowledge in creative ways and to build deep understanding (Crebert, Patrick, Cragnolini, Smith, Worsfold & Webb, 2011). The results if the teachers do not have sufficient problem solving skills is that they are: not able to train students to apply their knowledge in creative ways and to build deep understanding (Crebert et al., 2011), not able to improve their students' problem solving skills (Robert, MacLin & MacLin, 2010), and as a result the students would not able to solve complex problems in their daily lives (Ulger, 2018).

Previous research on the importance of creative thinking and problem solving skills need to be taught to pre-service teachers. One of efforts to improve those skills is to present science teaching with cultural approach integrated with science, environment, society, religion aspects and it is defined as Ethno-SETSaR. Community knowledge resulting from the cultural process and being studied is one of the innovations in science learning (Joseph, 2010; Sudarmin, 2014; Sarwi, Ellianawati & Suliyanah, 2019; Snively & Corsiglia, 2011). Stanley and Brickhouse (2001) suggests to balance between western science (normal science taught at a school) and indigenous science (traditional science) in a science teaching using cross-cultural approach.

SETS is a science learning approach that provides interdisciplinary studies (science, technology, environment, and society) (Chowdhury, 2016; Zoller, 2000; Pedretti & Nazir, 2011). Essential aspects in SETS teaching are critical social reconstruction, decision making, and sustainable actions (Rosario, 2009). Lately, the trend is STEM research. STEM research has a similar form to SETS in that it presents learning that presents connections between scientific fields. STEM has the meaning of teaching and learning related to Sciences, Technology, Engineering, and Mathematics to improve students' abilities through learning contextual (Kuenzi, 2008). STEM itself focuses on the application of each field of science, while SETS pays attention to environmental and societal aspects of the use of science and technology. because ethnoscience is used as a learning resource, the SETS approach was chosen as a way to learn science from the local wisdom of the community in terms of aspects of science, technology, society and the environment. The novelty in this research is that the religious aspect is used in studying local wisdom.

Humans often forget that the application of science in the form of technology often causes havoc for humans and the environment without regard to religious aspects. Therefore, apart from studying science, students must also get used to learning that integrates technology, environment and society and religion (SETS-aR). SETS research integrated with religion was done by Ahmed (2018) concluded that it could improve students' motivation at Najran University, Saudi Arabia. SETS research integrating religious values in Indonesia was conducted by Wahyuni, Astuti and Yuliati (2017) concluded that students experienced improvements on the aspects of religious attitude, discipline, and responsibility. Rahmaniati and Supramono (2015) argues that SETS could improve students' skills on decision making to problems

and relate them with religious values This approach is a starting point or a point of view to teaching process to achieve learning objectives (Arends, 2012).

The aims of this research are determine the improvement of problem solving skills and creative thinking of prospective teachers after participating in learning with the Ethno-SETSaR approach. Science teaching program through Ethno-SETSaR approach presents science basic concepts teaching that studies Javanese indigenous science (ethnoschience) and it is studied based on the aspects of science, environment, technology, society, and religion. Research on science teaching program through Ethno-SETSaR approach has novelty of integrating indigenous science from a society viewed from SETS and religion aspects. Previous research only studied STS and SETS and it did not yet study religious aspect.

Previous studies proved teaching that promotes ethnoscience and it is connected with science concepts will be able to improve creative thinking, problem solving, and communicative skills. Nieto and Booth (2010) explains that the integration of culture in various professions will become a determining factor of meaning in a professional service including educational service. Thus, teachers must be able to promote cultural elements to be accommodated in teaching practice. Ethnoscience is based on Vygotsky theory emphasizing on the interaction among interpersonal (social), cultural- historical, and individual factors as keys to human development (Wahyu, 2017). Vygotsky theory of learning emphasizes that human beings intelligence comes from the society, the environment and their culture. This theory also confirms that individual's cognitive acquisition occurs in the first time thorough interpersonal (interaction with the social environment) and intrapersonal (self-internalization) (Sumarni, 2017).

Ethnoscience teaching could be easily felt, sensed, and it is frequently found in students' daily life. Hence, it could provide meaningful teaching to them. In addition, this contextualized teaching causes the students to easily understand the learning material (Wati, Hartini, Misbah & Resy, 2017; Fuad, Misbah, Hartini & Zainuddin, 2018). The characteristic of ethnoscience is the transformation through observation, clarification, and problem solving from science and culture existing in the society (Aboyi, 2002) using scientific investigation (Sudarmin, 2014), and science reconstruction process of indigenous science to scholastic science (Ogawa, 2007). Sudarmin (2014) proposes that science teaching which integrates ethnoscience has three forms namely complementative model, integrated model, and distinct model. Previous research results showed that enthnoscience approach trained students to be able to think creatively (Khoiri & Haryanto, 2018), to solve problems (Supriyadi, Haeruddin & Nurjannah, 2016; Novia, Nurjannah, & Kamaluddin, 2015), to improve learning activities (Rahmawati, Subali & Sarwi, 2019), cognitive learning achievements and critical thinking skills (Afrianawati, Sudarmin & Sumarni, 2016), science literacy and character (Alim, Sarwi & Subali, 2019), interest of learning science (Fasasi, 2017), to increase understanding and motivation or interest (Holbrook & Ranikmae, 2009; Middleton, Dupuis & Tang, 2012).

SETS teaching is the development of STS (*Science Technology, Society)* teaching (Chowdhury, 2016). SETS approach is innovative teaching connecting science and technology applied to societal problems related to the environment (Zoller, 2000). The purpose of SETS is to provide interdisciplinary knowledge between science, technology, the environment and the society, and to develop/ to improve critical thinking, decision making, and higher order thinking skills (Zoller, 2012). The characteristics of SETS learning are (a) teach the nature of science, (b) students are trained to apply science concepts with technology, (c) students are trained to think about the impact on society and the environment from the application of science and technology (4) students are asked to explain the relationship between elements – elements of SETS (5) In the context of constructivism, students can make decisions about solving problems that apply science and technology, and their impact on the environment and society (Binadja, 2005; Lau, 2013). SETS research integrating religion conducted by Ahmed (2018) concluded that it could increase students' motivation at Najran University, Saudi Arabia. SETS research integrating religion in Indonesia was done by Wahyuni et al. (2017) came into conclusion that students experienced improvement in religious attitude, discipline and responsibility. Rahmaniati and Supramono (2015) suggested that SETS could improve students' skills on decision making to problems and they could relate it to Islamic values. Rahmah,

Mulyani and Masyikuri (2017) explained that SETS integrating Islamic values could increase conceptual understanding. Hervina-Emzulia (2014) found that science teaching with SETS could improve motivation and conceptual understanding, providing a meaningful learning activity (Gamal & Mahalle, 2012; Taskin, 2014) and thinking skills (Khasanah, 2018). Views, opinions, attitudes, and knowledge would be built by a person through interaction with socio-cultural context in one's life time and it is interpreted according to the religion the person believe in (Mansour, 2010).

Ethno- SETSaR approach is the way of students' learning to connect indigenous knowledge from the society and it is studied from scientific and technological aspects used by a society to solve problems they encounter with concern to environmental preservation in the context of a Javanese society. That approach is considered to be able to improve creative thinking and problem solving skills. Sternberg (2003) suggests that creative students teaching should be conditioned through information processing, to make, to find, to explore and to imagine, to present, to apply, and to transform scientific knowledge. The students are encouraged to develop interesting science with various scientific observations, clarification, suggesting scientific questions, forming a hypothesis, planning an experiment and its measurement method, using tools and instruments, and drawing conclusions from empirical data (Cheng, 2011). Teaching that improves problem solving skills is conducted by presenting problems and connecting them with daily life (Heller & Heller, 2010; Jonassen, 2011). A scientific investigation activity could facilitate creative thinking and problem solving skills (Cheng, 2011; Dinica, Dinescu, Miron & Barna, 2014; Joseph, 2010).

Learning model applied is based on a selected approach (Arends, 2012). The learning model used in this research is inquiry- based outdoor learning. Outdoor learning could be integrated with inquiry approach with potential to affect students' learning achievement in the aspect of cognitive, affective and psychomotor (Santiningtiyas, Prasetyo & Priyono, 2012). Science teaching could be implemented in every educational level because in the teaching process the students are involved maximally to develop their thinking ability, working and scientific attitude (Rustaman, 2012; Sarwi et al., 2019). A Study by Baihaqi, Sarwi and Ellianawati (2020) showed that guided inquiry learning improved students' communication skills. Inquire outdoor learning improved higher order thinking skill , students' motivation (Matthew & Kenneth, 2013), scientific working ability (Yildirim, Kurt & Güneş, 2014), critical thinking (Kitot, Ahmad & Seman, 2010), creative thinking (Wahyudi, Verawati, Ayub & Prayog, 2018), problem solving (Zulfiani, Yunistika & Juanengsih, 2018). Inquiri learning is able to improve students' communication skills (Sarwi, Fauziah & Astuti, 2018). Ethno-SETSaR approach with inquiry learning activities is considered to be able achieve planned learning objectives. Learning model applied in this research was inquiry learning. Learning method applied as learning procedure was investigation, discussion, assignment and presentation. Science learning model through Ethno-SETSaR approach is presented on Figure 1.

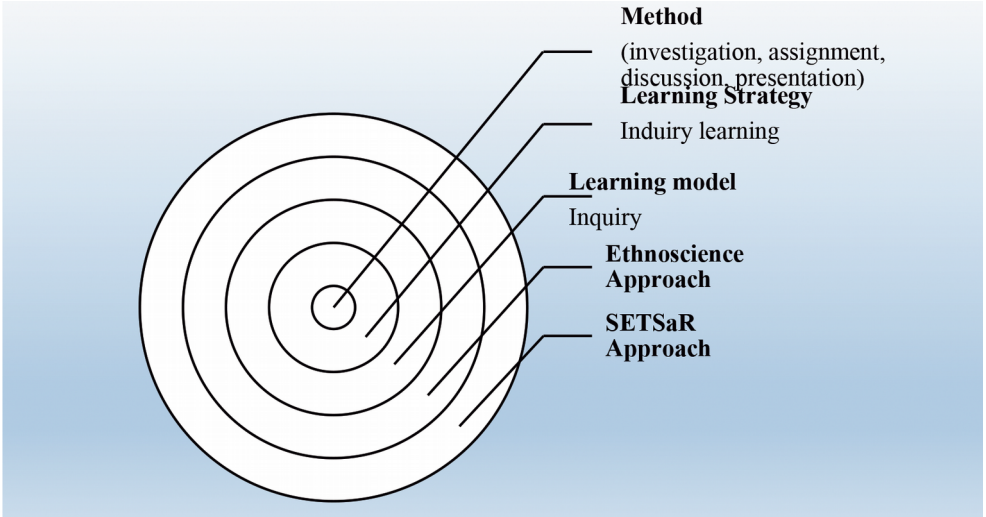

Figure 1. Ethno-SETSaR approcah

1.1. Creative Thingking Skills and Measurement

Creative thinking emphasizes on mental process to use various strategies to solve problems, to analyze from various perspectives, to adapt idea, to make a new solution, and to evaluate new idea (Torrance, 2006; Strenberg, 2003). Creativity is connected to finding new solutions (Cropley, 1997), generating new ideas, solutions or answers (Duff, Kurczek, Rubin, Cohen & Tranel, 2013) which is related to problem solving (Crilly, 2015). Creative thinking dimension based on experts' opinions refers to uniform conclusion on the use of creative thinking variable consisting of fluency, flexibility, elaboration and originality. Study on creative thinking done by previous researchers used testing technique. The testing instrument developed by Torrance (1974) is called The Torrance Tests of Creative (TTCT). Worthington and Whitaker (2006) measures students' creative thinking through exploring students' products representing their creative thinking process communicated by them by verbal or in written forms. Silver (1997) expresses another way to measure creative thinking ability using open-ended questions. According to Livne (2008) open-ended questions are the questions having various correct answers. Subali (2011) and Istiyono, Dwandaru & Rahayu, (2018) develop test instrument in the form of multiple choices to measure creative thinking ability.

1.2. Problem Solving Skills and Measurement

Problem solving is cognitive skills used to solve problems related to real life (Organization for Economic Co-operation and Development – OECD, 2003) with new, creative, systematic, and analytic ways (Bachtiyar & Can, 2016). Problem solving ability is connected to critical thinking, analytical thinking, creating productively where it as a whole involves quantitative, communicative skills, and the ability to respond critically (Chang, 2010). Selcuk, Çalýþkan and Erol (2008) states that problem solving skills consist of ability to understand problems, to plan and to implement the problem solving, and to evaluate problem solving solutions. The ways to measure problem solving skills done by educational experts are different. Istiyono, Mustakim, Widihastuti, Suranto and Mukti (2019) develop instruments in the form of multiple choices to measure problem solving ability. Greiff, Stadler, Sonnleitner, Wolff and Martin (2015) use multiple complex system to measure problem solving skills. Multiple complex system connects autonomous inter-items into a complex problem. Problem solving skills tests developed by Butterwoth and Thwaites (2013) rely on four indicators of problem solving ability: (1) merging skills and using imagination, (2) developing a model, (3) conducting an investigation, and (4) analyzing and concluding data. The measurement of problem solving skills done Jonassen (2011) are: problem schemata, analogy, causal, and argumentation. Problem solving ability on this study is the process of thinking to understand, to plan, to apply the plan, and to evaluate the problem solving plan.

2. Methodology

This research employed both quantitative and qualitative method or it was called mixed method. Applied research design was sequential exploratory design. This design begins with a qualitative study to formulate a research problem. The results of this study are used as the basis for conducting further studies to conclude based on quantitative studies (Creswell & Clark, 2011). The design of this research consisted of five stages, those are: 1) qualitative data gathering on creative thinking and problem solving skills accomplishments of pre-service teachers, problems on the teaching of science basic concept and the need analysis of science teaching program; 2) conducting qualitative data analysis obtained in the first stage to gain research questions; 3) quantitative data gathering, validating science teaching instruments with ESETSaR approach to experts, and experimental study on the design of non-equivalent control group, and measuring research variables; 4) quantitative data analysis through measuring Gain index, verifying independent test, finding the pattern on creative thinking skills relationship, and; 5) interpreting data and concluding the results of qualitative and quantitative study.

The sample of this research were 80 pre-service teachers from two universities with the same curriculum. The sample consisted of 10 men and 70 women. 20 samples came from West Java and 60 from Central Java. Sample gathering technique used purposive sampling. Instruments validation was analyzed by Partial

Credit Model (PCM) using QUEST software. Some consideration in using PCM was the availability to use sample not in the amount of polytomous data calibration using 2-PL or 3-PL model (Keeves & Masters, 1999; Subali & Suyata, 2012). QUEST program also presents a test reliability result as internal consistency index, for polytomous scoring is Cronbach alpha and for dichotomous scoring is KR-20 index (Adam & Khoo, 1996). The results of the development of the instrument as many as 19 items met the validity and reliability of the 21 items compiled. The instrumen which is using partial credit model based on the three categories in the polytomous data. Instrument reliability was 0.77 and it was concluded that the instruments were good to measure.

Data from qualitative study of science teaching problems, creative thinking and problem solving skills was analyzed by several steps. Those were: research data obtained, simplified, and focused. It also drawing data, and interpreting data (Miles, Huberman & Saldana 2014). Data from quantitative study was calculated according to gain score by Hake (1998) to investigate the improvement of creative thinking and problem solving skills. Independent T test was applied to determine the difference of inter- group creative thinking and problem solving skills. Correlation test was used to determine whether or not there was correlation between creative thinking and problem solving skills.

3. Result and Discussion

The qualitative study was conducted to analyze science teaching problem to pre-service teachers and to analyze teaching that could solve the problems. Science teaching problem was that time it was conducted with an orientation of science concept mastery only. Teaching method did not provide direct learning experience with the object (hand on science) and an inquiry activity because the teaching practice was conducted in the classroom and it had less connection between science and daily life. The teaching was conducted with presentation and discussion method. Thus the teaching was considered boring and it was viewed as a difficult subject because it contained full of concepts, formulas, mathematical calculations, and it did not yet develop science process skills. Applied teaching media did not yet meet the requirements for science concept subject. In addition, science teaching did not develop creative thinking skills because real problems in daily life to be solved were not presented. Science teaching did not quite facilitate thinking process that produced a solution of a problem. Not all pre-service teacher students learned much science concepts on their previous studies, so they were not too confidents to be successful in understanding the teaching. Teaching assessment only measured science concept mastery and it did not have an orientation of measuring higher order thinking skills.

Science teaching connecting science and community culture and discussing its problems to gain the solutions through SETSaR aspect study with an inquiry learning activity was considered to be able to improve creative thinking and problem solving skills of pre-service teachers. That hypothesis was formulated based on the literature review of the advantages of science teaching presenting inquiry learning activity, connecting science concepts and scientific knowledge owned by the society and it was produced from cultural activities studied from SETSaR aspect. The results of qualitative study was used as foundation quantitative study to investigate the effectiveness of science teaching through Ethno-SETSaR approach to improve creative thinking and problem solving skills of pre-service teachers. The results of qualitative study concluded the importance of presenting science teaching that connected with the real life, inquiry activities to scientific objects, and improvements of creative thinking and problem solving skills to pre-service teachers so science teaching objectives could be accomplished.

It was an experimental study of three groups to basic science concept subject. The teaching was conducted online by Zoom application. It was conducted in seven meetings. Learning activities blended online and offline mode. The online learning was used to facilitate inquiry planning and offline learning activities were used to apply a group inquiry. The science teaching studied three topics of Cirebon shrimps paste, stingrays smoking, and Sidoarjo fish farm.

The data of creative thinking skills from group 1, 2, and 3 were taken after the experiment had been done. The group 1 and 2 were given the treatment of science teaching though Ethno-SETSaR approach and

group 3 had science teaching through lecture and discussion. Data collected were calculated based on their gain score. The improvement of creative thinking and problem solving skills was presented on Table 1.

Data of creative thinking and problem solving skills on group 1, 2, and 3 were analyzed by independent T test. Hypothesis testing result using independent T test between group 1 and 3 and group 2 and 3 showed significant difference on the achievement of creative thinking and problem solving skills. The results of independent T test of creative thinking and problem solving skills were presented from Table 2 to Table 5.

The result of correlation test between creative thinking and problem solving skills on experiment class group of group 1 and group 2 was 0.179. The results of correlation test was presented on Table 6.

Variable	Subject	Average Pre-test	Average Post-test	Average Gain Score	Achievement Level
Creative thinking	Group 1	1.33	6.36	0.30	Medium
	Group 3	1.36	2.36	0.05	Low
	Group 2	0.35	5.75	0.30	Medium
Problem Solving	Group 1	14.5	29.7	0.31	Medium
	Group 3	18.4	25.8	0.17	Low
	Group 2	3.75	21.5	0.30	Medium

Table 1. Creative thinking and problem solving skills on group 1 and 3

Variable	F Value	Sig.	T value	Hypothesis Testing Results
Creative thingking	36.898	.000	27.025	There is a significant difference

Table 2. Differentiation test of creative thinking skill on group 1 dan group 3

Variable	F Value	Sig.	T value	Hypothesis Testing Results
Creative thingking	16.272	.000	19.012	There is a significant difference

Table 3. Differentiation test on creative thinking skills on group 2 and group 3

Variable	F Value	Sig.	T value	Hypothesis Testing Results
Problem solving skills	36.898	.000	27.025	There is a significant difference

Table 4. Differentiation of problem solving skills on group 1 and group 2

Variable	F Value	Sig.	T value	Hypothesis Testing Results
Problem solving skills	16.272	.000	19.012	There is a significant difference

Table 5. Differentiation Test of Problem Solving Skills on Group 2 and Group 3

		Problem solving skills	Creative thinking skills
Problem solving skills	Pearson Correlation	1	.179
	Sig. (2-tailed)		.112
	N	80	80
Creative thinking skills	Pearson Correlation	.179	1
	Sig. (2-tailed)	.112	
	N	80	80

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6. Correlation test on creative thinking and problem solving skills

Problem solving and creative thinking skills experienced an improvement on group 1 and 2 applying Ethno-SETSaR with medium category. The group not applying Ethno-SETSaR experienced low improvement. The experiment class was better than the control class when it was viewed from the result of gain score. Hypotheses testing with independent t test parameter to the experiment and the control

group showed there was significant difference of creative thinking and problem solving skills with significant level of 5%. Correlation testing between variable of problem solving and creative thinking skills resulted in correlation value of 0.179.

The improvement on problem solving and creative thinking on the experiment class applying Ethno-SETSaR teaching was considered as a result of learning activities facilitating process improving those two thinking skills. The teaching presented problems faced by communities from Cirebon shrimp paste making, Cilacap stingray smoking, and Sidoarjo milkfish farming. Those problems were investigated in group learning to find the best solution. In the process of finding the best solution, students studied aspects of science, technology, community, the environment, religion from local wisdom. Teaching done by presenting the problems and by initiating exploration to find the solution facilitated the emergence of creative thinking and problem solving process.

The difference between the experimental class and the control class is because the science learning program with the Ethno-SETSaR approach facilitates and trains creative thinking, problem solving, and communication processes. The stages of learning activities in this program are (a) finding problems; (b) formulate the problem formulation; (c) formulate hypotheses; (d) examine ethnoscience from the aspect of SETSaR, (e) prove the hypothesis; (f) solution evaluation; (g) define solution.

Learning the basic concepts of science using the Ethno-SETSaR approach was carried out for 7 times. The lesson examines three themes, namely making Cirebon shrimp paste, Cilacap smoked fish, and Sidoarjo milkfish ponds. Learning activities are carried out in groups. The group compiles an investigation report in accordance with the instructions contained in the teaching materials. Learning is equipped with teaching materials that have been compiled and validated. Teaching materials contain learning resources that are accessed online such as YouTube which contains content for making shrimp paste, smoking fish, and milkfish ponds in Sidoarjo. Learning is done through internet mode using the zoom meeting application and recording is done and the breakout room feature is available. The first learning phase, the theme of making terasi Cirebon begins with presenting problems obtained from online newspapers such as the reduced catch of rebon by farmers as a result of the construction of a Steam Power Company (PLTU) on the Cirebon coast, fishermen who do not go to sea during the rainy season so that the availability of rebon is reduced. In addition, the process of making shrimp paste, which depends on the weather to dry the bamboo shoots, is a problem faced by shrimp paste craftsmen. There is a new problem, namely the use of artificial dyes that are dangerous for consumption by several shrimp paste craftsmen. The problems with the theme of smoking fish in Cilacap are smoke pollution from the smoking process of fish, reduced fish catches during the rainy season, and liquid waste from the smoking process of fish. The problem with the Sidoarjo milkfish pond process is that winter makes milkfish farmers delay their harvest, and industrial pollution that flows into the pond.

Presenting problems, formulating problem formulations and formulating hypotheses in learning are thought to train the development of creative thinking and problem solving. Science learning that trains problem solving by presenting real problems to students. The problem solving process trains cognitive processes so that they are accustomed to recognizing problems, planning, and evaluating solutions (Chan, 2013). Good mastery of concepts will make it easier for students to be able to learn the relationship between the problems given. Students must recognize and understand patterns between problems and choose the best way as a solution to overcome them (Bachtiyar & Can, 2016). Creative thinking skills are supported by habituation of problem solving thinking. Chang (2010) states that problem solving skills are generally seen as abilities to think critically, think analytically, and to create productively, all of which involve quantitative abilities, communication skills, and the ability to respond critically.

In the next learning stage, students explore information from the SETSaR (Science, Environment, Technology, Society, and Religion) aspect. Students explore information on scientific aspects of the process of making Cirebon shrimp paste, smoking Cilacap fish, and Sidoarjo milkfish ponds such as the concept of unit size in measuring shrimp paste raw materials, the concept of material changes in making shrimp paste. The concept of temperature and heat from the smoking process of Cilacap fish, studied the

ecology of the Sidoarjo milkfish pond process. How to prepare land for ponds, provide fertilizer to trigger the growth of phylloplankton, the process of cleaning the ponds according to the size of the fish, the process of replacing pond water becomes a source of learning science for prospective teachers. The activity of analyzing various aspects provides interdisciplinary knowledge between science, technology, environment, and society as well as the development/improvement of critical thinking, decision making, and higher order thinking skills (Zoller, 2012). The advantages of SETS form graduates who have the ability to reason and think comprehensively when students are faced with a problem to solve (Binadja, 2005).

After exploring the SETSaR aspect, the next activity is hypothesis testing by conducting an investigation to find the best solution to the problems at hand. The COVID-19 pandemic has caused the government not to allow face-to-face learning, investigative activities by conducting literature studies in scientific journals/research reports/papers according to topics studied on the internet to find problem-solving solutions. In this activity, students are given the freedom to find more than one solution. Research activity on the shrimp paste theme, students reported solutions such as the use of roselle flowers and dragon fruit skin to increase the color of the shrimp paste and is safe if consumed. For the problem of drying rebon and shrimp paste dough using Tray-Driyer technology, rebon ponds on the beach, Lorong type drying technology. For the theme of smoking Cilacap fish, the solution presented by the group was modification of a cabinet-type fish smoking device to overcome air pollution. fish storage system with the ALDI system (refrigerated sea water or RSW (refrigerated sea water) to overcome the scarcity of fish during the rainy season, utilizing palliasa leaves as an alternative material for alum to maintain fish freshness and keep fish durable, using dryers using wind power to drying fish in the smoked fish production process so that it does not depend on the weather Safety factor for fish dryers based on solar and biomass technology using the finite element analysis method The solution presented by the group for the problem of milkfish ponds in Sidoarjo is Wastewater Treatment with Waste Stabilization Ponds), design and build a floodgate control system in IOT-based milkfish (chanos-chanos) ponds, mangrove plants to reduce waste, Hybrid System methods to manage pond water quality.

The evaluation stage and determine the solution/conclude is a learning activity to analyze the advantages and disadvantages of the solutions found from the previous stage. The solution to using dragon fruit skin as a natural dye for making terasi Cirebon, students wrote about its advantages, such as being safe for the human body, can be done with simple tools owned by farmers. However, for the shortcomings of this solution, the availability of dragon fruit and having to diligently look for dragon fruit skins that are obtained in large quantities, requires a fee to buy dragon fruit/skin. The solution to the problem of milkfish ponds in Sidoarjo is the Internet of Things for a water quality monitoring system in shrimp ponds. The advantage is that the system not only monitors water content but also controls water quality automatically. In addition, it is more practical because water quality information can be directly accessed on a smartphone. However, the drawback is that errors can occur in the delivery of water quality information. In addition, to build the technology requires a fee. The evaluation phase and determining the solution is thought to facilitate the problem solving thinking process.

The teaching which improves problem solving skills is done by presenting real problems could raise challenge and students' motivation to get involved in the problem solving process. Thus, the problems need to be related with daily life (Heller & Heller, 2010; Jonassen, 2011). Problems presented to train the students are structured, unstructured, complex, and diverse problems (Dixon & Brown, 2012). Problems presented in a teaching could also make the students to construct their knowledge and to take part in knowledge acquisition (Karatas & Baki, 2013). Students frequently trained to identify and to understand patterns among problems would be able to select the best way as a solution to solve the problems (Bachtiyar & Can, 2016). To gain creativity and problem solving skills through discovery activities, teachers could ask students to do an independent investigation or they could involve in students divergent thinking training in science process skills. The students are encouraged to develop interesting and diverse science, to do a scientific observation, to classify, to ask scientific investigation questions, to propose hypothesis, to

plan an experiment and its measurement, to use instruments, and to make conclusions from empirical data.

Aksoy (2005) found that science teaching based on scientific method process in creative thinking improved students' creative thinking, academic achievements, and their attitudes toward science subject. Creative thinking skills are generated from learning activities presenting problems, investigating and gaining solution to the problems. Teaching that involves science process skills at schools is very important to encourage creative thinking and to develop potency and the chance of those involving in scientific professions (Meador, 2003). Sternberg (2003) suggests in a creative student teaching to facilitate through information processing, creating, discovering, exploring and imagining, presenting, applying and transforming scientific knowledge. The students are encouraged to develop interesting and diverse science, to do a scientific observation, to classify, to ask scientific investigation questions, to propose hypothesis, to plan an experiment and its measurement, to use instruments, and to make conclusions from empirical data (Cheng, 2011). Science teaching presenting investigation activities and developing process skills could improve individuals' creative thinking skills who study science.

The improvement of creative thinking and problem solving skills of pre-service teachers on an experiment class through learning activities based on local wisdom and studying its problems to find the solution to problems in the society. Ethnoscience teaching could be easily felt, be observed directly, and be frequently found would give meaningful learning to students. In addition, this contextualized teaching makes students easy to understand the learning materials (Wati et al., 2017; Fuad et al., 2018). Research result concluded that ethnoscience trained students to think creatively (Khoiri, Kahar & Indrawati, 2018), to be more active and be appreciative toward their own regional potential (Khoiri & Haryanto, 2018), to improve their positive attitude towards science and to develop their own creative thinking in a learning environment (Sener, Türk & Taş, 2015; Kutlu & Gökdere, 2015), to improve their creative thinking (Pirto, 2011; Adams, Miller, Craig, Nyima, Droyoung & Varner, 2005), their problem solving skills (Supriyadi et al., 2016; Novia et al., 2015), their learning activities (Rahmawati et al., 2019), cognitive learning achievements and critical thinking (Afrianawati et al., 2016; Falah, Windyariani, & Suhendar, 2018), entrepreneurship character (Febu, Sudarmin, Sumarni & Nuswowati, 2017), attitude towards science (Fasasi, 2017), science literacy (Alim et al., 2019), and scientific communication (Asnawi, Nuroso & Patonah, 2017).

This research was in line with research results by Khoiri et al. (2018) that ethnoscience teaching trained students to be able to think creatively, to solve problems (Supriyadi, et.al., 2016; Novia et al., 2015), to improve cognitive learning outcomes and creative thinking skills (Afrianawati et al., 2016), science literacy and their noble characters (Alim et al., 2019), their entrepreneurship character (Febu, et al., 2017), interest to learn science (Fasasi, 2017), to improve their understanding and motivation or interest (Holbrook & Ranikmae, 2009).

Improvements on creative thinking and problem solving skills of pre-service teachers on an experiment class because the teaching presents real problems, and the solution of the problems by studying aspects of science, technology, the society, the environment and religion. SETS facilitated students to find SETS concepts and their connections to solve problems found in daily life (Binadja, 2005). SETS improved students' ability to apply their scientific knowledge to understand the connection between what they had learned in the classroom and problems they faced in daily life to realize meaningful science teaching (Pedretti & Nazir, 2011).

This research was in line a study conducted by Chamapimuk, Sawangmek and Nangngam (2018) and Yalaki (2016) concluding that SETS could optimize science literacy accomplishments, career planning (Yoruk, Morgil & Secken, 2009); attitude towards science (Ackay & Ackay, 2015), motivation (Cigdemoglu, 2015); concepts mastery (Yoruk et al., 2009), decision making, argumentation, and explanation skills (Yoruk et al., 2009), problem solving (Chowdhury, 2016), higher order thinking skills (Zoller, 2012), critical thinking (Ghofur & Raharjo, 2018), scientific generic skills (Lathifah, 2014; Susilogati, Binadja & Hidayah, 2014), and scientific thinking (Retno & Marlina, 2018).

The aspect of religion in this research is the ways in which certain people use a culture that has been passed down from generation to generation, such as to be grateful for the abundant sea harvest, fishermen hold the nadran tradition. Religious aspect in science teaching with Ethno- SETSaR approach was religious tradition practiced for generations as ancestor heritage; *nadran* tradition of Cirebon and Cilacap fishermen, and *maulud nabi* (Prophet Muhammad's Birthday Celebration). were examples of subjects to be studied in local wisdom discussion. *Nadrat* tradition started with cutting of a buffalo head and *tumpeng* rice prepared in a *meron*. That buffalo head was wrapped in white cloth with other custom instruments were floated to the sea by throwing and it was done to ask for abundant sea products and as a form of their gratitude. It was done as offerings by several ornamental ships. Milkfish auction tradition as part of tradition series done during *maulud Nabi Muhammad.* In this *maulud* celebration, there were *solawatan* (prayers) and *kenduren* (gratitude expression ceremony). In *kenduren,* the main course offered is *tumpeng* rice and milkfish as the main side dish. The milkfish is considered a special dish that must be presented during a custom or a religious ceremony. SETS research integrated with religion was conducted by Ahmed (2018) concluding that it imporved students' motivation at Najran University, Saudi Arabia. SETS research in Indonesia integrating religious values was conducted by Wahyuni et al., (2017) concluding that students experienced improvements on religious attitudes, discipline and responsibility. Rahmaniati and Supramono (2015) stated that SETS could improve students' decision making skills on problems they faced and they could connect them to Islamic values. Rahma et al., (2017) stated that SETS integrated to Islamic values could improve students' conceptual understanding. Hervina-Emzulia (2014) argued that science teaching integrating SETS improveed students' motivation and conceptual understanding, provided meaningful learning experience (Gamal & Mahalle, 2012; Taskin, 2014), and thinking skills (Khasanah, 2018). Views, opinions, attitudes, and knowledge would be constructed by an individual through interaction process in socio-cultural context on one's life time and they are translated or understood based on one's religious values (Mansour, 2010). The limitation of this study is that the sample used is not large. In addition, this research was conducted using an online mode so that student activities were limited when conducting an investigation

4. Conclusion and Implication for Further Research

Science teaching using Ethno-SETSaR approach could improve creative thinking and problem solving skills of pre-service teacher with medium category. There was correlation between creative thinking and problem solving skills with the value of 0.179. This research provides learning information that improves creative thinking and problem solving skills of prospective teachers by presenting problems related to ethnoscience and examined from the SETSaR aspect. Subsequent research examines ethnoscience in the territory of Indonesia and relates to the study of basic science concepts for prospective teachers. This study has limitations, namely not all topics of basic science concepts can be related to ethnoscience in Java. In addition, this study was conducted for seven meetings. While the lecture is designed for sixteen meetings.

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References

Aboyi, O.S. (2002). Effects of ethnoscience-based instructional package on students' interest in science. *Journal of the Science Teachers Association of Nigeria*, 37(1-2), 60-68.

Adams, R.J., & Khoo, S.T. (1996). *QUEST: the interactive test analysis system version 2.1.* Victoria: The Australian Council for Educational Research.

Adams, V., Miller, S., Craig, S., Nyima, S., Droyoung, L., & Varner, M. (2005). The challenge of cross-cultural clinical trials research: Case report from the Tibetan autonomous region, People's Republic of China. *Medical Anthropology Quarterly*, 19, 267-289. https://doi.org/10.1525/maq.2005.19.3.267

Adeyemo, S.A., Babajide, F.T., & Amusa, J.O. (2013). The Relationship among Teachers' Problem Solving Abilities Students' Learning Styles and Students' Achievement in Physics. Department of Science and Technology Education, University of Lagos, Lagos, Nigeria. Australian *Journal of Basic and Applied Sciences*, 7(4), 654-660.

Afrianawati, S., Sudarmin, & Sumarni, W. (2016). Model pembelajaran kimia berbasis Ethnosains untuk meningkatkan kemampuan berpikir kritis siswa, *Jurnal Pengajaran MIPA*, 21(1), 46-51.

Ahmed, G. (2018). Effectiveness of Science, Technology, Society, and Religion (STSR) on Achievement of Curricula Course and Development of the Inclinations Towards Study for Students at Najran University in KSA. Available at: https://ssrn.com/abstract=3355721 https://doi.org/10.2139/ssrn.3348254

Akcay, B., & Akcay, H. (2015). Effectiveness of science-technology-society (STS) instruction on student understanding of the nature of science and attitudes toward science. *International Journal of Education in Mathematics, Science and Technology*, 3(1), 37-45. https://doi.org/10.18404/ijemst.50889

Aksoy, G. (2005). *Create a button science education scientific method processbased learning products, the effect of UNMEE.* Master's thesis. Zonguldak: Zonguldak Karaelmas University.

Al-Abdali, N., & Al-Balushi, S.M. (2015). Teaching for Creativity by Science Teachers in Grades 5-10. *International Journal of Science and Mathematics Education,* 14, 251-268. https://doi.org/10.1007/s10763-014-9612-3

Alim, Sarwi, & Subali, B. (2019). Implementation of Ethnoscience-based Guided Inquiry Learning on The Scientific Literacy and The Character of Elementary School Students. *Journal of Primary Education*, 8(5), 139-147.

Arends, R. (2012). *Learning to Teach. Tenth Edition.* New York: McGraw-Hill Education

Asnawi, S.N., Nuroso, H., & Patonah, S. (2017). Pengaruh Model Pembelajaran TTW Berbantuan Bahan Ajar Berbasis Ethnosains terhadap Penguasaan Konsep dan Komunikasi Ilmiah. *Prosiding Lontar Physics Forum,* IV, 193-197.

Bachtiyar, A., & Can, B. (2016). An investigation of problem-solving skills of preservice science teachers, *Educational Research and Reviews Academic Journal,*11(23), 2108-2115. https://doi.org/10.5897/ERR2016.3054

Baihaqi, M., Sarwi, S., & Ellianawati, E. (2020). The Implementation of Project-Based Learning With Integrated STEM in Distance Learning. Educational Management, 9(2), 223-232. Retrieved from https://journal.unnes.ac.id/sju/index.php/eduman/article/view/39982

Bakir, S., & Oztekin, E. (2014). Creative thinking levels of preservice science teachers in terms of different variables. *Journal of Baltic Science Education*, 13(2), 231-242. https://doi.org/10.33225/jbse/14.13.231

Binadja, A. (2005). *Pedoman Praktis Pengembangan Rencana Pembelajaran Berdasar Kurikulum 2004 Bevisi dan Berpendakatan SETS SETS (Science, Environment, Technology, Society) atau (Sains, Lingkungan, Teknologi, dan Masyarakat)*. Laboratorium SETS Universitas Negeri Semarang.

Bolden, S.D., Harries, T., & Newton., N. (2010). Pre-service primary teachers' conceptions of creativity in mathematics. *Educational Studies in Mathematics*, 73(2):143-157. https://doi.org/10.1007/s10649-009-9207-z

Butterworth, J., & Thwaites, G. (2013). Thinking Skills: Critical Thinking and Problem Solving (2nd ed.). UK: Cambrige University Press.

Chamapimuk, K., Sawangmek, S., & Nangngam, P. (2018). Using Science, Technology, Society, and Environment (STSE) Approach to Improve the Scientific Literacy of Grade 11 Students in Plant Growth and Development. *Journal of Science Learning,* 2(1), 14-20. https://doi.org/10.17509/jsl.v2i1.11997

Chan, Z.C.Y. (2013). A systematic review of creative thinking/creativity in nursing education. *Nurse Education Today,* 33(11), 1382-1387. https://doi.org/10.1016/j.nedt.2012.09.005

Chang, C.Y. (2010). Does Problem Solving = Prior Knowledge + Reasoning Skills in Earth Science? An Exploratory Study. *Research in Science Education*, 40, 103-116. https://doi.org/10.1007/s11165-008-9102-0

Cheng, M.Y.V (2011). Infusing creativity into Eastern classroom: Evaluations from students perspectives. *Journal of Thinking Skills and Creativity*,6, 67-87. https://doi.org/10.1016/j.tsc.2010.05.001

Chia, L.W., & Goh, C.C.M. (2016). Teachers' Perceptions, Experience, and Learning. *Asia Pacific Journal of Education*, 36(S1), 1-4. https://doi.org/10.1080/02188791.2016.1141464

Chowdhury, M.A. (2016). Gifted education in science and chemistry: Perspectives and insights into teaching, pedagogies, assessments, and psychosocial skills development. *Journal for the Education of Gifted Young Scientists,* 4(1), 53-66. https://doi.org/10.17478/JEGYS.2018116581

Christiyoda, S. (2016). Pengembangan Modul Berbasis Kemampuan Pemecahan Masalah pada Materi Sistem Ekskresi untuk Meningkatkan Berpikir Kritis. *Jurnal Inkuiri*, 5(1), 74-84.

Cigdemoglu, C. (2015). Improving Students' Chemical Literacy Level on Thermochemical and Thermodynamics Concepts through Context-Based Approach. *Chemistry Education Research and Practice,* 16, 302-317. https://doi.org/10.1039/C5RP00007F

Crebert, G., Patrick, C.J., Cragnolini, V., Smith, C., Worsfold, K., & Webb, F. (2011). *Ethical behaviour and social responsibility toolkit.* Griffith University.

Creswell, J.W., & Clark, V.L.P. (2011). *Designing and Conducting Mixed Research Methods*. Thousand Oaks, California: SAGE.

Crilly, N. (2015). Fixation and creativity in concept development: The attitudes and practices of expert designers. *Design Studies*, 38: 54-91. https://doi.org/10.1016/j.destud.2015.01.002

Cropley, A.J. (1997). Fostering creativity in the classroom: General principles. In Runco, M.A. (Ed.), *The creativity research handbook* (83-114). Creskill, NJ: Hampton Press.

Daud, M.A., Turiman, P., Omar, J., & Osman, K., (2012). Creativity in Science Education. *Procedia - Social and Behavioral Sciences*, 59, 467-474. https://doi.org/10.1016/j.sbspro.2012.09.302

Davidovitch, N., & Milgram, R.M. (2006). Creative Thinking as a Predictor of Teacher Effectiveness in Higher Education. *Creativity Research Journal*, 18(3), 385-390. https://doi.org/10.1207/s15326934crj1803_12

Dinica, M., Dinescu, L., Miron, C., & Barna, E.S. (2014). Formative Values of Problem Solving Training in Physics. *Romanian Reports in Physics,* 66(4), 1269-1284.

Dixon, R.A., & Brown, R.A. (2012). Transfer of learning: Connecting concepts during problem solving. *Jounal of Technology Education,* 24 (I), 2-17. https://doi.org/10.21061/jte.v24i1.a.1

Dogru, M. (2008). The Application of Problem Solving Method on Science Teacher Trainees. *Journal of Environmental & Science Education*, 3(1), 9-18.

Duff, M.C., Kurczek, J., Rubin, R., Cohen, N.J., & Tranel, D. (2013). Hippocampal amnesia disrupts creative thinking. *Hippocampus*, 23, 1143-1149. https://doi.org/10.1002/hipo.22208

Falah, C.M.N., Windyariani, S., & Suhendar (2018). Peningkatan Kemampuan Berpikir Kritis Peserta Didik Melalui Model Pembelajaran Search, Solve, Create, And Share (Sscs) Berbasis Ethnosains. *Didaktika Biologi,* 2(1), 25-33.

Fasasi, R.A. (2017). Effect of ethnoscience instruction, school location, and parental education status on learners' attitude towards science. *International Journal of Science Education,* 3(5), 548-564. https://doi.org/10.1080/09500693.2017.1296599

Febu, R., Sudarmin, Sumarni, W., & Nuswowati, M. (2017). Development of Ethnoscience Approach in The Module Theme Substance Additives to Improve the Cognitive Learning Outcome and Student's entrepreneurship. *Journal of Physics Conference Series*, 824(1), 012024. https://doi.org/10.1088/1742-6596/824/1/012024

Fuad, Z., Misbah, M., Hartini, S., & Zainuddin, Z. (2018). Identifikasi kearifan lokal Kalimantan Selatan sebagai sumber belajar fisika kelas X. In *Seminar Nasional Pendidikan Banjarmasin* (158-169). Banjarmasin.

Gamal, A.N.Z., & Mahalle, S. (2012). Innovation and Creativity in Teaching Islamic Religious Knowlege (IRK) at Secondary Schools in Brunei Darussalam. *International Journal of Arts & Sciences,* 5(5), 239-252.

Ghofur, A., & Raharjo, B.N.R. (2018). Peningkatan Kemampuan Berpikir Kritis Mahasiswa Melalui Pendekatan 5E dan SETS Berbantu Aplikasi Media Sosial. *JINoP (Jurnal Inovasi Pembelajaran)*, 4(2), 102-112. https://doi.org/10.22219/jinop.v4i2.6678

Greiff, S., Stadler, M., Sonnleitner, P., Wolff, C., & Martin, R. (2015). Sometimes less is more: Comparing the validity ofcomplex problem solving measures. *Intelligence,* 50, 100-113. https://doi.org/10.1016/j.intell.2015.02.007

Guo, L. (2014). Preparing Teachers to Educate for 21st Century Global Citizenship: Envisioning and Enacting. *Journal of Global Citizenship & Equity Education*, 4(1), 1-23.

Hake, R. (1998). Interactive-Engagement Versus Traditional Methods: Asix Thousand-Student Survey of Mechanics Test Data for Introductory Physics Courses. *American Journal of Physics*, 66(1), 64-74. https://doi.org/10.1119/1.18809

Heller, P., & Heller, K. (2010). *Problem solving labs, in cooperative group problem solving in physics. Research Report.* Departement of Physics University of Minnesota.

Hendrix, R., Eick, C., & Shannon, D. (2012). The integration of creative drama in an inquiry-based elementary program: The effect on student attitude and conceptual learning. *Journal of Science Teacher Education*, 23(7), 823-846. https://doi.org/10.1007/s10972-012-9292-1

Hervina-Emzulia, M. (2014). Pengaruh Penerapan Model Pembelajaran Guided Discovery dengan Mengintegrasikan Ayat-ayat Al-Qur'an Terhadap Prestasi Belajar Siswa Kelas XI di SMA Muhammadiyah 2 Surabaya. *Jurnal Inovasi Pendidikan Fisika,* 3(2), 110.

Holbrook, J., & Rannikmae, M. (2009). The Meaning of Scientific Literacy. *International Journal of Environmental & Science Education*, 4(3), 275-288

Hosseini, A.S., & Watt, A.P. (2010). The effect of a teacher professional development in facilitating students' creativity. *Educational Research and Review*, 5(8), 432- 438.

Istiyono, E., Dwandaru, W.B., & Rahayu, F. (2018). Pengembangan Tes Creative Thinking Skills Fisika Sma (Physcrethots) Berdasarkan Teori Tes Modern. *Jurnal Cakrawala Pendidikan*, 37(2), 190-200. https://doi.org/10.21831/cp.v37i2.19233

Istiyono, E, Mustakim, S.S., Widihastuti, W., Suranto, S., & Mukti, T.S. (2019). Measurement Of Physics Problem-Solving Skills In Female And Male Students By Physteproos. *Jurnal Pendidikan IPA Indonesia*, 8(2), 170-176. https://doi.org/10.15294/jpii.v8i2.17640

Jonassen, D. (2011). Supporting Problem Solving in PBL. *Interdisciplinary Journal of Problem-Based Learning*, 5(2), 95-119. https://doi.org/10.7771/1541-5015.1256

Joseph, M.R. (2010). Etnhoscience and problem of method in the social scientific study of religion. *Oxfordjournal.* 39(3), 241-249. https://doi.org/10.2307/3710444

Karatas, I., & Baki, A. (2013). The Effect of Learning Environments Based On Problem Solving On Students' Achievements Of Problem Solving. *Journal of Elementary Education*, 5(3), 249-268.

Keeves, J.P., & Master, G.N. (1999). Introduction. In Masters, G.N., & Keeves, J.P. (Eds.), *Advances in measurement in education research and assess-ment*. Amsterdam: Pergamon, An imprint of Elsevier Science. https://doi.org/10.1016/B978-008043348-6/50001-2

Khasanah, N. (2018). Memberdayakan Hight Order Thinking Skills (Hots) Melaui Model Discovery Based Unity Of Sciences (DBUS). *Jurnal Phenomenon*, 8(2), 215-224. https://doi.org/10.21580/phen.2018.8.2.2944

Khoiri, A., & Haryanto, S. (2018). The 21St Century Science Skills Profile Based Local Wisdom Education (Tourist Attractions and Typical Foods in Regency of Wonosobo). *Jurnal Penelitian dan Pengabdian Kepada Masyarakat UNSIQ*, 5(3), 361-371. https://doi.org/10.32699/ppkm.v5i3.485

Khoiri, A., Kahar, M.S., & Indrawati, R.T. (2018). Ethnoscience Approach in Cooperative Academic Education Programs (COOP). *Journal of Physics: Conference Series*, 1114(1). https://doi.org/10.1088/1742-6596/1114/1/012018

Kitot, A.K.A., Ahmad, A.R., & Seman, A.A. (2010). The effectiveness of inquiry teaching in enhancing students' critical thinking. In *Procedia - Social and Behavioral Sciences* (7, 264-273). Elsevier Ltd. https://doi.org/10.1016/j.sbspro.2010.10.037

Kuenzi, J. (2008). *Science, technology, engineering, and mathematics (STEM) education: Background, federal policy, and legislative action.* CRS Report for Congress.

Kutlu, N., & Gökdere, M. (2015). The Effect of Purdue Model Based Science Teaching on Creative Thinking. *International Journal of Education and Research,* 3(3), 589-599.

Latifah, S. (2014). Implementasi Pembelajaran Bervisi SETS di Sekolah. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni,* 3(1), 27-38. https://doi.org/10.24042/jpifalbiruni.v3i1.63

Lau, K.C. (2013). Impact of a SETS high school biology course on the scientific literacy of hongkong students. *Asia Pasific Forum on Science Learning and Teaching*, 14(1), 1-25.

Livne, N.L. (2008). *Enhancing Mathematical Creativity through Multiple Solution to Open-Ended Problems*. Available at: http://www.iste.org/Content/NavigationMenu/Research/NECC_Re/Livne.pdf

Lotter, C., Singer, J., & Godley, J. (2009). The influence of repeated teaching and reflection on preservice teachers' views of inquiry and nature of science. *Journal of Science Teacher Education,* 20, 553-582. https://doi.org/10.1007/s10972-009-9144-9

Mansour, N. (2010). The impact of the knowledge and beliefs of Egyptian science teachers in integrating an STS based curriculum. *Journal of Science Teacher Education*, 21(4), 513-534. https://doi.org/10.1007/s10972-010-9193-0

Matthew, B.M., & Kenneth, I.O. (2013). A study on the effects of guided inquiry teaching method on students achievement in logic. *International Researcher,* 2(1), 133-140.

Mauke, M., & Sadia, I.W. (2013). Pengaruh Model Contextual Teaching and Learning Terhadap Pemahaman Konsep dan Kemampuan Pemecahan Masalah dalam Pembelajaran IPA-Fisika di MTs Negeri Negara. *Jurnal Pendidikan IPA*, 3(1), 281-293.

Meador, K.S. (2003). Thinking creatively about science. *Journal for the Education of the Gifted,* 26(1), 25-29. https://doi.org/10.4219/gct-2003-93

Middeleton, M., Dupuis, J., & Tang, J. (2012). Classrooms And Culture: The Role Of Context In Shaping Motivation And Identity For Science Learning In Indigenous Adolescents. *International Journal of Science and Mathematics Education*, 11(1), 111-141. https://doi.org/10.1007/s10763-012-9385-5

Miles, M.B, Huberman, A.M., & Saldana, J. (2014). Qualitative Data Analysis, A Methods Sourcebook (3th ed.). USA: Sage Publications.

Newton, D.P., & Newton, L.D. (2009). Some student teachers' conceptions of creativity in school science. *Research in Science & Technological Education* 27(1), 45-60. https://doi.org/10.1080/02635140802658842

Nieto, C., & Booth, M.(2010). Cultural Competence and its Influence on the Teaching and Learning of International Students. *Journal of Studies in International Education*, 14(4), 406-425. https://doi.org/10.1177/1028315309337929

Novia, Nurjannah, & Kamaluddin (2015). Penalaran Kausal dan Analogi Berbasis Ethnosains dalam Memecahkan Masalah Fisika. *Prosiding Simposium Nasional Inovasi dan Pembelajaran Sains*, (445-448). Bandung.

Ogawa, M. (2007). Toward a new rationale of science education in a non-western society. *European Journal of Science Education*, 8, 113-119. https://doi.org/10.1080/0140528860800201

Organization for Economic Co-operation and Development (OECD) (2003). *The PISA 2003 assessment framework – mathematics, reading, science and problem solving, knowledge and skills.* Paris: OECD Publishing.

Pedretti, E., & Nazir, J. (2011). Currents in STSE Education: Mapping a Complex Field, 40 Years on. *Science Education*, 95, 601-626. https://doi.org/10.1002/sce.20435

Piirto, J. (2011). Creativity for 21st century skills: *How to embed creativity into the curriculum*. Rotterdam: Sense Publishers. https://doi.org/10.1007/978-94-6091-463-8

Rahmah, S.Z., Mulyani, S., & Masyikuri, M. (2017). Pengembangan Modul Berbasis SETS (Science, Environment, Technology, Society) Terintegrasi Nilai Islam di SMAI Surabaya pada Materi Ikatan Kimia. *Jurnal Pendidikan*, 2(1), 57-62. https://doi.org/10.26740/jp.v2n1.p70-76

Rahmaniati, R., & Supramono (2015). Pembelajaran I-SETS (Islamic, Science, Environment, Technology, and Society) Terhadap Hasil Belajar Siswa. *Anterior Jurnal,* 14(2), 194-200. https://doi.org/10.33084/anterior.v14i2.185

Rahmawati, S., Subali, B., & Sarwi, S. (2019). The Effect of Ethnoscience Based Contextual Learning Toward Students' Learning Activity. Journal of Primary Education, 8(2), 152-160. https://doi.org/10.15294/jpe.v8i2.25688

Retno, S.R., & Marlina, D. (2018). Implementasi Sets (Science Environment Technology And Society) Pada Pembelajaran Ipa Sd Berbasis Inquiry Terhadap Berpikir Ilmiah Siswa kelas 4 MI Al-irsyad Madiun, *BIO-PEDAGOGI: Jurnal Pembelajaran Biologi,* 7(2), 54-58. https://doi.org/10.20961/bio-pedagogi.v7i2.27618

Robert, S., MacLin, M.K., & MacLin, O.H. (2010). *Cognitive Psychology.* Indonesian edition.

Rosario, B.I. (2009). Science, Technology, Society and Environment (STSE) Approach in Environmental Science for Nonscience Students in a Local Culture. *Liceo Journal of Higher Education Research Science and Technology Section,* 6(1), 2094-1064.

Rustaman, N.Y. (2012). *Trend Penelitian Pendidikan: Kasus Penilaian Pendidikan Sains. ProsidingSeminar Nasional Pendidikan IPA.* Yogyakarta: FMIPA UNY.

Santiningtyas, K., Prasetyo, A.P.B., & Priyono, B. (2012). Pengaruh Outdoor Learning Berbasis Inkuiri Terhadap Hasil Belajar Materi Ekosistem. *Jurnal Penelitian Pendidikan,* 1(2), 91-98.

Sarwi, S., Ellianawati, E., & Suliyanah, S. (2019). Grounding physics and its learning for building global wisdom in the 21st century, *IOP Conf. Series: Journal of Physics: Conf. Series 1171 (2019) 012001*. https://doi.org/10.1088/1742-6596/1171/1/012001

Sarwi, S., Fauziah, N., & Astuti, B. (2018). The analysis of scientific communications and students' character development through guided inquiry learning. *Journal of Physics: Conf. Series,* 983(1), 012031. https://doi.org/10.1088/1742-6596/983/1/012031

Snyder, L.G., & Snyder, M.J. (2008). Teaching Critical Thinking and Problem Solving Skills. *Delta Pi Epsilon Journal*, 50, 90-99.

Selcuk, G.S., Çalýþkan, S., & Erol, M. (2008). The Effect of Problem Solving Instruction on Physics Achievement, Problem Solvin performance and Strategy Use. *Latin America Journal Physics Education,* 2(3), 151-166.

Şener, N., Türk, C., & Taş, E. (2015). Improving Science Attitude and Creative Thinking through Science Education Project: A Design, Implementation and Assessment. *Journal of Education and Training Studies*, 3(4), 57-67. https://doi.org/10.11114/jets.v3i4.771

Silver, E.A. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. *ZDM-The International Journal on Mathematics Education,* 29, 75-80. https://doi.org/10.1007/s11858-997-0003-x

Snively, G., & Corsiglia (2011). Discovering Indigenous Science: Implications for Science Education. *Science Education*, 85(1), 7-34.

Stanley, W.B., & Brickhouse, N.W. (2001). The Multicultural Question Revisited. *Science Education,* 85(1), 35-48. https://doi.org/10.1002/1098-237X(200101)85:1<35::AID-SCE4>3.0.CO;2-6

Sternberg, R.J. (2003). A Broad View of Intelligence: The Theory of Successful Intelligence. *Consulting Psychology Journal: Practice and Research,* 55(3), 139-154. https://doi.org/10.1037/1061-4087.55.3.139

Subali, B. (2011). Pengukuran Kreativitas Keterampilan Proses Sains Dalam Konteks Assessment For Learning. *Jurnal Cakrawala Pendidikan,* 11(1), 120-144. https://doi.org/10.21831/cp.v1i1.4196

Subali, B., & Suyata, P. (2012). *Pengembangan Item Tes Konvergen dan Divergen: Penyelidikan Reabilitasnya Secara Empiris.* Yogyakarta: Diandara Pustaka Indonesia.

Sudarmin (2014). *Pendidikan Karakter, Ethnosains, dan Kearifan Lokal (Konsep dan Penerapannya dalam Penelitian dan Pembelajaran Sains).* Semarang: CV. Swadaya Manunggal.

Sumarni, W. (2017). *Pembelajaran Kimia Dalam Kehidupan Bebasis Proyek Terintegrasi Ethnosains Bagi Mahasiswa Calon Guru. Disertasi. Tidak dipublikasikan.* Program Pascasarjana Universitas Negeri Semarang.

Supriyadi, Haeruddin, & Nurjannah (2016). Peningkatan kemampuan memecahkan masalah antara model penalaran kausal berbasis Ethnosains dan sains modern. Jurnal Riset dan Kajian Pendidikan Fisika, 3(2), 35-40. https://doi.org/10.12928/jrkpf.v3i2.5142

Susilogati, S., Binadja, A., & Hidayah, FF. (2014). Developing module of practical chemistry physics SETS vision activity to increase science process skills of student teacher. *Greener Journal of Educational Research,* 4(2), 30-35. https://doi.org/10.15580/GJER.2014.2.021914117

Taskın, O. (2014). An exploratory examination of Islamic values in science education: Islamization of science teaching and learning via constructivism. *Cultural Studies of Science Education*, (9), 855-875. https://doi.org/10.1007/s11422-013-9553-0

Torrance, E. P. (1974). *The Torrance Tests of Creative Thinking: Norms-Technical Manual.* Princeton, NJ: Personal Press.

Torrance, E.P. (2006). *Torrance Tests Of Creative Thinking: Technical-norms manual.* Lexington, MA: Personnel Press.

Ulger, K. (2018). The effect of problem-based learning on the creative thinking and critical thinking disposition of students in visual arts education. *Interdisciplinary Journal of Problem-Based Learning*, 12(1), 3-6. https://doi.org/10.7771/1541-5015.1649

Wahyu, Y. (2017). Pembelajaran Ethnosains di Sekolah Dasar, *Jurnal Inovasi Pendidikan Dasar*, 1(2), 140-147.

Wahyudi, N., Verawati, N.S.P., Ayub, S., & Prayog, S. (2018) Development of Inquiry-Creative-Process Learning Modelto Promote Critical Thinking Ability of Physics Prospective Teachers. *Journal of Physics: Conference Series,* 1108, 012005. https://doi.org/10.1088/1742-6596/1108/1/012005

Wahyuni, I.A., Astuti, B., & Yuliati, D. (2017). Bahan Ajar Fisika Berbasis I-SETS (Islamic, Science, Environment, Technology, Society) Terintegrasi Karakter. *Unnes Physics Education Journal,* 6(3), 18-25.

Wati, M., Hartini, S., Misbah, M., & Resy, R. (2017). Pengembangan modul fisika berintegrasi kearifan lokal Hulu Sungai Selatan. *Jurnal Inovasi Dan Pembelajaran Fisika*, 4(2), 157-162.

Worthington, R.L., & Whittaker, T.A. (2006). Scale Development Research: A Content Analysis and Recommendations for Best Practices. *The CounselingPsychologist,* 34, 806-838. https://doi.org/10.1177/0011000006288127

Yalaki, Y. (2016). Improving University Student Science-Technology-Society-Environment Competencies. *International Journal of Progressive Education,* 12(1), 90-98.

Yildirim, N., Kurt, S., & Güneş, L. (2014). Effects Of Inquiry Based Learning Activities On Scientific Process Skills And Academic Achievement Of Preservice Classroom Teachers. *International Journal of Academic Research,* 6(6), 46-54.

Yoruk, N., Morgil, I., & Secken, N. (2009). The effects of science, technology, society and environment (STSE) education on students' career planning. *US-China Education Review*, 6(8), 68-74.

Zoller, U., (2000).Interdisciplinary Systemic Hocs Development The Key for Meaningful STES Oriented Chemical Education. *Chemistry Education: Research and Practice in Europe*, 1(2), 189-200. https://doi.org/10.1039/A9RP90021G

Zoller, U., (2012). Science Education for Global Sustainability: What is necessary for Teaching, Learning and Assessment Strategies? *Journal of Chemical Education*, 89, 297-300. https://doi.org/10.1021/ed300047v

Zulfiani, Z., & Yunistika, R., & Juanengsih, N. (2018). Enhancing Studentsr Higher-Order Thinking Skills Through Guided and Free Inquiry-Based Learning. *Proceedings of the International Conference on Education in Muslim Society (ICEMS).* https://doi.org/10.2991/icems-17.2018.6

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