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IMPROVING UNDERGRADUATE SCIENCE EDUCATION STUDENTS' ARGUMENTATION SKILLS THROUGH DEBATES ON SOCIOSCIENTIFIC ISSUES

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ABSTRACT

This research aims to examine undergraduate students' argumentation skills during and after the learning process in the classroom setting and their responses toward the implementation of socioscientific issues (SSI) through debate in the learning process. This research involved 32 undergraduate students and implemented design-based research with pretest and posttest in a natural classroom setting using three topics of SSI debate that widely discussed in Indonesia: Nuclear Powerplant (Topic 1), Food Preservation (Topic 2), and Genetically Modified Organism (Topic 3). Data was collected using observation sheets, tests, and questionnaires. Observation is to measure argumentation ability when applying the debate method in class settings, the test measures the improvement of argumentation skills, and questionnaires measure students' responses to the application of the debate method. In this study, argumentation scores were obtained from six indicators and divided by a maximum score of 24 times 100. Normalized gain (N-gain) was calculated to determine the effectiveness of the intervention in the classroom. T-test was also conducted to test the significance of the differences in the pretest and posttest results on argumentation skills. The results obtained in this study are: the argumentation skills score during the learning process for six groups were 95, 80.6, 90.3, 95, 83.3, and 77.5; the mean score of pretest and posttest were 52.22 ± 6.62 and 85.78 ± 4.72. The consistency of opinions shows the change from "agree" to "disagree" for Topics 1 and 3. The undergraduate students agree and consistently agree toward Topic 2. The paired t-test result also shows that the intervention statistically has a significant difference between the two means, indicating that the undergraduate students' argumentation skills are better than before the intervention. Otherwise, most of the undergraduate students respond positively toward the implementation of the debate related to SSI. Despite some limitations, the debate on SSI can improve argumentation skills in classroom settings, especially in science education majors.

Keywords: debate method; socioscientific issues; argumentation skills

INTRODUCTION

Science teachers' mastery of content knowledge is vital for assessing contemporary issues in the community's conversation topic. Science content knowledge is also associated with scientific inquiry because it includes subject matter knowledge and science process skills (Ling & Lim, 2014).

Science learning must also provide space to create a democracy that provides freedom to students to use their knowledge of scientific content, discuss, and maintain opinions with peers (Nielsen, 2012; Dawson & Carson, 2017). Science learning must also be part of people's lives, taking place in various settings that involve students and community members in activities that are beneficial to their lives (Genisa et al., 2020). Based on the importance of contemporary issues in the community, democracy, and scientific contents, it

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is necessary to incorporate socioscientific issues (SSI) that emerge in the society in learning science so that students have knowledge related to these problems. Evagorou et al. (2012, in Espeja & Lagaron, 2015) said that the Socioscientific issues (SSI) are socially controversial (or socially alive) topics or issues which have a scientific component and often include other disciplines and interests (political, economic, ethical, etc.) and which involve the evaluation of moral and ethical aspects. In addition, learning using SSI can also motivate and encourage critical thinking in students (Solbes et al., 2018).

However, the current condition of the learning process at the graduate level in Indonesia is influenced mainly by the Confucian learning cultures based on memorizing material or teacher-centered traditional approaches as a learning resource. The Confucian learning cultures are primarily found in East Asia countries like Taiwan (Huang & Asghar, 2018). Emphasizing memorizing material in learning is also found in Indonesia's primary and secondary school levels (Prayitno et al., 2017). Likewise, in the science education study program, although learning has been designed to give students the freedom to express their opinion, only a few students use the opportunity to ask questions about studied material, argue the things discussed, agree or disagree about a statement. Based on the Huang & Asghar (2018) and Prayitno et al. (2017) studies, the low students' participation is caused by the learning method used that does not require all students to learn. Therefore, we need a suitable method to carry out a lesson.

For SSI-based learning, students are required to argue. The term argument, in general, is described as a conflicting discussion or dialogue. Scientific argumentation is a complex disciplinary practice in which individuals engage in examination, critique, and revision of claims about content (Lobczowski et al., 2020). Argumentation includes the presentation of a claim about a scientific phenomenon that is backed with evidence and reasoning (Lobczowski et al., 2020). One method to improve undergraduate students' argumentation skills is the debate method. Class debate is a systematic teaching method that has the potential to foster active student engagement. Using classroom debate as a teaching method brings many advantages for students, which include critical thinking skills, mastering material content and improving communication skills (Zare & Othman, 2013). Currently, there is little data on the use of the debate method to improve the argumentation skills of science student teachers related to SSI, especially in Indonesia. Previous research has shown that debate will enable students to master content and advance scientific thinking and communication skills (Zare & Othman, 2013). The use of debate methods in the educational process of science student teachers would theoretically be constructive in analyzing students' content knowledge related to concepts, laws, principles, and theories that apply in science and are also associated with popular SSI. The debate methods in SSI are supported by the SSI and Model-based Learning (SIMBL) framework (Sadler et al., 2019; Ke et al., 2020). This framework encourages the students to explore, engange in SSI thinking (debate) toward a particular issue, and synthesize both social and scientific aspects from the SSI.

Socioscientific Issues (SSI), the emphasis in the debate, were three viral issues on Indonesian social media today: (a) construction of nuclear power plants (NPP); (b) food preservation; and (c) genetically modified organism (GMO). These three problems are expected to motivate science student teachers to discuss and learn to build arguments during lectures actively. The active participation within and across the team will also help them to understand comprehensively. All the students' arguments in the pro team and contra team were recorded, and the pattern of thinking then was analyzed whether it gets an increase or not. The implementation of the debate method starts with all students preparing materials according to the topic of their assignment. For each topic, two groups were prepared as a pro-team and contra-team. Furthermore, each team was assessed for readiness and mastery of the topic (argument ability) by conducting a debate between the two teams (pro-contra) in a class setting. By implementing the SSI debate method, students will have the insight to participate in solving problems in society with the right attitude and reasoning.

Aslan (2019), in his research results, shows that argument-based and scenario-based learning methods significantly influence students' academic performance. In agreement with the previous research, the researcher considers it necessary to train the students' argumentation skills to contribute to decision-making related to sociological-related issues. The meaning of students' argumentation skills is that generating and evaluating sound arguments has received increasing recognition as fundamental to good thinking (Mercier, 2011; Sari & El Islami, 2020).

Research conducted by Kapici & Ilhan (2016) regarding the attitudes and views of student teachers on the nuclear power plant shows

that while student teachers want to investigate more about SSI, they have doubts about religion, morals, and ethics. Both groups of student teachers have some general perspectives about the nuclear power plant, and both groups do not have a more positive perspective of the need for the nuclear power plant in their countries. Food preservation is also a challenge for the agro-food industry, politics, hunger, and malnutrition (Wu et al., 2014). Food preservation is a multi-process and involves a vast technology from traditional technology (food recipe and traditional herbal) to modern technology with the application of atomic radiation (Zachmann, 2011; Havard, 2019). Food preservation and food availability are also associated with Genetically Modified Organisms (GMO, which are concerned with public controversy and labeling caused by genetic engineering and the impact of GMO on the environment and human health (Nep & O'Doherty, 2013; Olalekan, 2019). GMO also impacts public food framing from multiple sources that cause misconceptions on scientific and social-economy aspects (Sarah et al., 2019; Zahry & Besley, 2019).

The undergraduate science education students are familiar with the three topics related to SSI in their future careers as science teachers. SSI in science education can contribute to promoting citizenship through personally responsible and participatory reflection to support the development of desirable citizens (Chowdhury et al. 2020). SSI can also help students be ready and carry out their roles as active citizens in a democratic society. Therefore, as active citizens, students need the skills of critical thinking and decision-making. Socio-scientific issues (SSI) context is suitable for students to actively debate about complex social issues related to science (Christenson & Rundgren, 2015). Socioscientific arguments, like scientific arguments, involve evaluating evidence. It also involves the conceptualization of the nature of science and how scientific value plays a role in judgment making. From the previous study results, we also wanted to find out what the undergraduate science education students thought about the need for nuclear power plants in Indonesia and the controversy on food preservation and GMOs. By implementing the debate method in the classroom setting by raising the SSI related to the nuclear power plant, food preservation, and GMO, we aim to improve the undergraduate students' argumentation skills by giving opinions on the three issues debated in the classroom setting.

Based on the argumentation above, the main research problem of this study was, "how is the effectiveness of the SSI debate method to improve undergraduate students' argumentation skills?". The problem is detailed into three questions: how are undergraduate students' argumentation skills during the learning process in the classroom setting?; how are undergraduate students' argumentation skills after the implementation of the debate method in the classroom setting?; how are the responses of undergraduate students to the implementation of the SSI debate in the classroom setting?

METHODS

This study uses a one-group pretest and posttest design, which aims to improve the argumentation skills of undergraduate students through SSI debates. In this study, three data were collected: (1) score of the undergraduate students' argumentation skills during the learning process in the classroom setting obtained through observation; (2) score of the undergraduate students' argumentation skills after the classroom setting, obtained through the pre-/post-test; and (3) the undergraduate students' responses to the implementation of the SSI debate method in the classroom. The SSI debate method is carried out in the Basic Science Course in the Department of Natural Sciences at one of the public universities in Indonesia. The procedures for applying the debate method in the classroom are: (1) determining topics related to three main issues (NPP, food preservation, and GMO); (2) debate format; (3) debate rules; (4) providing additional information; and (5) assessment or evaluation.

The subject/participant of this research was the 32 undergraduate students (science student teachers) from the Basic Science Course in the Academic Year of 2018/2019. The instruments of data collection used in this research were observation forms, tests, and questionnaires. The tests have tested the validity and reliability. The validity of the test is based on a rating from three subject matter experts. The reliability of the tests is also good (α = 0.72). Observations were carried out to measure the undergraduate students' argumentation skills when implementing the debate method in the classroom setting. The scoring for argumentation indicators and skills is based on criteria in Table 1 adapted from The Great Chemistry Debate Description of Project (n.d.).

In this research, we used the rubric provided by The Great Chemistry Debate Description of Project (n.d.). The observation technique and instrument were also used to assess the undergraduate students' performance when implementing the debate method. During the intervention, three observers were involved and recorded their observations in the instruments. The overall inter-rater reliability from the observers was 0.85, indicating that the observers' observation is reliable.

Table 1. Indicators and Score for Argumentation

No.	Indicator(s)	Maximum Score
1	Organization and clarity	4
2	Understanding of topics	4
3	Use of arguments	4
4	Use of examples/references/ scientific facts/statistic	4
5	Use of rebuttal	4
6	Presentation style	4
	Total	24

There are several steps in the learning process in the classroom setting. The first is determining the topic. Three topics established are nuclear powerplant, food preservation, and GMO. The second is debate format, establish affirmative and negative (pro- and contra-team). There are two sides (teams) in every debate in the classroom setting. Naturally, one team will argue, and the other team opposes the resolution. The groups will argue for the problem presented. Followed by debate rules, each group had the opportunity to submit their arguments related to their assignment topic within ten minutes. They were starting from the pro-team and then the contra-team. The next is providing additional information. After the pro and contra team delivered their narratives, the activity continued with arguing. To strengthen their argument, each team can provide supporting facts. The last is assessment or evaluation. Each group was assessed for performance using the assessment rubric. The undergraduate students' argumentation skills related to SSI were evaluated by pre-/post-test. Students are asked to describe related issues and provide opinions and reasons with supporting evidence or information in this test.

The test covers three issues: (1) Does Indonesia need a nuclear power plant?; (2) Addition of food preservatives: do we need them?; (3) Do we need food that comes from GMOs: Should we go there?. The assessment of the test results includes: (1) statement of agreement/disagreement; (2) reason writing; (3) writing evidence that supports the reasons. Indicators of success are achieved when students get a test score $\geq$ of 75 (good criteria) adopted from the study conducted by Foutz (2018).

In this study, data were analyzed using indicator and argumentation scores in Table 1. University student scores can be calculated by formula. The six-component scores are added up and divided by a maximum score of 24, multiplied by 100. Normalized gain (N-gain) is calculated to know the effectiveness of the intervention in the classroom according to the Hake formula. The t-test was also conducted to examine the significance of differences between pretest dan posttest results on the argumentation skills.

RESULTS AND DISCUSSION

From this study, three data were obtained: (1) score of the undergraduate students' argumentation skills during the learning process in the classroom setting obtained through observation; (2) score of the undergraduate students' argumentation skills after the classroom setting, obtained through the pre-/post-test; and (3) the undergraduate students' responses related to the intervention in the classroom setting. Each result section can be described in the following: first, the undergraduate students' argumentation skills during the learning process in the classroom setting. The undergraduate students were divided into six groups. Each group discussed the same topic, and the two groups were designated as pro-team and others as contra-team. Both groups debate the same topic. Both teams had the same argumentation score for the nuclear power plant topic, but for the food preservation topic, contra-teams had better scores than pro-team and vice versa for GMO topics. The results of the assessment through observation on each topic showed in Figure 1.

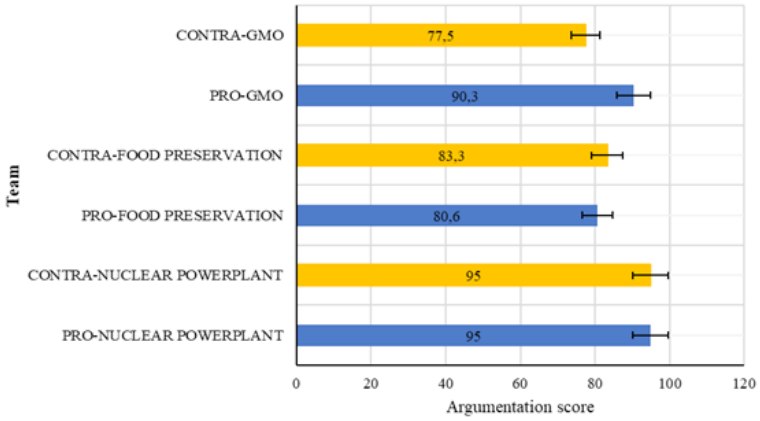

Figure 1. Average Argumentation Score of Both Teams on Each Topic (error bar: 5%)

Second, the undergraduate students' argumentation skills after the implementation debate method in a classroom setting. The undergraduate students' argumentation skills were also obtained through tests before and after implementing the debate method. Before we analyze the test results, we must know the change in students' opinions during the debates. The debate aimed to explore the undergraduate students' opinions about SSI by giving "agree" or "disagree," supported by reasons and evidence to strengthen these opinions. The changes of the students' opinion classified into four groups: (1) Consistently Agree (CA); (2) Consistently Disagree (CD); (3) Inconsistent, Opinions Change from Disagree to Agree (DA); and (4) Inconsistent, Opinions Change from Agree to Disagree (AD). The calculation results were obtained by the percentage of students' opinions for each group, shown in Figure 2.

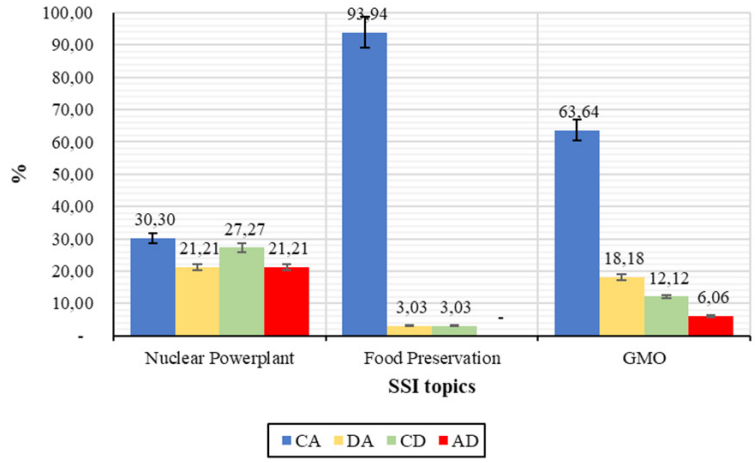

Figure 2. Percentage of the Undergraduate Students' Opinions related to the SSI (error bar: 5%)

Based on Figure 2, for Question 1 (Does Indonesia need a nuclear power plant?), The undergraduate students' opinions are almost equal. The percentage of students who agreed (30.30%) plus the percentage of the undergraduate students who changed their opinions from "disagree" to "agree" (21.21%) giving the total number of students who supported the existence of the nuclear powerplant in Indonesia was 51.51%, and those who did not support there are 48.48%. The percentage is almost balanced because the nuclear power plant issues are new, so caution is needed in expressing opinions. The test results showed that the undergraduate students, who agree and disagree, have given rational reasons supported by some relevant information as evidence. Question 2 (Should food be preserved?) and Question 3 (Are we need the GMO?) showed that almost 80% of the undergraduate students agreed. The undergraduate students only focus on the benefits of food preservation and GMOs rather than the negative impact of the two SSI topics. Rational reasons and some supporting information are given to strengthen this opinion.

The final test results related to the three SSI showed in Table 2. The percentage increase in scores showed 43.75% in the medium category and 56.25% in the high category. The mean score for the pretest was 52.22 ± 6.62, increased to 85.78 ± 4.72 at the posttest.

Table 2. Results of Argumentation Tests for SSI

Subject	Pretest Score (0-100)	Posttest Score (0-100)	N-gain	Category
1	58	84	0.62	Medium
2	54	83	0.63	Medium
3	53	83	0.64	Medium
4	57	81	0.56	Medium
5	54	77	0.50	Medium
6	43	82	0.68	Medium
7	56	89	0.75	High
8	52	91	0.81	High
9	56	94	0.86	High
10	60	89	0.73	High
11	58	93	0.83	High
12	58	92	0.81	High
13	56	88	0.73	High
14	58	92	0.81	High
15	52	88	0.75	High
16	52	84	0.67	Medium
17	54	80	0.57	Medium
18	38	84	0.74	High
19	56	83	0.61	Medium
20	50	86	0.72	High
21	50	83	0.66	Medium
22	52	83	0.65	Medium
23	42	85	0.74	High
24	58	82	0.57	Medium
25	54	94	0.87	High
26	56	77	0.48	Medium
27	58	88	0.71	High
28	56	92	0.82	High
29	34	82	0.73	High
30	52	83	0.65	Medium
31	38	84	0.74	High
32	46	89	0.80	High
Average	52.22	85.78	0.70	High
SD	6.62	4.72	0.10	

Pretest and posttest scores were obtained from students' answers to questions related to three socioscientific issues. Students are asked to describe related issues and provide opinions and reasons with supporting evidence or information in this test. Students did not get a good score during the pretest because they only agreed or disagreed without being given adequate reasons and supporting evidence in giving opinions. After learning by implementing the debate method, students get much new information about the issues being debated and why they should agree or disagree. The pro-contra team, when debating, gave reasons that were supported by several data so that students gained knowledge that they did not know before. This fact is known from the res-

ponses of students who stated that they liked the application of the debate method because it provided much information that they did not know (statements 8, 9, and 10). From the new knowledge gained by students, they use it to answer questions during the posttest so that the students' posttest score increases. Hypothesis testing results H_0: $m_{pre} = m_{post}$ and H_1: $m_{pre} < m_{post}$, with a significance level .05. The results of paired t-test calculations using SPSS are shown in Table 3.

Table 3. Paired t-test Results for the Undergraduate Students' Argumentation skills

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Paired Pretest - Posttest	-33.563	7.030	1.243	-36.097	-31.028	-27.008	31	.000

The significance value (sig) < probability 0.05, so the null hypothesis is rejected. It reveals that the implementation of the SSI debate method can improve undergraduate students' argumentation skills. This is in line with Christenson et al. (2014) through teaching argumentation on four SSI topics, namely global warming, genetically modified organisms (GMOs), nuclear power, and consumer consumption, students are given the best conditions to develop argumentation skills. Therefore, structuring science education to focus on arguments makes students experience science as it is. Argumentation is an epistemic practice in science that involves students in their argumentation (McNeill et al., 2017; Ong et al., 2020).

Third, the undergraduate students' responds to the implementation of debate method related to SSI in the classroom setting. The undergraduate students' responses are captured through the questionnaire form. The questionnaire provides four scales Agree/Disagree format. The omitting of the mid-point is to avoid a dumping ground from the students when they fill the questionnaire (Chyung et al., 2017). The majority of them respond positively to the implementation of the SSI debate method in the classroom. 3.3% of the undergraduate students disagree with the application of the debate method in the classroom. On the nuclear power plant topic, 3.3% also stated that they did not provide much information to them. Overall, they agreed that applying the debate method facilitated the undergraduate students to express ideas and develop their communication skills. The undergraduate students' responses are presented in Table 4.

Table 4. Students' Responses to the Implementation of the Debate Method

	Statement	Response (%)			
		SD	D	A	SA
1	The use of debates is good because we can express your ideas	0	0	35.5	64.5
2	Debates allow us to develop communication skills and learn to argue from two sides of the debate	0	0	51.6	48.4
3	The use of debates is good because we can contribute opinions on debated topics	0	0	51.6	48.4
4	Debates allow individuals to investigate an area, focusing on one side of the debates	0	0	51.6	48.4
5	Debates allow us to hear many opinions on a debate topic, and we can develop our opinions based on the evidence provided	0	0	32.2	67.8
6	I think discussion is far better than reading off slides	0	3,3	35.4	61.3
7	I learned a lot from debates and discussions because everyone was actively involved in their opinions	0	0	29.0	71.0
8	I like the debate related to the nuclear power plant issue because it provides much information that I do not know yet	0	3,3	35.4	61.3
9	I like the debate related to the food preservation issue because itprovides much information that I do not know yet	0	0	48.4	51.6
10	I like the debate related to the GMO issue because it provides much information that I do not know yet	0	0	45.1	54.9

Note: SD = strongly disagree; D = disagree; A = agree; SA = strongly agree (Chyung et al., 2017)

Implementation of the debate method in learning aims to explore and to find answers or solutions. Two or more people give opinions on a topic and exchange ideas to express opinions (Najafi et al., 2016). The debate aims to explore the truth through interactions that significantly impact the mental aspects of the human mind. The debate includes an orderly and directed exchange of concepts and ideas that a group of people can carry out. Before applying the debate method, the undergraduate students were asked to prepare materials related to the specified SSI. The undergraduate students search or study literature to get information according to the topic of their assignment. Through this searching activity, it is expected that students' insights regarding sociological issues will become more comprehensive. Learning science in the context of socio-scientifc issues (SSI) can promote scientifc literacy that links science to everyday life and society (Ke et al., 2021). Scientific literacy requires the capability to debate, describe relevant evidence, and draw conclusions related to SSI. Students' vast insight makes it easy for them to develop debate material and develop opinions based on the evidence obtained— content written by each group of students, taken from one side (pro- or contra-team).

The team that prepares the materials well looks at the implementation of the debate method (Indicator 1: Organization and Clarity) delivers the main arguments clearly and regularly. In indicator 2 (Topic Understanding), the team also showed a deep understanding of the topics for debate. The team communicated information freely without reading it from notes or paper. The situation gives an advantage in scoring because a maximum value of 4 (four) can be obtained. From Table 3, it appears that almost all agree with nuclear powerplant. The team members scored 4 for indicators 1 and 2, showing that the team is excellent. The Pro-team of the nuclear power plant can provide a statement supported by more than one piece of evidence or facts. They agreed that nuclear power plant would be established in Indonesia. Some of the reasons submitted by the Pro-team of the nuclear power plant were: (1) availability of coal fuel is running low, so it needs other energy sources which are used in nuclear reactors such as uranium and plutonium; (2) based on data, only 65% of the people enjoy electricity from the National Electricity Company to become a developed country, the nuclear power plant is needed; (3) accidents due to nuclear powerplant are lower because the safety procedures are strict and multi-layered; and (4) the survey showed the increase of the nuclear powerplant acceptance from the Indonesian people. Besides that, the nuclear powerplant Contra-team also provides a sufficient argumentation supported by the social media opinion. Some of their argumentation were: (1) geographic factors that are prone to earthquakes and tsunamis, so it is not suitable to build the nuclear powerplant; (2) the construction of the nuclear powerplant requires quite expensive costs; and (3) handling residual radioactive waste requires a long and complicated process.

Based on the argumentation from the Pro- and Contra-team on the nuclear powerplant issue, we knew that the argumentation from the Contra-team lacked evidence and concept of substantive related to the current nuclear power plant and nuclear reactor. Today, building a nuclear powerplant with more safety is relatively easy because of the advanced technology engineering with digital systems and the enhanced operational mitigation procedures severe accidents in the nuclear powerplant based on the previous accident (Murata et al., 2016; Singh & Rajput, 2017). The pro-team of the food preservative can provide a statement supported by more than one piece of evidence or facts. They agreed that abundant food commodities and not directly consumed make food preservation essential. With this preservation process, humans can also benefit if they need certain foodstuffs; for example, fruits can always be available outside the harvest season. On the other side, the contra-team of the food preservative argues that preserved food has a low nutritional value; for example, vegetables only have 65% of vitamins and minerals compared to fresh.

On the other hand, the Pro-team of GMO can provide a statement supported by more than one piece of evidence or facts. They agreed that the amount of food is not proportional to the population, making food modifications necessary. On the contrary, the Contra-team of GMO believes that food modification causes a reduction in biodiversity, the monopoly of GMO seeds by capital owners, thus creating a gap between local farmers and capital owners. GMO plants can damage the soil structure due to the use of chemicals.

The SSI debate method in a classroom setting also allows science student teachers to develop their communication skills based on their science content knowledge. The majority of the undergraduate students' argumentation, based on pretest score, lacks scientific evidence according to scientific content knowledge, and their argumentation is relatively different from each other ($SD_{pre\text{-}tets}$ = 6.62). The SSI debate method facilitated the student teachers to be active in the learning process in the natural classroom setting. The undergraduate students were divided into two groups, Pro-/Contra-team. The dynamics process debate in the classroom also shapes their argumentation quality. The SSI topics influence argumentation quality trends in undergraduate students. In the topic of nuclear power plants, the

undergraduate students have a different view on it (see Figure 2), but their argument lacks scientific knowledge on the atom, nuclear reaction, and radioactivity.

On the other hand, the undergraduate students have a standard view on the issues related to food preservation and GMOs. The majority of them agree on food preservation issues. Whereas on the GMO issue relatively agree, but slightly different than the food preservation topic. Based on these facts, the undergraduate students' scientific content knowledge still lacks, and their meta-conceptual understanding is not robust yet. Because of that, their view can change in the debate during the learning process in the classroom setting. Most undergraduate students did not receive a meta-conceptual understanding objective during the lecture, but it is shaped by teleology from the commonsense knowledge and their concept usually developed by interaction in their team and across the team in the classroom (Delgado, 2015; Warfa et al., 2018; Yuliastini et al., 2018). After the implementation of the debate method, we evaluate the undergraduate students' argumentation skills by a posttest. In agreement with the posttest result, the undergraduate students' argumentation tended to have a complete argumentation indicator in their argumentation ($SD_{post\text{-}test}$ = 4.72).

According to the pre-/post-test, the implementation of the debate method related to SSI in the natural classroom setting has a positive impact on the undergraduate students' argumentation skills. The average of science student teachers' N-gain reached the high category, and the paired t-test also showed statistically different argumentation skills. Based on the N-gain and paired t-test results, the debate method related to SSI in the natural classroom setting was effective. The undergraduate students' active participation and responses were positive toward the debate method related to SSI in the classroom. Future additional research will be required to establish an entire picture of the undergraduate students' argumentation from science education major, especially implementing the experimental design with the experiment and control group and replication to examine the effectiveness of the implementation debate method in the natural classroom setting.

CONCLUSION

The implementation of the debate method with SSI on learning in the classroom can help the undergraduate students improve their argumentation skills by giving an opinion (agree or disagree), giving a reason why to agree or disagree, and showing evidence or facts that support the reason. For example, students gave logical arguments when they agreed to build a nuclear power plant in Indonesia. The reason given is that the availability of coal fuel is running low, thus requiring other energy sources such as uranium and plutonium. Students also provide logical arguments when they disagree, such as geographical factors that are prone to earthquakes and tsunamis so that they are not suitable for building nuclear power plants. This research has implications for the undergraduate students' skills to express their ideas or views on the topic, evolve their speaking skills, and study both sides to an argument. The undergraduate students also can hear multiple opinions on one subject and establish their argumentation based on scientific concepts and evidence. The debate method can also help undergraduate students to practice critical thinking skills related to SSI. This research recommends implementing learning by debating other more controversial issues related to science in the natural classroom setting. Besides that, scientific content knowledge is also a fundamental aspect of improving the scientific argumentation quality and making a robust meta-conceptual understanding for undergraduate science education students. The science student teachers can also encourage themselves to promote argumentation learning by implementing debate in the classroom.

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