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The Issue of Air Quality in Socio-Scientific Teaching: Does it Impact 11--13-years-old Students' Informal Reasoning Skills?

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Abstract.
Various land transportations mostly use fossil fuels which produce greenhouse gas emissions. This is a challenge of how to teach the content to elementary school students with a socio-scientific issue approach to the theme of the water quality index. The method used was a pre-experiment with a one-group pretest-posttest design that involved 25 students aged 11–13 at one of the private schools in Bandung. The instrument used was questions of reasoning skills that asked students argumentation. Students' reasoning skills are analyzed and classified based on the quality of their answers. The results showed that thematic teaching strategies with socio-scientific issues were able to improve the quality of students' reasoning skills. Students' answers were not only dominated by claims but also provided with data and evidence even though they were not found in large numbers. In the opinion of students, the packaging of thematic teaching through scientific issues on the theme of water quality index was able to attract their attention. This indicates that increasing reasoning skills can be improved by infusing socio-scientific issues into teaching themes.

Keywords: socio-scientific issue, water quality index, reasoning skills.

1. INTRODUCTION

The high mobility of people cause the significant increase in greenhouse gas emissions due to high consumption of fossil fuels, especially motor vehicles [1, 2]. Increased consumption of fossil fuels has an impact on air quality which causes various health problems, one of which is related to the number of healthy babies born [3–6]. These conditions should be stopped by giving an understanding through scientific education in science classroom. Therefore, teaching cases related to air quality issues must be taught to school students aged 11-13 years to foster sustainable awareness related to environmental topic [7, 8].

This condition shows the needs of science learning process in the classroom that must encourage students to combine knowledge from all disciplines to advance understanding and action related to sustainable development issues in education (ESD=Educational for Sustainable Development) [9]. ESD is a means to transfer knowledge, values, and skills as well as develop human capacity related to sustainability issues so that they can determine how to sustain their life. It should be underlined that ESD contains characteristics, namely the creation of an awareness, local and global vision, learn to be responsible, learning to change, participation, lifelong learning, critical thinking, systemic approach and understanding complexity, decision-making, interdisciplinarity, problem-solving, satisfying the needs of the present without compromising future generation[10].

The results showed that ESD could indeed have an impact on student learning outcomes as well as in terms of their awareness of sustainability. The results reveal the key role of ESD is to pave the way for a better sustainable future [11]. One approach that can be used is through socio-scientific issues that are able to present factual problems into everyday contexts that can be understood not only by people with special expertise in the field of science but also by elementary school students. This approach is able to improve the fundamental concept of science and even the informal reasoning skills of students at various levels of education [12–15].

The current conditions compel people to give a better understanding through scientific education, one of them is on science education. The science learning through socio scientific approach is expected to build and increase students' understanding of science concept and their informal reasoning. Therefore, the purpose of this study was to observe the effect of teaching socio scientific approach to informal reasoning skills of twenty-five students aged 11-13 years in Bandung.

2. RESEARCH METHOD

The method used was a pre-experiment with a one-group pretest - posttest design [16]. The study involved twenty-five students aged 11-13 in the Bandung, West Java who were selected by purposive sampling technique. They have science and environmental education class in the school. The instrument was a scientific informal reasoning test that collects students' argumentative skills regarding air quality adapted from air pollution problems that was modified from Sukardi et al [17]. Scientific argumentation is a form of reasoning skills.

There were two questions on the test. The first indicator was understanding and analysing the process of filtering and managing the factory haze. The second indicator was understanding and analysing the composition of motor vehicle fuel then choosing the better fuel among them. All of questions require students' answer on a form of claim and strengthen the answer with data, warrant, backing, or qualifier even rebuttal if it's needed. The first question was asking students opinion which one was the better, building a tall chimney or using chemical filter to minimize the air pollution. The second question was asking students opinion which one was better fuel brand, using pertamax or pertalite.

Students' arguments were analyzed based on the existence of the argument components, then classified them based on their quality. The rubric used was the Sukardi rubric [17]. Students' answers are classified based on the completeness of their arguments. Then compare the students' answers before and after learning. The first level was the answer only contains a simple claim, the second level was the answer that only contains claim and data, and/or there is a warrant, the third level was the answer that only contains claim, data, warrant, and backing/qualifier/rebuttal. The fourth level was the answer that only contains claim, data, warrant, backing, and qualifier/rebuttal, and the fifth level was the answers that contains claim, data, warrant, backing, qualifier, and rebuttal. Those data were analyzed using SPSS ver.26 to earn many findings and interpretations. Unstructured interview was done to get clear findings.

3. RESULT AND DISCUSSION

The results showed that most of the students' informal reasoning skills are at level 1 because they only contain simple arguments before the implementation of the learning with socio scientific approach. For example, one of student answer that he choose pertamax turbo as his vehicle fuel. His answer was only a claim. After the class, there

were increase of students' informal reasoning skills from 1st level to 2nd level even 3rd level. For example, one of student choose pertamax turbo (claim) because pertamax turbo has a higher octanes number than pertalite (data) so that less carbon dioxide is emitted. He suggested to take a look at the colour (warrant). Another student will use a filter in the chimney (claim) because it is able to filter dust and absorb black gases (data). Besides that, he believed that the chemical filter can absorb the odor from the haze.

The N-Gain test were conducted to interpretate the statistical data by using SPSS ver. 26. Table 1 showed that the average N-Gain of first indicator was under 50 % (23.96%). The N-Gain of second indicator was also under 50% (26.64%). The interpretation showed that teaching air quality with socio scientific issue was less effective to increase students' informal reasoning skills because they were under 50%.

Although the statistical data claimed the learning process was less effective but the increase of students' informal reasoning showed the good signal in thinking skills. They were directed not only to have environmental awareness but also the skills to analyse the problems by giving the scientific argument. The students were not usually taught the skills in the past. The interview showed that students felt more confident after the learning because they could support their argumentation with more reasons.

This increase argument components were caused by several things, the first was the socio-scientific issue made environmental problems easier to understand because it was presented in simple scientific perspective. Knowing and understanding the issue of air quality even the pollution could be mastered by everyone from various educational backgrounds [14]. In learning with a socio-scientific approach, students must be equipped with various initial knowledge related to fundamental science concepts. This can be achieved by asking questions before learning. These questions can also be given through the online platform [18, 19]. In addition, the use of real problems was one of the important things in teaching and building students' informal reasoning through argumentation[20].

The less of arguments component did not show that the thinking skills of students were low category but the interviews showed they need more reading. Therefore, the steps of learning should accommodate the needs of students to gain more information and knowledges. One of students said that he needs a set of questions that should be mastered to be able to deliver argumentations. When students are googling and seeking information, they find more information and knowledges more that planned previously. They were called unintended knowledges. Delivering a set of questions before learning is one of good strategy to support the development of informal reasoning skills.

TABLE 1: The N-Gain test.

Descriptive					
	Indicator			Statistic	Std. Error
N-Gain_Percent	Indicator 1	Mean		23.9600	2.93398
		95% Confidence Interval for Mean	Lower Bound	17.9046	
			Upper Bound	30.0154	
		5% Trimmed Mean		23.8444	
		Median		25.0000	
		Variance		215.207	
		Std. Deviation		14.66992	
		Minimum		.00	
		Maximum		50.00	
		Range		50.00	
		Interquartile Range		4.00	
		Skewness		-.195	.464
		Kurtosis		.107	.902
	Indicator 2	Mean		26.6400	3.39994
		95% Confidence Interval for Mean	Lower Bound	19.6229	
			Upper Bound	33.6571	
		5% Trimmed Mean		26.8222	
		Median		25.0000	
		Variance		288.990	
		Std. Deviation		16.99971	
		Minimum		.00	
		Maximum		50.00	
		Range		50.00	
		Interquartile Range		16.50	
		Skewness		-.162	.464
		Kurtosis		-.654	.902

4. CONCLUSION

The results showed that the teaching strategy with socio-scientific issues was able to improve the quality of students' informal reasoning skills. Students equipped the arguments with other complements. There were the level changing of reasoning skills from 1st level to 2nd level even 3rd level. Although the statistical data showed it was less effective, but it helped students to develop their thinking skills. They also need more reading to equip their argumentation to reach higher level. This indicates that

the socio-scientific issue is still needed because it attracts students' attention so the increasing reasoning skills can be improved by infusing socio-scientific issues into teaching themes.

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